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The effect of preoperative oral hygiene on postoperative infections after cystectomy and urethroplasty—A quasi-experimental study

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Abstract

Research has demonstrated that systematic preoperative oral hygiene reduces nosocomial infections after elective thoracic surgery. However, the impact of preoperative oral hygiene on patients undergoing urologic procedures is unknown. Therefore, the aim of this study was to investigate the effects of systematic preoperative oral hygiene on prescriptions with antibiotics following cystectomy or urethroplasty. A quasi-experimental study design included all patients undergoing elective radical cystectomy or urethroplasty from 1 January 2018 to 31 May 2021. Patients undergoing cystectomy or urethroplasty were grouped into a prospective intervention group and a retrospective control group. Patients in the intervention group were admitted from 1 January 2020 to 31 May 2021, and were recommended to brush their teeth and rinse their mouths with chlorhexidine gluconate 0.12% four times a day starting 2 days before surgery and continuing until the morning of the operation. Patients admitted from 1 January 2018 to 31 December 2019 received no oral hygiene recommendations and were used as a retrospective control group. Data on oral hygiene performance were self-reported and collected at admission and data on prescription of antibiotics were collected through the patients' records. The relative risk was calculated to report the effect of the intervention. In total, 39 patients with cystectomy were in the intervention group, whereas 31 were in the control group. For patients having urethroplasty, 27 were in the intervention group and 98 were in the control group. The effect of oral hygiene on the prescription of antibiotics for patients who completely adhered to the oral hygiene recommendations showed a relative risk of 0.554 (95% CI 0.333–0.921) $p = 0.02$ for cystectomy and 0.825 (95% 0.308–2.209) $p = 0.70$ for urethroplasty. This study showed a statistically significant reduction in the prescription of antibiotics following oral hygiene recommendations for patients undergoing cystectomy. However, no statistically significant effect was demonstrated for patients undergoing urethroplasty. Despite this result, it seems

important to be aware of oral hygiene in patients undergoing surgery to potentially reduce the number of infections and the use of antibiotics because of the antimicrobial resistance that the healthcare system faces.

KEYWORDS
chlorhexidine, cystectomy, nosocomial infections postoperative complications, preoperative oral hygiene, toothbrush, urethroplasty

What is known about this topic

Despite many initiatives to reduce nosocomial infections, respiratory, urinary and surgical site infections are frequent complications related to surgery and hospital admissions. Oral care is a fundamental care activity that involves a person-centred approach when assessing the oral cavity, disrupting plague, reducing microorganisms and improving well-being.

What this paper adds

Systematic preoperative oral hygiene with toothbrushing and mouth rinse with chlorhexidine in patients having radical cystectomy reduces prescriptions of antibiotics postoperatively whilst no effect of preoperative oral hygiene on prescription of antibiotics for patients undergoing urethroplasty was demonstrated.

1 | BACKGROUND

Despite many initiatives to reduce nosocomial infections, respiratory, urinary and surgical site infections are frequent complications related to surgery and hospital admissions.[1] Cystectomy is an extensive urological procedure with an opening of both the urinary and gastrointestinal tract and is associated with considerable postoperative morbidity.[2,3] During hospitalisation, a systematic review demonstrated that the overall in-hospital complication rate was 34.9% (28.8–68.8) but increased to 39% (27.3–80.0) with 30-day follow-up and to 58% (36.1–80.5) 90 days postoperatively.[3] Postoperative infections after radical cystectomy are associated with re-admission,[4,5] prolonged hospital stay,[6–8] increased cost of care[7,8] and increased in-hospital mortality.[7,8]

Patients undergoing urethroplasty often receive urethral reconstruction with the use of oral mucosa.[9] The most frequent postoperative infection stem from the urinary tract regardless of the type of urethroplasty, the site of the stricture and the patient's co-morbidities; however, any complication was associated with prolonged hospitalisation.[10] Another study found that wound infection is another frequent complication.[11]

