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Does an Antimicrobial Incision Drape Prevent Intraoperative Contamination? A Randomized Controlled Trial of 1187 Patients

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Abstract

Background The risk of periprosthetic joint infection (PJI), a serious complication after arthroplasty, has not changed for years. Interventions such as eradication of *Staphylococcus aureus* and antibiotic bone cement are used to diminish infection risk but despite these efforts, the percentage of infection in TKA remains constant. Antimicrobial drapes have a dual action, acting both as a physical and antimicrobial barrier to counter bacterial contamination of the surgical wound. To study the effect of antimicrobial drapes, we used intraoperative contamination as a proxy for infection in our investigation.

Questions/purposes (1) Do antimicrobial surgical drapes reduce the risk of intraoperative microbial contamination in patients undergoing primary knee arthroplasty? (2) Are other factors such as sex, season, age, type of arthroplasty and duration of surgery associated with an increased risk

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Each author certifies that his or her institution approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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of contamination in patients undergoing primary knee arthroplasty? (3) Does loosening of the antimicrobial drape increase contamination risk?

Methods An investigator-initiated, two-arm, nonblinded, multicenter, randomized, controlled trial was performed at five different hospitals in the capital and central regions of Denmark. Twenty-four surgeons participated in the study. Participants were patients older than 18 years undergoing primary knee arthroplasty. We excluded patients with an iodine allergy, previous open knee surgery, previous septic arthritis, any antibiotics taken 4 weeks before surgery, and if they were unable to understand the implications of study participation. Patients were randomly assigned to operation with an antimicrobial drape (intervention group) or operation without (control group). We screened 1769 patients, of which 100 were ineligible and 10 declined to participate. In all, 94% (1659 of 1769) of patients consented and were randomized to the intervention group (51%, 838 of 1659) and control group (49%, 821 of 1659), respectively. In all, 36% (603 of 1659) of patients in the intervention group and 35% (584 of 1659) patients in the control group were available for final analysis. No crossover was performed, and analysis was done per-protocol. Patients were excluded due to logistic failures like lack of utensils, samples disappearing en route to the laboratory mainly caused by implementation of a new electronic patient chart (EPIC, Verona, WI, USA), and forgetful surgeons. Intraoperatively, we swabbed for bacteria at the surgical site and in a rinse from the surgeons' gloves. All samples were sent for cultivation, and colony forming units (CFUs) counts ≥ 1 were deemed contaminated. The primary outcome measure was the difference in the proportion of contaminated patients between the two randomized groups. Secondary outcome measures were the affiliation of sex, season, age, type of implant used, and duration of surgery on contamination risk. To investigate whether other factors were affiliated with contamination risk, we did a logistic regression to control for confounding variables, including sex, age, season, type of implant and duration of surgery.

Results Use of iodinated drapes reduced contamination, with contamination detected in 10% (60 of 603) procedures where iodinated drapes were used compared with 15% (90 of 584) when they were not (odds ratio 0.61 [95% CI 0.43 to 0.87]; p = 0.005), with a relative risk reduction of 35% (95% CI 12.3 to 52.5) and a number needed to treat of 18 patients. After controlling for confounding variables such as sex, age, type of implant, and duration of surgery, we found that not using an antimicrobial drape increased contamination risk by a factor of 1.6 (95% CI 1.08 to 2.35; p = 0.02). Female sex and undergoing surgery in the central region were associated with lower odds of contamination (OR 0.55 [95% CI 0.39 to 0.8]; p = 0.002 and OR 0.45 [95% CI 0.25 to 0.8]; p = 0.006, respectively). Patients with more than a 10-mm separation of the drape from the skin had higher odds of contamination (OR 3.54 [95% CI 1.64 to 11.05]; p = 0.0013).

Conclusions The use of an antimicrobial drape resulted in lower contamination risk than operating without an antimicrobial drape. Our findings suggest that antimicrobial drapes are useful in infection prevention, but further studies are needed to investigate the effect of antimicrobial drapes on infection.

