Predictors of Surgical site infections among patients undergoing open urological surgery at a Tertiary hospital, Tanzania: A cross sectional study

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Abstract

Background Surgical site infection (SSI) is one of the major hospital acquired infections highly associated with prolonged hospitalization, morbidity and mortality. In open urological surgeries, little is known on magnitude and factors associated with development of SSI. Methods and Materials This was a cross-sectional prospective observational study performed between August 2015 and March 2016 at Muhimbili National hospital (MNH), Dar es Salaam, Tanzania. All patients who underwent open urological surgery and met inclusion criteria were consecutively enrolled, and followed up for 30 days. Patients´ and operative characteristics were recorded using standard structured questionnaires. Wound/pus swabs were collected from patients with clinical evidence of SSI for bacteriological processing. Data analysis was performed using SPSS version 20. Results Of 182 patients who underwent open urological surgery, 22% developed SSI. Pre-operative urinary tract infection (aOR 9.73, 95%CI 3.93-24.09, p<0.001) and contaminated wound class (aOR 24.997, 95%CI 2.58-242.42, p = 0.005) were independent predictors for development of SSI. Shaving within 30 hrs before surgical procedure was found to be protective for developing SSI (aOR 0.26, 95%CI 0.09-0.79, p = 0.02). Escherichia coli (20/40) was the most predominant pathogen in SSI followed by Klebsiella pneumoniae (7/40) and S. aureus (6/40). Gram-negative bacteria were highly resistant to ceftriaxone, gentamicin, amoxicillin-clavulanic acid and trimethoprim-sulfamethoxazole. Conclusion SSI was high in open urological interventions. Pre-operative urinary tract infection and contaminated wound class predicted SSI. Bacteria causing SSI were highly resistant to commonly used antibiotics.

Background

Surgical site infection (SSI) is one of the major hospital acquired infections in patients undergoing surgical procedures. It is highly associated with prolonged hospital stay, increase in health care costs and mortality (1, 2). Previously, certain patient and operative (preoperative, operative and postoperative) characteristics have been documented to contribute to the risk of SSI development (3, 4).

Besides improvement in infection prevention and control practices in surgical procedures such as improved operating rooms, trained medical personnel, sterilization techniques and provision of surgical antimicrobial prophylaxis SSI remains a common hospital acquired infection which significantly hinders the valuable effect of surgical interventions. Depending on geographical location, the rates of SSI in developing countries accounts between 10.9-26% among patients undergoing major surgeries (5-7). In addition, appreciable morbidity and mortality is attributed to SSI (1, 8).

Determining the magnitude and identifying risk factors associated with development of SSI in preoperative and operative stage is critical for prevention and control of SSI. Few studies in Tanzania have reported predicting factors for development of SSI among patients admitted in general surgical ward, and pregnant mothers undergoing caesarian sections (6, 9). However, little is known on factors associated with development of SSI in patients undergoing open urological surgery. In this study, we

performed cross-sectional observation study to determine the rate and predictive factors for SSI, for the purpose of establishing objective evidence for predicting and identifying SSI.

Methods

Study design and settings

This was a cross-sectional prospective observational hospital-based study conducted between August 2015 and March 2016 at urology ward at Muhimbili National hospital (MNH), Dar es Salaam, Tanzania. MNH is the main specialized tertiary and training hospital for Muhimbili University of heath and Allied Sciences. It has 1500-bed capacity and attends 1000 to 1200 outpatients a week. It serves approximately six million people living in the Dar es Salaam and Pwani regions. The urology unit has approximately 70 bed capacity and performs at least 5 urological procedures in a day.

Study population

All patients who underwent open urological procedure were included in the study. Patients were followed up for duration of 30 days. Surgical wounds were examined 48 hours after surgery and on each day until the patient was discharged. At 7th day during suture removal the wound was also examined and whenever required until day 30. During examination the attending surgeon determined whether the patient had signs and symptoms of SSI. Clinical and microbiological evidence of SSI was defined as previously described by the Centers for Disease Control and Prevention (3). A total of 212 patients underwent open urological surgery during the study period, 182 patients were followed for a period of 30 days, 9 patients died before completion of follow up and 21 patients were lost to follow up.

Data collection

Standard structured questionnaires were used to collect patients´ clinical, social and demographic information. Information recorded included sex, age, co-morbidities, history of cigarette smoking, days of hospitalization before surgery, history of abdominal hair removal before surgery, class of surgical incision, pre-operative urinary tract infection, duration of surgery, and pre-catheterization before operation.