The oral cavity is home to about 700 microorganisms, some of which are potentially pathogenic. These microorganisms colonize the mucosa and teeth and thrive in biofilm and plaque.[12,13] Removal of biofilms and plaques can reduce the risk of postoperative infections. A cohort study with 509.1079 having surgery for cancer demonstrated that pre-operative professional support in oral hygiene, mechanical tooth cleaning and necessary treatment from dental therapists or dentist reduced post-operative pneumonia and the 30-day mortality rate.[14] Systematic reviews and prospective studies have shown that preoperative oral hygiene with chlorhexidine mouthwash and toothbrushing lead to a reduction in prescription of antibiotics,[15–17] nosocomial infections,[15,18] surgical site infections[15] and respiratory tract infections[15,18,19] after elective thoracic surgery. A systematic review also demonstrated a plausible, although non-significant, protective effect of preoperative oral hygiene against urinary tract infection after thoracic surgery.[15] However, the impact of preoperative systematic oral hygiene to patients undergoing urologic procedures is unknown.

2 | AIM

The aim of this study was to investigate whether preoperative oral hygiene using chlorhexidine mouthwash and toothbrushing could reduce the number of patients treated with antibiotics postoperatively following cystectomy or urethroplasty.

3 | METHODS

3.1 | Study design

This quasi-experimental study was conducted at the Department of Urology at Aalborg University Hospital in Denmark. The department includes a ward, day surgery and an outpatient clinic and has the national responsibility for patients having urethroplasty. The department also receives patients from the Faroe Islands because cystectomies and urethroplasties are not offered there.

3.1.1 | Patient eligibility

The inclusion criteria were patients undergoing elective radical robot-assisted cystectomy with a Bricker ileal conduit or open buccal graft

urethroplasty from 1 January 2018 to 31 May 2021. Urethroplasty was done for both bulbar and 1 stage distal. At the beginning of 2018, a new standard antibiotic prophylactic regime was implemented for patients undergoing cystectomies. Only patients receiving the new antibiotic regime were included in the study. There were no changes in the prophylactic antibiotic regime for patients undergoing urethroplasty during the study period. The exclusion criteria were patients who died within 30 days of surgery and patients from Faroe Island, because we had no access to their prescriptions of antibiotic after discharge from the hospital.

Patients admitted from 1 January 2018 to 31 December 2019, received no oral hygiene recommendations and were used as a retrospective control group. Patients admitted from 1 January 2020 to 31 May 2021 all received oral hygiene recommendations.

3.1.2 | Standard antibiotic prophylaxis

All patients undergoing cystectomy received intravenous gentamycin 240 mg, metronidazole 500 mg and ampicillin 1000 mg perioperatively. Six hours after surgery, metronidazole 500 mg and ampicillin 1000 mg were administrated. On the first postoperative day, gentamycin was administered in a single dose whilst metronidazole was administered twice a day. Ampicillin was given four times a day. Metronidazole and ampicillin were continued for 3 days after surgery.

All patients eligible for chemotherapy (<76 years, T2+, eGFT>60) received four series of gemcitabine/cisplatin. This was almost 50% of the cystectomy patients. If patients had received chemotherapy prior to surgery, they received cefuroxime 750 mg four times a day and metronidazole 500 mg twice a day. Cefuroxime and metronidazole were continued for 3 days after surgery. Ten days after surgery, the patients had to have their ureteric stents removed. Bioclavid® 500 mg was administered before the procedure and 6 h after the procedure.

All patients undergoing urethroplasty received ciprofloxacin 500 mg orally twice a day for a total of 5 days, starting from the night before surgery.

3.1.3 | Recommendations for oral hygiene

Participants were recommended to brush their teeth and rinse their mouth with chlorhexidine gluconate 0.12% for 30 s four times a day starting 2 days before surgery and continuing until the morning of the operation. Prior to surgery, the participants in the intervention group received oral and written information from a nurse in the outpatient clinic on how to perform oral hygiene. Furthermore, the written information was e-mailed to the participants close to the day of the surgery, reminding them of the oral hygiene recommendations. The written information contained a checklist where patients could register how many times oral rinses and toothbrushing were performed per day. At admission, the participants were asked to hand in their checklists. If they had forgotten their checklists, the participants were contacted by phone to hand in the data.