Level of Evidence Level I, therapeutic study.

Introduction

Periprosthetic joint infection (PJI) causes severe morbidity and results in heavy costs to the healthcare system [3, 24]. Several interventions are used to try to decrease the frequency of PJI, including decontamination with chlorhexidine, eradication of *Staphylococcus aureus* in carriers, and antibiotic bone cement [1, 17]. Despite these efforts, the PJI risk has remained relatively constant [13, 20]. Although the interplay between bacteria and the immune system in infection pathogenesis is complex, it seems apparent that the prevention of intraoperative contamination would be promising in reducing PJI risk.

Standard techniques, such as the use of preoperative skin antiseptics, reduce surgical field contamination, but even with attentive skin preparation, skin sterilization is impossible. Live microorganisms will remain in the deeper parts of the skin, such as the hair follicles, and appear at the skin surface during surgery, where they may potentially contaminate the surgical field [15].

Iodine-impregnated incision drapes are in common use, with the dual function of providing continuous antimicrobial activity throughout the surgical procedure and physically sealing the skin surface, thereby reducing surgical field contamination [6, 12, 19]. Previously published studies [6, 19] have shown beneficial effects of antimicrobial drapes on contamination, but no study has investigated the effect on the contamination rate compared with no drape in primary arthroplasty surgery [23]. In clean surgery, the infection risk is usually low, but the risk increases when a foreign body is introduced [2]. Foreign bodies promote biofilm formation and affect the local immune system [9], making the infection slow and turning otherwise nonpathogenic bacteria into pathogens.

We therefore asked: (1) Do antimicrobial surgical drapes reduce the risk of intraoperative microbial contamination in patients undergoing primary knee arthroplasty? (2) Are other factors such as sex, season, age, and type of arthroplasty associated with an increased risk of contamination in patients undergoing primary knee arthroplasty? (3) Does loosening of the antimicrobial drape increase contamination risk?

Patients and Methods

Study Design and Setting

We performed an investigator-initiated, non-blinded, two-arm, prospective, multicenter, randomized controlled trial of 1187 patients undergoing primary knee arthroplasty (both total and unicompartmental implants). The study was registered at ClinicalTrials.gov (NCT03139539). The study was performed at five orthopaedic departments at regional university hospitals in two administrative regions of Denmark: the capital region and the central region. One hospital in the central region and four hospitals in the capital region participated and all hospitals are in metropolitan areas. All surgeons received instructions on sampling and the use of antimicrobial drapes before the study was initiated. The samples were processed at two different clinical microbiology departments according to Danish guidelines.

Twenty-four orthopaedic surgeons participated in this study. All perform only lower-limb arthroplasty and all but three surgeons perform knee arthroplasty surgery exclusively. The median number of procedures per surgeon was 103.

Participants

All patients undergoing primary knee arthroplasty were potentially eligible for enrollment. We included patients older than 18 years undergoing primary knee arthroplasty. We excluded patients with an iodine allergy, previous open knee surgery, previous septic arthritis, patients who had taken any antibiotics 4 weeks before surgery, or who were unable to understand the implications of participating in the study, such as, language barriers or psychiatric disorders. We included only one knee per patient. When patients were erroneously included with both knees, we excluded the latter knee from the analysis. All patients received written and oral information before giving written consent.

Between March 1, 2016 and April 13, 2018, 1769 patients were screened, of which 100 were ineligible and 10 declined. In all, 1659 patients consented and were subsequently randomized to either the intervention group (51%, 838 of 1659) or the control group (49%, 821 of 1659). A total of 72% (1187 of 1659) of consented patients were available for final analysis: 36% (603 of 1659) of patients in the intervention group and 35% (584 of 1659) of patients in the control group (Fig. 1).

The main reason patients were lost in this study was due to the implementation of Epic (Verona, WI, USA), which had a large impact on the logistics of the study, making electronic requisition of laboratory work unfeasible. Requisitions had to be done using paper forms. Other factors were lack of utensils, forgetful surgeons, lost consent forms, no postoperative forms and exclusion of the patients' second operated knee (Fig. 1).