Specimen collection and laboratory procedures

Patients with clinical evidence of SSI had two pus swabs or pus collected under aseptic procedure from the base of the wound and immediately transported to the laboratory in Amie's transport media (Oxoid, UK) for processing. Gram´s stain was performed on the first swabs for assessing the quality of the specimens and stain morphology. When the first swab was of good quality, then the second pus swab or

pus from wound was plated onto MacConkey agar (Oxoid, UK) and blood agar (Oxoid, UK) and incubated under aerobic condition at 37°C for 18–24 hours. Bacteria isolates were identified based on colonial morphology, Gram stain and a set of biochemical tests including API 20 E.

Antibiotic susceptibility testing was performed using the Kirby Bauer's disc diffusion method in line with the clinical and laboratory standard institute (CLSI) guidelines.

Data analysis

Data were entered and analysed using SPSS software version 20. Data were summarized as frequency, percentage and proportion. Binary logistic regression analysis was performed to identify the association between independent and dependent variables. Odds ratios were used to test the strength of association between predictor variables. Significance was defined as a p-value of less than 0.05.

Results

Prevalence of SSI

The rate of SSI in relation to various factors among patients who underwent open urological surgeries at MNH is summarized in Table1. Of 182 patients who were followed up for 30 days, 22% (95% CI 16.6 – 28.5) developed SSI. SSI was more common in males (22.2%) and those aged between 54 – 71 years (27.7 %). Patients with diabetes had high rates of SSI (33.3%) compared to those with other co-morbidities. Interestingly SSI was observed more among non-smokers (22.6%) compared to those who were smoking cigarette. The rate of SSI was higher in patients who were admitted for more than 3 days compared to those admitted for lesser days. Patients who had shaving more than 30 minutes before operation had high rate of SSI (39.1%) compared to those who shaved within 30 minutes and those who did not require shaving. Participants who had pre-operative urinary tract infections had increased prevalence compared to those without. SSI rate was more common (33.8%) in catheterized patients compared to those who were not catheterized (14.4%). Patients who had duration of surgery for more than 90 minutes presented with higher rate of SSI compared to those who had less.

Predictors of SSI

Shaving patients more than 30 minutes before operation was significantly associated with development of surgical site infection cOR 3.451 (95%CI 1.308 – 9.105, P = 0.012). Having urinary catheterization in situ before operation was significantly associated with surgical site infections on univariate analysis cOR 3.032 (95%CI 1.472 – 6.246, p value 0.003). The odds of SSIs were 12 times in who had pre-operative urinary tract infections before surgery (cOR 12.794, 95%CI 5.655 – 28.94, p value <0.001). On univariate analysis, contaminated surgical procedures was found to be a factor significantly associated with

development of surgical site infection cOR 20.3, (95%CI 3.651 – 112.3, p=0.001) (Table 2). Age, history of cigarette smoking, comorbidities, duration of admission before surgery and duration of surgery were found not be associated with development SSI among patients who underwent urological surgery.

On multivariate analysis, pre-operative urinary tract infection was found to be independently associated with the development of surgical site infections aOR 9.73 (95%CI 3.93-24.09, p <0.001). Contaminated surgical procedures were also an independent factor associated with surgical site infection aOR 24.997 (95%CI 2.58-242.42, p 0.005) (Table 2). Shaving more than 30 minutes and urinary catheterization were found not independently associated with surgical site infections and shaving within 30 before surgical procedure was found to be protective against developing SSI aOR 0.26 (95%CI 0.09-0.79, P=0.02)

Bacteria aetiology of SSI/ UTI and their Antimicrobial susceptibility pattern

A total of 40 bacteria were isolated from patients with SSI, majority of the isolates were Gram negative bacteria. *Escherichia coli* were the most predominant pathogens causing SSI in 50% (20/40) patients undergoing urological surgery. *Klebsiella pneumoniae* accounted for 17.5% (7/40), *S. aureus* 15% (6/40), *Pseudomonas aeruginosa* 10% (4/40) and *Proteus mirabilis* 7.5% (3/340).