Participants who had performed oral rinse with chlorhexidine and toothbrushing four times a day for 2 days and on the day of surgery were categorized as having adhered to the recommendations. A margin of one missed toothbrushing and/or one missed oral rinse was accepted. Participants who missed more than one oral rinse and/or one toothbrushing were considered to having partly adhered to the recommendations. Participants who did not perform any oral rinses were excluded.

3.2 | Data collection

Medical records were reviewed for the following data: date of birth and surgery, type of surgery, smoking status, diabetes as a comorbidity, height, weight, prescription of antibiotics during the 30 days following surgery, and the indication for prescription of antibiotics. This also included antibiotics prescribed by general practitioners.

Indications for the prescription of antibiotics were classified as urogenital infection, airway infection, deep abscess, superficial surgical site infection, unknown infection, or other infection. The classification 'other infection' included prescriptions of antibiotic before an eventual re-operation. If no further statement than 'infection' was noted in the medicine list the classification, 'unknown infection' was chosen.

3.3 | Data analysis

Statistical analysis was performed using Stata v. 16 by one of the authors (NHB), a statistician at Aalborg University Hospital. The analyses were conducted separately for the urethroplasty and cystectomy group separately. The continuous variables age and BMI are presented as medians/interquartile intervals (IQI). Categorical data are presented as frequencies. Continuous data were compared between the intervention and the control groups using the Kruskal–Wallis test and categorical variables were compared between groups using Fisher's exact test. We present the effects as relative risk and evaluated confounding from binary versions of age, BMI, smoking and diabetes by comparing adjusted relative risks from Mantel–Haenszel with the crude relative risk estimates (Table 3). A subgroup analysis was performed by excluding participants in the oral hygiene group who only adhered to the recommendation partly (Table 2B). We added a 95% confidence interval to the relative risk estimates. The α-level was set at 0.05 for statistical significance.

3.4 | Ethical considerations

The study was approved by hospital management and by the research registration in the North Denmark Region, (ID 2019–147). According to the Danish law, it was determined that no further approval was necessary. All participants were asked to sign a written consent form before inclusion in the study. The study was undertaken in accordance with the Declaration of Helsinki.[20]

TABLE 1 Patient characteristics.