Sixty percent (359 of 603) of patients in the intervention group and 61% (355 of 584) in the control group were female, similar to the population in the Danish Knee Arthroplasty Registry [7]. Possible predisposing factors for infection such as skin disease, diabetes, alcohol use, smoking habits, and BMI were recorded. In 9% of the patients (105 of 1187), there was no information on comorbidities, in 24% (288 of 1187) of the patients, there was no record of BMI, and in 3% (38 of 1187) and 3% (35 of 1187) of patients, there was no information on operation time and use of cement, respectively. Six percent of patients had an alcohol intake of above 14 units/week. Lower intake of alcohol was not recorded. In all, 6% of the population reported they were active smokers and the mean weight was 85 kg (Table 1). All data were patient reported. There were no differences in the predisposing factors, age or sex. Operation time was different between the two groups, but only by a minute and thus not clinically important.

Randomization and Masking

Patients were randomized to either the antimicrobial drape group or the control group using a 1:1 randomization ratio stratified by hospital. The randomization was done at the pre-assessment consultation. Patients were randomized by either specially assigned medical students or one of the surgeons, using Procordo (Procordo Software, Copenhagen, Denmark). Patients were told their group allocation on request. Patients who did not receive their allocation (forgetful surgeons or the surgeon not adhering to protocol for other reasons) were excluded from the analysis.

All laboratory personnel who plated the samples and read them were blinded to the randomization. The surgeons did not have access to the microbiological findings so that it would not influence the subsequent treatment of the patients.

Procedures

Patients were instructed to shower preoperatively on the day of the procedure using a normal body wash and no moisturizer afterwards. Local guidelines do not include any preadmission skin or nasal decontamination. Preoperative clipping of the surgical site was used by the center in the central region, while the other centers did not. Prophylactic intravenous antibiotics were administered 30 minutes before skin incision. Either dicloxacillin 2 g or cefuroxime 1.5 g was used as standard, depending on the hospital routine and allergy status of the patient. This information was not recorded by individual patient.