Escherichia coli isolates from SSI were highly resistant to ceftriaxone (84.2%), gentamicin (86%), amoxicillin-clavulanic acid (84%) and trimethoprim-sulfamethoxazole (82.3%). Seventy eight percent (78%) of *Klebsiella pneumoniae* and 62% of *P. mirabilis* were resistant to ceftriaxone. *S. aureus* displayed high rate of resistance to amoxicillin –clavulanic (68.4%), while low rates of resistance were observed in ceftriaxone (42%), gentamicin (36%) and ciprofloxacin (27%).

Discussion

The overall prevalence of SSI among patients undergoing open urological surgery at a tertiary hospital in Tanzania was 22%. Our finding was much higher compared to a study from developed countries like Serbia 5.9%, (2) and a recent study in Egypt (9%) (10) among patients undergoing urological surgery. The contributing factors for the observed high rates of SSI in this study could be attributed to insufficient infection control and prevention measures. During the study duration wards were congested with many patients and patients who underwent surgery were also mixed with other patients. In addition, most of the surgical procedure lasted more than 90 minutes, which also could have contributed to an increased rate of SSI. Conversely, the setting of our study was completely different from that in Serbia and Egypt, being developing country with limited resources could count for observed high rates. The rate of SSI reported in the present study was lesser than that reported in general surgery, (6) but higher than reports from obstetrics surgeries in Northern, Tanzania (9). These findings from the same study settings suggest that patients' characteristics (risk factors) and surgical procedures determine the occurrences of SSIs.

Patients from urology might not share the same risk factors with their counterparts from general surgery and obstetrics.

Our finding compares with those from previous studies (11-13), which reported that urinary tract infections before urological surgical procedures is a risk factor for development of SSI among patients undergoing open urological surgery. Besides, SSI still developed in all our patients with urinary tract infections being treated with antibiotics before surgery. Our study could not ascertain if the same bacteria isolated from urinary tract infection were causative of SSIs, further molecular studies need to be performed to establish the clonal relationship. However, previous studies elsewhere (11, 14), documented that not all causative bacteria of SSI were the same species as those from pre-operative urinary tract infections. Ideally, in a setting with culture facilities and elective surgery, urine culture needs to be performed before surgery.

Contaminated surgical incision was found to be the risk factor for development of SSI. This finding is consistent with those reported in several previous studies performed in urology and general surgery wards (2, 4, 10, 15-17). Previous studies have reported correlation between wound class and development of SSI, the risk increases with classification of incision, surgeries on clean and clean – contaminated incision carry low risk compared to surgeries performed on contaminated and dirty incisions, which might be accounted for by high loading dose of microbes (7, 18, 19).

Interestingly, shaving less than 30 minutes before surgical procedure on univariate analysis was associated with development of SSI. However, after controlling other factors, on multivariate analysis shaving less than 30 minutes before surgical procedure was found to be protective factor for development of SSI. This result is similar to findings from other previous studies from different geographical settings (7, 20), which documented that increased time lapse between shaving and surgical procedure significantly increases risk for SSI.

The most common source of pathogens causing SSIs is endogenous from patients' own body flora. Bacteria are mainly transmitted to the surgical sites during surgical manipulation. In this study, Gram negative bacteria such as *E. coli* and *Klebsiella pneumoniae* were the most common causes of SSI. Since all surgeries did not involve the opening of gastro-intestinal tract, it was hardly unexpected to find predominance of these bacteria, which are flora of the gut. Due to close proximity of the rectum and site of incision, possibly the organisms may have ascended from the rectum. Our results are consistent with those from the previously reported studies among patients who underwent open urological procedures (14, 21).

Recent studies in Tanzania have reported increased rate of antibiotic resistance among bacteria causing SSI (6, 22, 23). Consistent with those reports (22, 24, 25), in this study Gram negative bacteria causing SSI were highly resistant to ceftriaxone, which is commonly used for surgical antimicrobial prophylaxis. Bacteria resistance to third generation cephalosporin is on increasing trend in Tanzania, an observation that calls for further studies to assess the effectiveness of use of third generation cephalosporin as prophylaxis to prevent SSI.

Conclusion: The rate of SSI among patients undergoing urological surgery was high. History of pre-operative urinary tract infections and contaminated wounds were predictors for SSI. Most of Gram-negative bacteria isolated from SSI were highly resistant to ceftriaxone and other commonly used antibiotics.