	Control	Intervention	Total	*p*-value
n (%)	129 (66.2)	66 (33.8)	195 (100.0)	
Age, median (iqi)	54.0 (38.0; 64.5)	67.0 (47.0; 74.0)	58.0 (39.0; 69.0)	
BMI, median (iqi)	27.1 (24.1; 29.4)	26.1 (24.1; 30.3)	26.9 (24.2; 29.4)	
Gender, *n* (%)				
Female	12 (9.3)	10 (15.2)	22 (11.3)	
Male	117 (90.7)	56 (84.8)	173 (88.7)	
Type of surgery, *n* (%)				
Urethroplasty	98 (76.0)	27 (40.9)	125 (64.1)	
Cystectomy	31 (24.0)	39 (59.1)	70 (35.9)	
Smoking, *n* (%)				
Current	20 (15.5)	10 (15.2)	30 (15.4)	
Non	109 (84.5)	56 (84.8)	165 (84.6)	
Diabetes, *n* (%)				
Yes	12 (9.3)	9 (13.6)	21 (10.8)	
No	117 (90.7)	57 (86.4)	174 (89.2)	
Urethroplasty				
Age, median (iqi)	47.5 (33.8; 58.0)	40.0 (30.0; 62.0)	46.0 (33.0; 58.0)	0.38
BMI, median (iqi)	26.6 (23.9; 28.8)	27.2 (25.1; 30.7)	26.9 (24.2; 29.2)	0.32
Gender, *n* (%)				
Female	0 (0.0)	1 (3.7)	1 (0.8)	
Male	98 (100.0)	26 (96.3)	124 (99.2)	0.22
Smoking, *n* (%)				
Current	11 (11.2)	1 (3.7)	12 (9.6)	
Non	87 (88.8)	26 (96.3)	113 (90.4)	0.46
Diabetes, *n* (%)				
Yes	8 (8.2)	1 (3.7)	9 (7.2)	
No	90 (91.8)	26 (96.3)	116 (92.8)	0.68
Cystectomy				
Age, median (iqi)	69.0 (64.0; 74.0)	72.0 (67.0; 76.0)	70.0 (64.0; 75.0)	0.13
BMI, median (iqi)	28.0 (24.2; 30.9)	25.9 (22.8; 29.1)	26.8 (24.0; 30.2)	0.07
Gender, *n* (%)				
Female	12 (38.7)	9 (23.1)	21 (30.0)	
Male	19 (61.3)	30 (76.9)	49 (70.0)	0.19
Smoking, *n* (%)				
Current	9 (29.0)	9 (23.1)	18 (25.7)	
Non	22 (71.0)	30 (76.9)	52 (74.3)	0.59
Diabetes, *n* (%)				
Yes	4 (12.9)	8 (20.5)	12 (17.1)	
No	27 (87.1)	31 (79.5)	58 (82.9)	0.53

3.5 | Results

The total number of participants who met the inclusion criteria during the study period was 202. Initially, the control group consisted of 129 participants and the intervention group of 73. Five of the participants in the intervention groups did not adhere to the recommendations and two participants did not hand in their checklist and could not be reached by phone (four cystectomy and three urethroplasty participants). All seven participants were excluded from the analysis. The adherence rate to the oral hygiene recommendation was (66/73) 90.4%. In total, 195 patients were included in the study (controls $n = 129$; intervention $n = 66$). When stratifying surgery type, the intervention group and the control group were comparable with respect to gender, age, BMI, smoking habits and diabetes for both the urethroplasty and cystectomy groups (Table 1).

TABLE 2A Proportions of infections by oral hygiene and surgery type.

	Control	Intervention	Total	*p*-value
Urethroplasty				
n (%)	98 (78.4)	27 (21.6)	125 (100.0)	
Postoperative infection (yes), *n* (%)	19 (19.4)	5 (18.5)	24 (19.2)	1.00
Cystectomy				
n (%)	31 (44.3)	39 (55.7)	70 (100.0)	
Postoperative infection (yes), *n* (%)	21 (67.7)	18 (46.2)	39 (55.7)	0.09

TABLE 2B Proportions of infections by oral hygiene and surgery type (excluding patients who performed oral hygiene partly).

	Control	Intervention	Total	*p*-value
Urethroplasty				
n (%)	98 (79.7)	25 (20.3)	123 (100.0)	
Postoperative infection (yes), *n* (%)	19 (19.4)	4 (16.0)	23 (18.7)	1.00
Cystectomy				
n (%)	31 (49.2)	32 (50.8)	63 (100.0)	
Postoperative infection (yes), *n* (%)	21 (67.7)	12 (37.5)	33 (52.4)	0.02

TABLE 3 Crude and adjusted relative risk estimates with 95% confidence intervals.

		Crude RR	95% CI		Adjusted RR	95% CI		*p* (homogeneity)
Urethroplasty	Age	0.955	0.393	2.322	0.915	0.378	2.214	0.66
	BMI	0.955	0.393	2.322	0.922	0.368	2.310	0.19
	Smoking	0.955	0.393	2.322	0.911	0.374	2.219	0.96
	Diabetes	0.955	0.393	2.322	0.962	0.392	2.364	0.90
Cystectomy	Age	0.681	0.449	1.034	0.692	0.449	1.067	0.75
	BMI	0.681	0.449	1.034	0.712	0.460	1.102	0.81
	Smoking	0.681	0.449	1.034	0.696	0.459	1.053	0.70
	Diabetes	0.681	0.449	1.034	0.676	0.444	1.027	0.98