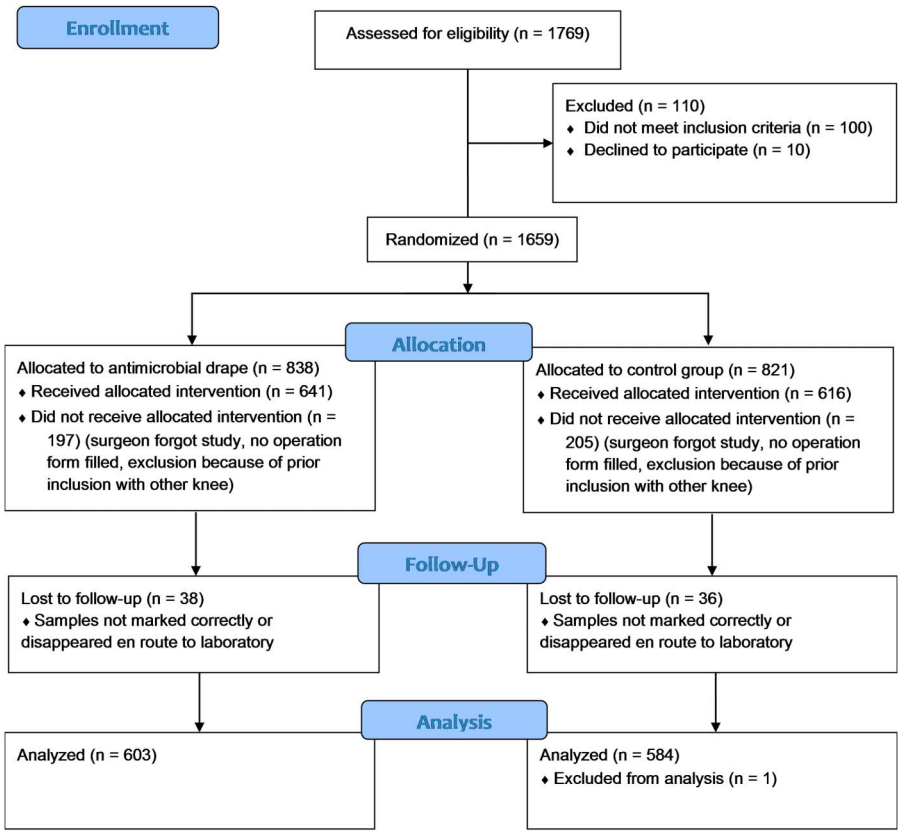

Fig. 1. This flowchart shows the patients who were included in this randomized, controlled trial. The operation form was completed by surgeons with information on the use of an antimicrobial drape, drape loosening, implant type, and cement use.

To assess the degree of contamination, three swabs (Copan ESwab, Brescia, Italy) and a glove wash, named Samples 1 to 4, were sampled on each patient. Sampling was undertaken by either the surgeon or a scrub nurse. The first swab (Sample 1) was taken before surgery on clean but surgically unprepared skin. The swab area was a 3 x 3 cm area adjacent to where the incision would be made. The swab time was a minimum of 20 seconds in duration, and all sides of the swab were used. Before surgery, all patients were disinfected twice using a 0.5% chlorhexidine gluconate solution with 80% alcohol. Afterwards, the patients in the intervention group were draped with an antimicrobial drape. The second swab (Sample 2) was taken immediately after the skin incision, on the lateral side of the incision at the dermis level. The swab time was 20 seconds. A glove wash (Sample 3) of the glove from the surgeon's dominant hand was taken approximately 30 minutes into surgery, when the gloves were changed before handling the implant, that is, before the possible use of bone cement-containing antibiotics. When the surgeon removed the glove, they turned it inside out, and 10 mL of sterile saline was poured into the glove so that the outer surface of the glove was washed. After the glove was rubbed for approximately 20 seconds, the fluid was removed using a sterile needle and syringe and transferred into a sterile tube . Finally, a swab (Sample 4) was taken before wound closure at the same site as the second swab, from the lateral incision edge. The swab was taken after closure of the joint capsule and before closure of the skin. The swab time was 20 seconds. If any of the three intraoperative samples (Samples 2 to 4) had positive results for bacterial growth (≥ 1 CFU), the patient was deemed contaminated.

After the operation, the surgeon completed an online form (Procordo Software) with information about the procedure and samples (see Appendix, Supplemental Digital Content, http://links.lww.com/CORR/A293). The drape used was Ioban™2 (3M Health Care, St. Paul, MN, USA).

Plating

All samples were sent to one of the two participating clinical microbiology departments for plating and susceptibility testing. Swabs were cultured for the first stroke using the swab on the plate and second and third strokes

Table 1. Patient demographics

Parameter	Bare skin (n = 584)	Antimicrobial drape (n = 603)	p value
Age (years)[a]	68 ± 10	68 ±10	0.63
Weight (kg)[b, c]	86 (45 to 192)	85 (45 to 161)	0.38
Female sex	61% (355)	60% (359)	0.66
Diabetes[d]	8% (45)	11% (60)	0.16
Alcohol use[d]	9% (49)	8% (42)	0.37
Smokers[d]	6% (67)	6% (66)	0.80
Skin disease[d]	7% (36)	6% (42)	0.56
Type of prosthesis[e]			
TKA	70% (397)	70% (408)	
UKA	30% (167)	30% (177)	0.81
Operation time [a, e] (min)	65 ±15	66 ±15	0.04
Cemented prosthesis[f]	81% (461)	81% (475)	0.87
Region			
Central	23% (136/1187)	23% (140/1187)	
Capital	77% (448/1187)	77% (463/1187)	0.98

