Original Article

Epidemiology of Surgical Site Infection Following Abdominal Surgeries at a Reference Hospital in North-West Cameroon

Ngwa T. Ebogo Titus[1,2], **Joy R. Nzinga**[1], **Ndouh R. Nchufor**[1,3], **Tamufor E. Njuma**[2], **Liekeh M. Ntih**[1], **Guylene R. Sena**[1,2], **Christopher T. Pisoh**[1]

[1]Department of Clinical Sciences, Faculty of Health Sciences, The University of Bamenda, [2]Department of Surgery, Nkwen Baptist Hospital, Cameroon Baptist Convention Health Services, [3]Regional Hospital Bamenda, Cameroon

Abstract

Background: Though abdominal surgery is a risk factor for surgical site infection (SSI), limited data exist in this environment on the burden and risk factors of SSI following abdominal surgeries in our setting. **Aim:** The aim of this article is to study the prevalence, risk factors, and outcome of SSI following abdominal surgeries at the Mbingo Baptist Hospital, Bamenda, North-West Region, Cameroon. **Materials and Methods:** This was a hospital-based retrospective cross-sectional study. We reviewed records of all patients who underwent an abdominal surgery at the Mbingo Baptist Hospital from January 2020 to December 2020. We excluded patients under the age of 18 and patients who died in the early post-op without developing an SSI. For each participant, we collected socio-demographic data, clinical features, and factors related to the surgery and its outcome. **Results:** A total of 304 (25.7% males) participants with a mean age of 40.8 years (SD ±15 years) were enrolled. In all, 37/304 participants developed SSI giving an overall prevalence of 12.2%. The incidence was higher in males and in emergency procedures. The spectrum of infection ranged from superficial (19%) to organ space (64%) through deep SSI (14%). Human immunodeficiency virus, operatory time >4 h, contaminated/dirty procedures, and gastrointestinal perforation repair were independently associated with SSI. Length of hospital stay (days) was significantly higher in patients who developed SSI (18.0 vs. 4.0). An overall mortality of 2% with case fatality of 19% was recorded. **Conclusion:** SSI remains a common complication of abdominal surgeries. Prompt recognition and control of potentially modifiable risk factors may improve the burden and outcomes in this high-risk population.

Keywords: *Abdominal surgery, incidence, outcomes, risk factors, surgical site infection*

Introduction

The European Centre for Disease Prevention and Control defines a surgical site infection (SSI) as an infection that occurs within 30 days after the operation and involves the skin at the incision site or any part of the anatomy other than the incision that was opened or manipulated during an operation.[1] For surveillance classification purposes, SSIs are divided into incisional and organ/space SSI. Incisional SSI is further classified into superficial incisional SSI and deep incisional SSI.[1,2]

SSI is the second-most common type of healthcare-associated infection and one of the most common nosocomial infections that cause an increase in morbidity, mortality, economic costs, days of hospitalization, and use of antibiotics in a number of surgical procedures.[3,4] It has been demonstrated that SSIs are considered culprit for 38–40% of all hospital-acquired infections and may complicate up to 2–5% of all operations run annually in the USA.[5] In Cameroon, an incidence rate of up to 30.7% has been reported with main risk factors identified being age, status of surgery with higher rates among emergency surgeries, type of surgical procedure, wound contamination class with the rate increasing significantly with the wound contamination class, American Society of Anesthesiology (ASA) score, and preexisting remote site infection.[6-8] Abdominal surgery has been identified as an independent risk factor of SSI and the most commonly performed major surgical procedures in our setting.[9,10] This study was aimed at finding more about the prevalence, spectrum, risk factors of SSIs, and outcome of SSIs and will therefore be essential in the prevention and management of SSIs.

Materials and Methods

Study setting and patients

We carried out a hospital-based retrospective study at the Mbingo Baptist Hospital,

How to cite this article: Ebogo Titus NT, Nzinga JR, Nchufor NR, Njuma TE, Ntih LM, Sena GR, *et al.* Epidemiology of surgical site infection following abdominal surgeries at a reference hospital in North-West Cameroon. J West Afr Coll Surg 2021;11:1-6.