3.5.1 | Urethroplasty

In total, 125 participants underwent urethroplasty. Of these, 98 in the control group and 27 were in the intervention group. Of all the participants, 124 were male. Please see the patients' characteristics in Table 1 In the control group, 19.4% ($n = 19$) had infections and received antibiotics postoperatively. In comparison, 18.5% ($n = 5$) of the intervention group had infections and received antibiotics postoperatively ($p = 1.00$) (Table 2A). One participant in the intervention group only adhered to the oral hygiene recommendation partly and when excluding this participant from the analysis, 16% ($n = 4$) received antibiotics ($p = 1.00$) (Table 2B). The relative risk for the prescription of antibiotics was 0.955 (95% CI 0.393–2.322, $p = 0.92$). When excluding the patient who adhered partly to the oral hygiene recommendation, the relative risk was 0.825 (95% 0.308–2.209 $p = 0.70$). Adjusted relative risk estimates were calculated for the four variables (age, BMI, smoking and diabetes). Because of the small numbers stratified analysis was performed using binary versions of age and BMI. The total medians (Table 1) for age and BMI were 46 and 26.9, so age and BMI were split into 46 and 26.9. Crude and adjusted estimates by age groups, BMI groups, smoking and diabetes were similar in size, that is, showing no strong confounding effect (Table 3). The effects of oral hygiene by age and groups, BMI groups, smoking and diabetes showed no significant difference. Hence, no effect modification was assumed for urethroplasty (Table 3).

There was no significant change in the distribution of infection types in the intervention group compared with the control group for urethroplasty (Tables 4A and 4B).

3.5.2 | Cystectomy

A total of 70 participants underwent cystectomies. Of these, 49 were male. Please see the patients' characteristics in Table 1. In total, 31 were in the control group and 39 were in the intervention group. In the control group 67.7% ($n = 21/31$) had infections and received antibiotics postoperatively. In comparison 46.2% ($n = 18/39$) of the intervention group received antibiotics postoperatively ($p = 0.09$) (Table 2A). Excluding the seven patients in the intervention group who did not adhere completely, 37.5% ($n = 12/32$) ($p = 0.02$)

TABLE 4A Distribution of infection types.

	Control	Intervention	Total	*p*-value
Urethroplasty				
n (%)	19 (79.2)	5 (20.8)	24 (100.0)	
Unknown (yes), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Airway infection (yes), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Urogenital infection (yes), *n* (%)	15 (78.9)	2 (40.0)	17 (70.8)	0.13
Deep abscess (yes), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Superficial surgical site infection (yes), *n* (%)	4 (21.1)	3 (60.0)	7 (29.2)	0.13
Other (yes), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Cystectomy				
n (%)	21 (53.8)	18 (46.2)	39 (100.0)	
Unknown (yes), *n* (%)	4 (19.0)	5 (27.8)	9 (23.1)	0.71
Airway infection (yes), *n* (%)	2 (9.5)	2 (11.1)	4 (10.3)	1.00
Urogenital infection (yes), *n* (%)	7 (33.3)	4 (22.2)	11 (28.2)	0.50
Deep abscess (yes), *n* (%)	1 (4.8)	0 (0.0)	1 (2.6)	1.00
Superficial surgical site infection (yes), *n* (%)	1 (4.8)	2 (11.1)	3 (7.7)	0.59
Other (yes), *n* (%)	6 (28.6)	5 (27.8)	11 (28.2)	1.00

TABLE 4B Distribution of infection types (excluding patients who performed oral hygiene partly).