[a]Data are presented as mean ± SD or [b]median (range).
[c]n = 904 patients with available data.
[d]n = 1082 patients with available data.
[e]n = 1149 patients with available data.
[f]n = 1152 patients with available data.
TKA = Total Knee Arthroplasty; UKA = Unicompartmental Knee Arthroplasty.

using a sterile needle. The used plates were the Columbia blood agar base with 5% horse blood (Oxoid, Basingstoke, UK), blue lactose agar plates selective for gram-negative bacteria and *Enterobacteriaceae*, and anaerobe basal agar with 5% horse blood. Blood plates were incubated in 35% CO_2 for 48 hours and read on Days 1 and 2. Blue plates were incubated aerobically at 35° C for 48 hours and read on days 1 and 2. The anaerobic plates were incubated anaerobically immediately after plating and read after two days of incubation.

The glove wash was centrifuged at 3000 rpm for 3 minutes. Inoculum was plated from the pellet. Ten microlitres from each glove was plated on a chocolate agar plate and 5% blood agar plate. Plates were read after two days.

Identification was performed using matrix-assisted laser desorption ionization-time of flight (Bruker Daltonics, Bremen, Germany), and susceptibility was tested with discs using clinical break point values from the European Committee on Antimicrobial Susceptibility Testing [8].

All bacteria grown on the plates were identified, and susceptibility was tested regardless of the number of CFUs. The CFU/mL count was not recorded; it was a logistically unfeasible task because of the large number of patients in this study. Specimens that were not labelled correctly were excluded from the laboratory analysis. Culture results were not accessible to the surgeons to avoid an influence on patient treatment.

Outcome Measures

The primary outcome was to investigate whether the use of an antimicrobial drape influenced the contamination rate. The secondary outcome was to determine whether factors such as sex, season, type of implant (unicompartmental arthroplasty or TKA), and duration of surgery affected the contamination rate.

Statistical Analysis

We made a power calculation based on an unpublished pilot study including 33 patients, which showed that an antimicrobial drape prevented contamination in 19 of 19 patients compared with contamination in three of 11 patients when an antimicrobial drape was not used.

To demonstrate the effect of the incision drape, using a power level of 0.8 and alpha error of 0.5, we needed two groups with 448 patients in each group. We also conducted a study in which we evaluated the correlation between contamination and infections (still unpublished data). For this study, we needed 1180 patients, and we decided to randomize these patients into two groups with 590 patients in each. Statistical analyses were performed using SAS Studio University edition for iOS X, (SAS Institute, Cary, NC, USA). Online randomization, data

collection, and the study's website were managed using Procordo Software.

We used a chi-square test to analyze differences in the contamination rate and patient characteristics between the intervention and control groups. Relative risk reduction and the number needed to treat were also calculated with a chi-square test. We performed multiple logistic regression with forward elimination to investigate the correlation between contamination and patient characteristics, the use of an antimicrobial drape, sex, type of implant (unicompartmental versus TKA), duration of surgery, and season. A post-hoc analysis with logistic regression was performed in the intervention group to investigate whether loosening of the antimicrobial drape increased the contamination risk.

The analysis was done per protocol and no crossover was performed. No intention-to-treat analysis was done as it was not possible because of missing data.

Results

Use of the antimicrobial drape reduced contamination risk, with contamination detected in 10% (60 of 603) of procedures where antimicrobial drapes were used compared with 15% (90 of 584) when they were not used (OR 0.61 [95% CI 0.43 to 0.87]; p = 0.005). The relative risk reduction of contamination in the intervention group was 35% (95% CI 12.3 to 52.5), with a number needed to treat of 18 patients (Fig. 2).

The overall contamination rate was 12% (150 of 1187 patients). A total of 53% (79 of 150) of the contaminated patients were male. The contamination rates differed markedly between the two regions; 7% (18 of 276) of the patients in the central region and 14% (132 of 911) of the patients in the capital region were contaminated (Table 2).