Received: 08-Mar-2022
Accepted: 15-Mar-2022
Published: 12-Jul-2022

Address for correspondence:
Dr. Ngwa T. Ebogo Titus, Department of Clinical Sciences, Faculty of Health Sciences, The University of Bamenda, P. O. Box 39 Bambili, North West Region, Cameroon.
E-mail: ngwa.ebogo@uniba.cm

Access this article online
Website: www.jwacs-jcoac.org
DOI: 10.4103/jwas.jwas_51_22
Quick Response Code:

Bamenda: a 310-bed capacity referral hospital in the rural North-West Region of Cameron. We reviewed files of all patients who had an abdominal surgery between January 2020 and December 2020 for inclusion in the study. Excluded from this study were patients who died during the surgery or in the early post-operative period or before discharge without developing an SSI and patients less than 18 years of age.

The sample size was calculated using the Cochran's formula:

$$n = \frac{p\,(100-p)Z^2}{E^2}$$

where p=% of occurrence of state or condition. In this case, we shall use 9.16% which was obtained in Yaounde (2013) by Ntsama *et al*.[7]: Z=1.96 (i.e., for a 95% confidence interval [CI], E= 5%, n = 9.16 (100–9.16)(1.96)^2/52 = 128.

Study procedure

Ethical clearance for the study was obtained from the Institutional Review Board of the Faculty of Health Sciences, University of Bamenda (2021/032H/UBa/IRB) and the Cameroon Baptist Convention Health Board Institutional Review Board (IRB2021-20). Participants were recruited using consecutive non-probability sampling including all files fulfilling the inclusion criteria. Identification codes were attributed to all participants to ensure anonymity throughout the study. The theatre registers were consulted in order to identify patients who had an abdominal surgery within our study period. Their records were reviewed to sort out inclusion and exclusion criteria, after which the variables of interest were collected. The variables of interest were collected using a well-designed data collection form. At the end of daily collection, completed forms were assessed, validated, and stored. Statistical Package for Social Sciences (SPSS) version 25 was used to analyse data. Continuous variables were expressed as means ± SD (standard deviation) for normally distributed data or median with corresponding interquartile range (IQR) for skewed distributions. Categorical variables were expressed as proportions or percentages. The χ^2 and Fisher's exact tests (when expected counts will be <5) were used for comparison of qualitative variables between SSI spectrum and comorbidities/associated factors in different patient groups, and where applicable, P-values <0.05 were considered significant. Student's t-test was used to compare the means for continuous variables between the two groups.

Results

A total of 304 patients were included in the study, of which 78 (25.7%) patients were males and 226 (74.3) patients were female. The age range was 18–85 years with a mean age of 40.8 years and a standard deviation of 15 years.

A total of 37 patients developed SSI, thus giving an overall prevalence of 12.2%. Of the 204 female patients, 22 female patients developed SSI giving an incidence of 10.8% among females and of the 63 men included, 15 men developed SSI giving a prevalence of 23.8% among males (P < 0.001). Of the patients who developed SSI, the highest prevalence was seen in patients living with human immunodeficiency virus (HIV), 8 (21.6%) patients; hypertension, 5 (13.5%) patients; and patients who had a blood transfusion peri-operatively, 5 (13.5%). SSI was higher in emergency abdominal surgeries (20.7%) than elective cases (4.9%). The prevalence of SSI increased with increasing wound class and increasing ASA score. SSI occurred in 12/231 (4.9%) patients with clean and clean-contaminated wound classes and 25/61 (41%) patients with contaminated and dirty wounds; 4/8 (50%) patients with ASA scores 3 and 4 had SSI and 33/292 (11.3%) patients with ASA 1 or 2 had SSI. The procedures with the highest rates of SSI were in gastrointestinal (GI) perforation repairs (75%), cholecystectomy (33.3%), and abdominal washout (30%).

In our study population, SSI ranged from superficial to organ space with most cases (67%, n = 25/37) being organ space SSI.

In the univariate analysis, age and sex were the only sociodemographic factors [Table 1] that are significantly associated with SSI (P= 0.026 and 0.027, respectively). The only comorbidity [Table 2] significantly associated with SSI was HIV (P = 0.001). Surgical factors [Table 3] significantly associated with SSI were emergency surgeries, ASA scores of 3 and 4, contaminated and dirty wounds, the use of an abdominal drain, and the duration of surgery >4 h. In our study population, GI perforation repair and caesarean section (C/S) were significantly associated with SSI in the univariate analysis (P-values 0.03 and <0.001, respectively) [Table 4].