	Control	Intervention	Total	*p*-value
Urethroplasty				
n (%)	19 (82.6)	4 (17.4)	23 (100.0)	
Unknown (yes), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Airway infection (yes), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Urogenital infection (yes), *n* (%)	15 (78.9)	2 (50.0)	17 (73.9)	0.27
Deep abscess (yes), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Superficial surgical site infection (yes), *n* (%)	4 (21.1)	2 (50.0)	6 (26.1)	0.27
Other (yes), *n* (%)	0 (0.0)	0 (0.0)	0 (0.0)	
Cystectomy				
n (%)	21 (63.6)	12 (36.4)	33 (100.0)	
Unknown (yes), *n* (%)	4 (19.0)	2 (16.7)	6 (18.2)	1.00
Airway infection (yes), *n* (%)	2 (9.5)	1 (8.3)	3 (9.1)	1.00
Urogenital infection (yes), *n* (%)	7 (33.3)	2 (16.7)	9 (27.3)	0.43
Deep abscess (yes), *n* (%)	1 (4.8)	0 (0.0)	1 (3.0)	1.00
Superficial surgical site infection (yes), *n* (%)	1 (4.8)	2 (16.7)	3 (9.1)	0.54
Other (yes), *n* (%)	6 (28.6)	5 (41.7)	11 (33.3)	0.47

received antibiotics (Table 2B). The relative risk for the prescription of antibiotics was 0.681 (95% CI 0.449–1.034, $p = 0.07$). When excluding the participants who adhered to the intervention only partly, the relative risk was 0.554 (95% CI 0.333–0.921, $p = 0.02$).

Adjusted relative risk estimates were calculated for the four variables (age, BMI, smoking and diabetes). Due to small numbers, stratified analysis was performed using binary versions of age and BMI, as described for the urethroplasty group. Crude and adjusted estimates by age groups, BMI groups, smoking and diabetes were similar in size, that is, showing no confounding effect (Table 3). The effects of oral hygiene by age group, BMI group, smoking and diabetes showed no significant difference. Hence, no effect modification was assumed for cystectomy (Table 3).

There was no significant change in the distribution of infection types in the intervention group compared with the control group for cystectomy (Tables 4A and 4B).

4 | DISCUSSION

This study showed a significant reduction in the prescription of antibiotics following cystectomy when participants completely adhered to preoperative oral hygiene recommendations (RR = 0.554, 95% CI 0.333–0.921, $p = 0.02$). In addition, a trend towards a reduction in the prescription of antibiotics following cystectomy was seen when

the intervention was partly adhered to (RR = 0.681, 95% CI 0.449–1.034, $p = 0.07$). However, no effect of preoperative oral hygiene on the prescription of antibiotics for patients undergoing urethroplasty was demonstrated (RR = 0.825, 95% CI 0.308–2.209, $p = 0.70$). There was no significant evidence of effect modification or strong confounding by the variables of age, BMI, diabetes and smoking.

To the best of our knowledge, no other study has evaluated the effect of preoperative oral hygiene on postoperative infections following urologic surgeries. The results from our study are in line with results from studies that included patients other than urology. Systematic reviews have demonstrated that preoperative oral hygiene with chlorhexidine mouthwash and toothbrushing provides a protective effect against lower respiratory infections and surgical site infections following thoracic surgeries.[15,18,19,21] Nobuhara et al.[21] suggested that odontogenic bacteraemia is the most important route by which oral bacteria are associated with postoperative surgical site infections. Several studies support this mechanism as they found that oral bacteria could enter blood vessels through the dental pulp or periodontal tissue and cause systematic dissemination of oral bacteria.[22–24] Therefore, preoperative oral hygiene may have the potential to reduce postoperative infections as demonstrated in our study. Thus, oral care is an important component of nursing care and involves a person-centred approach when assessing the oral cavity, disrupting plague, reducing salivary microorganisms and improving well-being.[25] However, oral care often has a low-priority status compared with other nursing care activities,[26,27] and is often spontaneous and of varying quality, and not always based on the best available evidence.[26,27] Oral hygiene is especially important in patients undergoing surgery, as they are vulnerable to infections since surgery induces immunosuppression in the postoperative period.[28,29] Furthermore, during hospitalisation, the oral flora can change, and nosocomial pathogens can colonize the oral cavity because of medication, poor oral care, decreased saliva and invasive treatments.[30] The bacteria that colonize the oral cavity during hospitalisation are often *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae* and Enterococcus. These are also some of the bacteria that cause nosocomial urogenital infections.[30,31] Thus, the reduction in the prescription of antibiotics in our study could be due to fewer bacteria in the oral cavity of the patients, hence a lower risk of odontogenic bacteriemia and transportation of bacteria to remote organs.