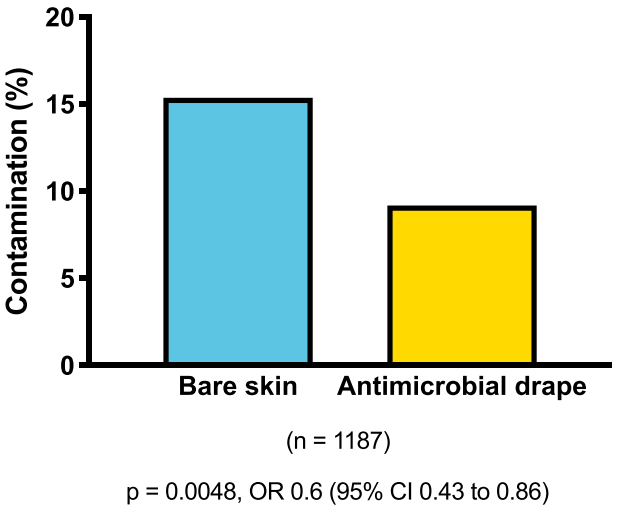

Fig. 2. The risk of contamination by allocation group is shown here.

Table 2. Differences in patient population by contamination

Parameter	Contaminated patients (n = 150)	Non-contaminated patients (n = 1037)	p value
Age (years)[a]	68 ± 9	68 ± 10	0.47
Female sex	10% (71)	90% (644)	< 0.001
Weight[b,c]	86 (51 to 130)	85 (45 to 192)	0.93
Diabetes[d]	15% (16)	85% (89)	0.32
Alcohol used	10% (9)	90% (83)	0.48
Smokers[d]	10% (13)	90% (120)	0.36
Skin disease[d]	9% (5)	94% (73)	0.1
Type of prosthesis[e]			
TKA	14% (109)	86% (696)	0.09
UKA	10% (34)	90% (310)	0.09
Operation time[a, e] (minutes)	69 ± 15	65 ± 15	0.009
Region			
Central	7% (18)	93% (258)	< 0.001
Capital	14% (132)	86% (779)	

[a]Data are presented as mean ± SD or [b]median (range).
[c]n = 904 patients with available data.
[d]n = 1082 patients with available data.
[e]n = 1149 patients with available data.
[f]n = 1152 patients with available data.
TKA = Total Knee Arthroplasty; UKA = Unicompartmental Knee Arthroplasty.

After controlling for potential confounding variables like sex, age, type of arthroplasty, season, duration of surgery, and country region, we found that procedures in females (OR 0.55 [95% CI 0.39 to 0.80]; p = 0.002) and those performed in the central region were less likely to show contamination (OR 0.45 [95% CI 0.25 to 0.78]; p = 0.006) (Fig. 3); we found no other factors that were associated with the risk of contamination.

Subgroup analysis showed that separation of the drape from the skin by more than 10 mm was associated with an increased risk of contamination (OR 0.6 [95% CI 0.43 to 0.86]; p = 0.005).

The predominant bacterial species isolated were coagulase negative staphylococci and micrococci (see Appendix, Supplemental Digital Content, http://links.lww.com/CORR/A293).

Discussion

PJI is a rare but devastating occurrence for patients, with considerable consequences for both patients and society. To avoid PJI, one rationale is to prevent bacteria from entering the surgical site. Antimicrobial drapes have dual action in preventing bacteria from doing so by acting as a physical barrier as well as an antimicrobial barrier. We sought to