After adjustment, SSI was independently positively associated with operatory time > 4 h (adjusted odds ratio [AOR] 8.35; 95% CI 1.31–53.18; P = 0.02), wound class (contaminated/dirty) (AOR 6.54; 95% CI 1.8–24; P = 0.005), HIV (AOR 13.29; 95% CI 3.6–48.6; P < 0.001), and GI perforation repair (AOR 9.7; 95% CI 2.4–39.2; P = 0.001) on multivariate analysis [Table 5].

Table 1: Sociodemographic factors associated with SSI (univariate analysis)

Variables		SSI no	SSI yes	*P*-value	OR (95% CI)
Sex	Male	63 (23.6%)	15 (40.5%)	0.027	2.21 (1.08–4.51)
	Female	204 (76.4%)	22 (59.5%)		
Age	≤50	210 (78.7%)	23 (62.2%)	0.026	2.24 (1.09–4.64)
	>50	57 (21.3%)	14 (37.8%)		
Religion	Christian	261 (97.8%)	36 (97.3%)	0.6	1.2 (0.14–10.3)
	Others	6 (2.2%)	1 (2.7%)		

Table 2: Comorbidities associated with SSI (univariate analysis)

Variables	SSI no	SSI yes	*P*-value	OR (95% CI)
Diabetes	4	0	0.59	—
Hypertension	23	5 (13.5)	0.36	1.66 (0.59–4.67)
HIV	12	8 (21.6)	0.001	5.86 (2.21–15.52)
Obesity	3	0	0.68	—
Cancer	43	6 (16.2)	0.57	1.01 (0.40–2.56)
Systemic infection	0	1 (2.7)	0.12	—
Remote infection	0	2 (5.4)	0.01	—
Peri-Op transfusion	27	5 (13.5)	0.35	1.39 (0.50–3.86)
Alcohol	12	1 (2.7)	0.52	0.59 (0.08–4.68)
Smoking	8	1 (2.7)	0.7	0.90 (0.11–7.4)
Previous abdominal surgery	54	8 (21.6)	0.84	1.09 (0.47–2.52)

Table 3: Surgical factors associated with SSI (univariate analysis)

Variable		SSI no	SSI yes	*P*-value	OR (95% CI)
Type of surgery	Elective	156 (58.4%)	8 (21.6%)	<0.001	5.1 (2.25–11.56)
	Emergency	111 (41.6%)	29 (78.4%)		
ASA score	ASA 1 and 2	259 (97.0%)	33 (89.2%)	0.045	3.9 (1.12–13.75)
	ASA 3 and 4	8 (3.0%)	4 (10.8%)		
Wound class	Clean/clean contaminated	231 (86.5%)	12 (32.4%)	<0.001	13.4 (6.2–29.0)
	Contaminated/dirty	36 (13.5%)	25 (67.6%)		
Drain used	Yes	29 (10.9%)	19 (51.4%)	<0.001	8.7 (4.1–18.4)
Duration of surgery	≤ 4 h	261 (97.8%)	32 (86.5%)	0.005	6.8 (2.0–23.5)
	>4 h	6 (2.2%)	5 (13.5%)		

ASA = American Society of Anesthesiology

Table 4: Surgical procedures associated with SSI (univariate analysis)

Variable	SSI no	SSI yes	*P*-value	OR (95% CI)
C/S	65 (24.3%)	3 (8.1%)	0.03	0.24 (0.08–0.92)
Appendicectomy	4 (1.5%)	0 (0.0%)	0.59	—
Bowel resection and anastomosis	27 (10.1%)	6 (16.2%)	0.26	1.72 (0.66–4.5)
GI perforation repair	5 (1.9%)	15 (40.5%)	<0.001	35.7 (11.87–107.51)
Hernia repair	27 (10.1%)	3 (8.1%)	0.49	0.78 (0.23–2.73)
Abdominal washout	7 (2.6%)	3 (8.1%)	0.11	3.28 (0.81–13.28)
Hysterectomy	43 (16.1%)	0 (0.0%)	0.01	—
Myomectomy	13 (4.9%)	0 (0.0%)	38	—
Cholecystectomy	2 (0.7%)	1 (2.7%)	0.32	3.68 (0.33–41.62)
Gastroduodenostomy	26 (9.7%)	2 (5.4%)	0.55	0.53 (0.12–2.33)
Urolithotomy	10 (3.7%)	2 (5.4%)	0.65	1.47 (0.31–6.98)
Nephrectomy	5 (1.9%)	0 (0.0%)	0.52	—
Salpingo-oophorectomy	20 (7.5%)	2 (5.4%)	0.48	0.71 (0.16–3.15)
Cholecystojejunostomy	9 (3.4%)	0 (0.0%)	0.31	—
Heller myotomy	4 (1.5%)	0 (0.0%)	0.59	—