Patients undergoing cystectomy are hospitalized for a longer period and undergo more invasive procedures than patients undergoing urethroplasty. In situations where people are deteriorating or are undergoing distressing treatment, oral hygiene is an essential condition that can contribute to preventing the risk of postoperative infections.[32,33] Furthermore, patients undergoing cystectomy are generally older and one study has shown that the elderly are transiently colonized with enterococcus.[34] This might explain why the protective effect of preoperative oral hygiene in our study is only found in patients undergoing cystectomy and not in patients undergoing urethroplasty, as patients undergoing cystectomy are older than patients undergoing urethroplasty. On the contrary, it can be discussed why protective oral hygiene was not seen in the urethroplasty group, where most were men, as a review has demonstrated that men are likely to ignore their oral health, have poorer oral hygiene habits, and visit dentists less frequently than women.[35] However, patients having urethroplasty are often admitted for a shorter period compared with patients having cystectomy, which may prevent an essential change in the oral flora.

5 | STRENGTH AND LIMITATIONS

Our study has a few limitations. First, our sample size was smaller than expected because of the corona pandemic leading to a reduction in elective surgery, which affected the incidence of urethroplasty. Second, this was a quasi-experimental study with a retrospective control group and a prospective intervention group, which meant that the groups were not undergoing surgery within the same year. This was balanced by ensuring that the same surgeons operated during the study period and that the same prophylactic antibiotic regime was used during the entire period. In addition, our study registered only the first prescription of antibiotics. We did not register if any second or third prescription of antibiotics was administered during the defined postoperative period, which might have impacted the results.

In our study, self-reported data regarding adherence to the intervention were used. Using self-reported data on oral hygiene may have led to inaccurate self-reports and erroneous study results representing social desirability bias.[36] However, a systematic review demonstrated that self-reported data could be used to measure patient-reported medication adherence preoperatively.[37] The limitations of this study were balanced by several strengths. There was a prospective intervention with a clearly defined outcome for the prescription of antibiotics. Data on the prescription of antibiotics were acquired from the patients' medical records. This is a safe method, as all antibiotics must be documented in medical records before nurses can administer them or patients can receive a prescription at the pharmacy. Additionally, the reason for the prescription had to be noted by the physician. Some infections might have been misclassified, as some patients could have been prescribed antibiotics without an infection; however, this condition would apply to both the control and the intervention group. In this study, patients bought their own bottle of chlorhexidine and no adverse effect to chlorhexidine was reported, making the intervention inexpensive and safe.

6 | CONCLUSION

Our study adds to the growing knowledge about the role of preoperative oral hygiene in nosocomial infections. The intervention used in our study offers an inexpensive and simple way of reducing postoperative infections following cystectomy, thus reducing the use of antibiotics.

7 | IMPLICATIONS FOR CLINICAL PRACTISE

Preoperative oral hygiene is an essential nursing care activity that can prevent nosocomial infections after cystectomy and contribute to the

reduced use of antibiotics. This is of particular importance because of the antimicrobial resistance that the healthcare system faces.

AUTHOR CONTRIBUTIONS

Study design: LSB, BBP, HJ and LS. *Data collection*: LSB, BBPand HJ. *Data analysis*: LSB and NHB. *Manuscript preparation*: LSB, BBP, HJ, LJ, NHB and LS.

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None.

CONFLICT OF INTEREST STATEMENT

The authors report no conflict of interest.

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