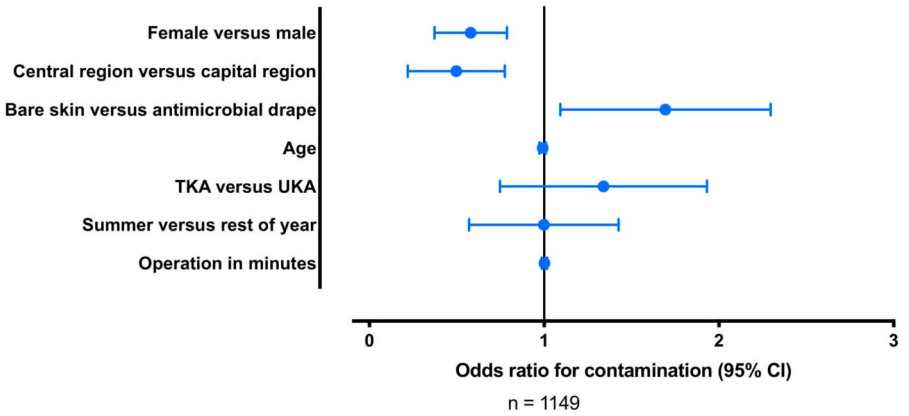

Fig. 3. Odds ratio plot for predisposing variables and their influence on the risk of contamination are shown here. TKA = total knee arthroplasty; UKA = unicompartmental arthroplasty.

elucidate the subject by performing a randomized controlled trial investigating the use of an antimicrobial drape versus no drape on the risk of intraoperative contamination. We found a substantial difference in the percentage of contamination in our study groups in favor of antimicrobial drapes. When we controlled for variables such as sex, comorbidities, and duration of surgery, we found that the risk reduction of contamination was associated with female sex, the use of antimicrobial drapes and operation in the central region of Denmark. When the antimicrobial drape was separated from the skin during surgery by more than 10 mm, we also found an increased risk of intraoperative contamination.

This study has several limitations. We do not know if the difference in contamination risk we found is clinically important. No studies have been able to prove a correlation between intraoperative contamination and subsequent infection [4, 5, 14] in orthopaedic surgery, even with higher contamination rates. The endpoint for these investigations is infection but infection in arthroplasty surgery can arise many years later and are not all infections are attributable to contamination of the surgical wound, making it a difficult endpoint [22]. Intraoperative contamination with long-term follow-up of patients is, in our opinion, the best way to investigate any interventional effect on infection. In all, 29% of the enrolled patients were excluded from the final analysis, mainly because of logistic problems, many of which were caused by the introduction of a new electronic patient chart. We cannot say how excluding these patients could have affected the results, but since the demographic profile of the study group resembles that of the background population, we believe the effect to be minor. We used a dry Eswab for sampling instead of a moistened one, which could have given a lower culture positive rate. It should not influence the comparison between the two study groups, but the overall contamination rate would possibly have been higher. Only one of the two laboratories was monitored by the principal investigator, whereas investigators at the other laboratory had written instructions. This could have affected the interpretation of the cultures, giving the latter laboratory an "advantage" of lower contamination.

All the intraoperative samples had very low CFUs. We estimate that more than 90% of samples had light growth but we did not record CFU/mL counts on the cultures for two reasons. It was not feasible to do a CFU/mL count in the everyday setting of a clinical laboratory, and we did not expect a direct correlation between the number of bacteria and risk of later infection.

The patients were not stratified by use of antibiotic prophylaxis, which due to the differences in antimicrobial spectrum, could have caused fewer gram-negative isolates in patients who received cefuroxime. Flucloxacillin/dicloxacillin and cefuroxime all have good bone penetration [21] and a comparable effect on gram-positive bacteria. The use of cefuroxime is common in the central region and less common in the capital region so it is possible that the difference in contamination risk between the two regions is also affected by the difference in antibiotic use.

We analyzed the data per-protocol, which can overestimate the effect of the intervention, as an intention-to-treat analysis could not be performed because we had no data to analyze on patients who had not been sampled during surgery.