C/S = caesarean section; GI = gastrointestinal

Evaluating the outcome based on post-operative hospital stay and SSI, the median length of hospital stay in the study population was 4.0 (3.0–8.0) days. The length of hospital stay was significantly longer in the SSI group (18.0 vs. 4.0 days) ($P < 0.001$), as shown in Tables 6 and 7. Also, length of hospital stay in our study population significantly increases with an increase in SSI class ($P < 0.001$), as indicated in Table 7. Of the 304 patients, 37 developed SSIs and 6 died as a result of SSI giving a mortality of 2% and a case fatality of 16.2%. Death was not significantly higher in organ space SSI when compared with superficial and deep SSI [Table 8].

Discussion

In this hospital-based retrospective study, we sought to analyse the prevalence, risk factors, and outcome of SSI among patients undergoing abdominal surgery in a tertiary hospital. We observed an incidence of 12.2% of SSIs with 67% being organ space SSI. In all, 75% of gastrointestinal perforation

Table 5: Factors associated with SSI (multivariate analysis)

Variable	OR (95% CI)	AOR	95% CI	Adjusted *P*-value
Age >50	2.24 (1.09 – 4.64)	1.17	0.41–3.35	0.77
Male sex	2.21 (1.08 – 4.51)	0.76	0.26–2.23	0.62
Emergency surgery	5.1 (2.25–11.56)	1.84	0.61–5.53	0.28
ASA	3.9 (1.12–13.75)	1.46	0.28–7.67	0.66
Drain	8.7 (4.1–18.4)	1.70	0.55–5.21	0.36
Contaminated/dirty wound	13.4 (6.2–29)	6.54	1.78–24.04	0.005
Op time (> 4 h)	6.8 (2.0–23.5)	8.35	1.31–53.18	0.02
HIV	5.86 (2.21–15.52)	13.29	3.63–48.63	<0.001
GI perforation repair	35.7 (11.87–107.51)	9.69	2.4–39.24	0.001
CS	0.24 (0.08–0.92)	1.18	0.24–5.9	0.84

CS = caesarean section, GI = gastrointestinal, ASA = American Society of Anesthesiology

Table 6: Effect of SSI on post-operative hospital stay

Variable	Total	SSI no	SSI yes	*P*-value
Post-op hospital stay*	4.0 (3.0–8.0)	4.0 (3.0–6.0)	18.0 (9.5–25.5)	<0.001

*Median (IQR)

Table 7: Post-operative hospital stay within SSI class

Variable	Superficial	Deep	Organ space	*P*-value
Post-op hospital stay*	11.0 (8.5–15.5)	18.0 (7.0–23.0)	20.0 (9.0–29.0)	<0.001

*Median (IQR)

Table 8: Univariate analysis of death and SSI group

Type of SSI	Dead	Alive	*P*-value	OR (CI)
Superficial/deep	2 (33.3%)	11 (35.5%)	0.65	0.9 (0.1–5.8)
Organ space	4 (66.7%)	20 (64.5%)		

repairs developed SSI. HIV (AOR 13.29; 95% CI 3.6–48.6; $P < 0.001$), operatory time >4 h (AOR 8.35; 95% CI 1.31–53.18; $P = 0.02$), wound class (contaminated/dirty) (AOR 6.54; 95% CI 1.8–24; $P = 0.005$), and GI perforation repair (AOR 9.7; 95% CI 2.4–39.2; $P = 0.001$) were independently associated with SSI. The median length of hospital stay was significantly higher in patients who developed SSI (18.0 vs. 4.0 days, $P < 0.001$). An overall mortality of 2% with case fatality of 19% was recorded.