List Of Abbreviation

CI Confidence interval

MNH Muhimbili National Hospital

SSI Surgical site infection

Declarations

Ethical approval

The ethical approval was obtained from Muhimbili University of Health and Allied Sciences, Senate Research and Publications Committee. Written informed consent was obtained from all study participants prior to enrollment.

Competing interests

The authors declare no any competing interests.

Author´s contributions

JM conceived idea, design, analysis and drafting of manuscript. UK helped in drafting manuscript and performed experiment. VS collected data and analysis SY participated in conception and revised the manuscript. EL revised the manuscript.

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Tables

Table 1: The rate of SSI among patients who underwent open urological surgeries between August 2015 and March 2016 at MNH

Variables	Total	Frequency	SSI (%)
Age in years			
≤17	27	3	11.1
18-35	29	9	20.7
36-53	39	8	20.5
54-71	47	13	27.7
>71	40	7	28
Sex			
Male	144	32	22.2
Female	38	8	21.1
Comorbidities			
Diabetic mellitus	6	2	33.3
Hypertension	50	13	26.0
Diabetic mellitus+Hypertension	27	7	25.9
No comorbidities	99	18	18.2
Cigarette smoking			
Yes	18	3	16.7
No	164	37	22.6
Days admitted			
One day	69	14	20.3
2 days	47	7	14.9
3 days	16	1	6.2
>3 days	50	18	36
Shaving			
Within 30 minutes	38	12	31.6
>30 minutes	23	9	39.1
No need	121	19	15.7
Catheterization			
inserted	71	24	33.8
Not inserted	111	16	14.4
Pre-operative urinary tract infection			
Yes	44	26	59.1
No	138	14	10.1
Duration of surgery (Minutes)			
≤ 90	55	7	12.7
>90	127	33	26.0
Type of wound			
Clean	38	2	5.3
Clean contaminated	127	29	22.8
Contaminated	17	9	52.9

Table 2: Predictors of SSI among patients who underwent open urological surgery between August 2015 and March 2016 at MNH

Variable	Number of patients	Rate of SSI n (%)	cOR	95%CI	P value	aOR	95%CI	P value
Age (years)								
≤17	27	3(11.1)	1					
18 – 35	29	9(31.0)	2.087	0.466 – 9.346	0.336			
36 – 53	39	8(20.5)	2.065	0.494 – 8.626	0.320			
54 – 71	47	13(27.7)	3.056	0.785 – 11.915	0.107			
>71	40	7(28.0)	2.667	0.659 – 10.786	0.169			
Cigarette smoking								
Yes	18	3(16.7)	0.686	0.188 – 2.500	0.568			
No	164	37(22.6)	1					
Comorbidities								
Diabetic mellitus	6	2(33.3)	2.25	0.38 – 13.24	0.37			
Hypertension	50	13(25.5)	1.54	0.68 – 3.46	0.25			
DM + Hypertension	27	7(26.9)	1.66	0.61 – 4.53	0.33			
No comorbidities	99	18(18.2)	1					
Days admit pre-operation								
1 day	69	14 (20.3)	1					
2 days	47	7(14.9)	0.687	0.254 – 1.859	0.460			
3 days	16	1(6.3)	0.262	0.032 – 2.155	0.213			
>3 days	50	18(36.0)	2.210	0.970 – 5.034	0.059			
Shaving								
Within 30 minutes	38	12(31.6)	2.478	1.068 – 5.747	0.035*	0.26	0.09-0.79	0.02*

>30 minutes	23	9(39.1)	3.451	1.308 – 9.105	0.012*	0.420	0.12 – 1.45	0.170
No need	121	19(15.7)	1					
Catheterization								
Inserted	71	24(33.8)	3.032	1.472 – 6.246	0.003*	1.670	0.664-4.198	0.275
Not inserted	111	16(14.4)	1					
Pre-operative urinary tract infection								
Yes	44	26(59.1)	12.794	5.655 – 28.94	<0.001*	9.73	3.93-24.09	<0.001*
No	138	14(10.1)	1					
Wound class								
Clean	38	2(5.1)	1					
Clean contaminated	127	29(23.0)	5.327	1.209 – 23.46	0.027			
Contaminated	17	9(53.0)	20.250	3.651 – 112.3	0.001*	25	2.58-242.42	0.005*
Duration of surgery								
0 to 90 minutes	55	7(17.5)	1					
>90 minutes	127	48(33.8)	2.407	0.992 – 5.842	0.052			

- Statistically significant