We found that use of an antimicrobial drape reduced contamination risk. To our knowledge, only two randomized studies on the antimicrobial drape effect on contamination exist [6, 19]. They both reported a lower percentage of contamination when an antimicrobial drape was used. The study of Dewan et al. [6] is comparable to ours in size, but they evaluated several different procedures, including clean and dirty procedures and elective and acute procedures, so the study lacked the homogeneity of our study. They reported a difference in contamination risk in their

clean procedures only, which correlates with our study findings, but they found no overall difference in contamination rates between the control and intervention groups, which is possibly explained by highly diverse procedures. They took only one swab from the wound at the end of surgery, which they cultured both aerobically and anaerobically, so the bacterial findings should have been comparable to ours. Unfortunately, they did not report the type of bacteria found other than gram-positive skin organisms; thus, any comparison is unfeasible. Rezapoor et al. [19] used an intraoperative sampling similar to ours, but they found a higher contamination risk in the control group (27%) than we did. The contamination in the antimicrobial drape group resembled what we found (12%). They used pre-moistened swabs, which could explain the higher bacterial yield. There was no information on the culture technique, but they had a very low gram-negative sample set compared with ours, which suggests that the samples were not anaerobically cultured. When stratifying patients according to baseline bacterial colonization, they found an increased contamination risk in the control group. They report that none of their patients experienced surgical site infection (SSI) during the 6 months follow-up, so they could not conclude whether antimicrobial drape inhibits SSI, which is of course, the core question of interest in all studies done on antimicrobial drapes. Our present study cannot conclude on the risk of postoperative SSI nor will we conclude anything before an appropriate follow-up time has passed. The nature of PJIs is varied with acute onset and slow, asymptomatic infections, consequently, follow-up time of less than 2 years on these patients will presumably be of little value. We intend to follow our patients for the next 10 years to gain insight to these slow, asymptomatic infections and the possible correlation with the use of antimicrobial drape.

Of the factors we investigated, only female sex and surgery performed in the central region versus the capital region were associated with lower contamination risk. No other studies have reported a sex-specific difference in contamination risk. We theorize that the reason for our finding may be that males have larger hair follicles, which harbour larger amounts of bacteria [10]. Perhaps the opening of the hair follicle is also wider and allows for larger efflux of bacteria during surgery. Some studies have found higher risk of infection in male patients than in female patients [18], and our finding could potentially explain this phenomenon. The observed sex difference obviously leads to the question of whether an antimicrobial drape should be used in men only; however, nothing in our study suggests an adverse effect of using antimicrobial drapes, and our findings should be corroborated by other studies before this question can be answered. The likely differences between the sexes in skin care and hair removal on the extremities are variables we have not considered. Given that the central region had a much lower contamination rate and that they perform electric clipping of their patients before surgery gives us reason to suspect a correlation between hair removal and contamination risk. Possible explanations for this effect could be that antimicrobial drapes adhere better to skin with no hair and, therefore, have a diminished effect on contamination in patients with hairy extremities. Hair removal is more common in the female population [11], and their lower risk of contamination may also corroborate this explanation.

Subgroup analysis showed that loosening of the drape increased the contamination risk. Rezapoor et al. [19] also tested whether drape lift influenced contamination risk but found no effect in the drape group, probably because of lack of power due to the small study population. They did not report the degree of drape lift, so it is impossible to compare the studies in this manner. Jacobson et al. [12] found the areas of drape lift to be larger in their contaminated patients compared with non-contaminated patients (8.1 cm^2 and 4.8 cm^2, respectively). Their findings, along with ours, suggest drape lift to be an important factor in intraoperative contamination and implies that for antimicrobial drapes to work properly, it is crucial that the drape be applied according to guidelines and stay in place throughout the procedure. When surgeons remove the drape before closing the wound, there is a risk of contamination [16]. To minimize contamination risk at this point in surgery, it is prudent to decontaminate the skin with chlorhexidine gluconate or a similar disinfectant before stapling or suturing the wound.

In summary, we found that an antimicrobial drape reduces the contamination rate in patients undergoing knee arthroplasty. It is a safe and inexpensive method of reducing intraoperative contamination and is easy to implement in any orthopaedic surgery setting. It remains to be investigated whether the lower contamination risk also leads to a lower risk of surgical-site infection in these patients and whether the differences in contamination risk in men and women contributes to the difference in infection incidence. Future studies of this study population aim to answer these questions.

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