The prevalence of SSI following abdominal surgery in our study was 12.2%. This high prevalence could be related to the systematic use of pre-operative prophylactic antibiotics which promotes microbial resistance to antibiotics. Nevertheless, this value is in accordance with the worldwide prevalence reported by Bhangu *et al.*[11] to be 12.3%. However, this finding is lower than that reported by Yaouba *et al.*[6] in Cameroon and Nwankwo *et al.*[12] in Nigeria, who reported global prevalence rates of 30.7% and 20.3%, respectively. Other studies from high- and low-income countries also reported higher rates such as 17% in USA, 16.3% in Saudi Arabia, and 17.4% in Iran.[5,13,14] The lower prevalence in our study can be associated with the retrospective nature of our study, which does not allow active screening of SSI and post-discharge follow-up as seen in the above prospective studies. This may account for our lower prevalence of superficial SSI, which is most often diagnosed and managed as outpatient during post-discharge follow-up. The prevalence was higher in males than in females (19% vs. 10%). This observation could be due to the difference in the nature of surgeries carried out on males and females, with females having relatively cleaner surgeries such as caesarean sections and other obstetric and gynaecological surgeries. Similar trends have been observed by Aghdassi *et al.*[15] in Germany who reported rates of 3.9% and 2.6% in males and females, respectively. The difference in magnitude of our results could be explained by the difference in sizes of our study populations with over 1.2 million participants over a 10-year period in the above study. HIV was the comorbidity with the highest prevalence of 40% in our study, which is similar to that reported by Zhang *et al.* in China[16] (47.5%). These findings seem conceivable given that the immunodepressed status of HIV patients favours the proliferation of microorganisms responsible for SSIs. Emergency surgeries had a significantly higher prevalence than elective procedures (20.7% vs. 4.9%). Similar observations have been made in multiple studies.[8,10,13] Among others, Alkaaki *et al.*[13] reported a prevalence of 37.5% and 9.7% within emergency and elective surgeries, respectively, in Saudi Arabia. Also Agrawal and Singh[8] and Işık and co-workers[10] reported higher rates of SSI in emergency surgeries. This could be explained by the limited time available to identify and correct potentially modifiable risk factors of SSI in emergency surgeries. The prevalence of SSI was found to increase significantly with increasing wound class, with rates of prevalence up to 50% observed in dirty wounds. Akoko *et al.*[17] and Mawalla *et al.*[18] all reported similar findings in Tanzania. Wound class depicts the level of exposure of the surgical site to contaminants and is therefore directly related to SSI. There was a significant increase in SSI rates with increasing ASA score. Rates of up to 100% were observed with ASA 4. This finding is however confounded by the fact that a single case of ASA 4 was recorded. Yaouba *et al.*[6] reported a similar trend in the northern part of Cameroon.

The spectrum of SSI in our study population ranged from superficial to organ space, with most cases (67%) being organ space SSI. This is in contrast with multiple studies reporting higher rates of superficial SSI, with organ space SSIs ranging only from 9% to 29.6%.[13,18,19] For instance, Mawalla *et al.*[18] reported 86.2% of SSI being superficial SSI. This difference could be explained by the difference in study designs. The above studies were prospective studies with 30-day post-discharge follow-up, allowing more cases of superficial SSIs to be identified after discharge. In our study however, limited data were available for the discharged patients, leaving us with mostly in-hospital cases of SSIs which were mostly organ space SSIs. This hypothesis is supported by Gaynes *et al.*[20] who reported that most of the post-discharge surveillance cases of SSI in the USA were superficial (78%).

Factors associated with SSI in our study were: HIV, length of surgery >4 h, contaminated and dirty procedures, and GI perforation repair. HIV-positive patients were significantly more likely to develop SSI with a prevalence of up to 40% among HIV patients (AOR 13.29; 95% CI 3.6–48.6; $P < 0.001$). Very few studies have been done to assess the independent association of HIV with SSI; however, Zhang *et al.*[16] reported prevalence rates of 47.5%, whereas Akoko *et al.*[17] reported a five times likelihood for HIV patients to develop SSI. Our study showed that surgeries that lasted more than 4 h were eight times more likely to develop an SSI (AOR 8.35; 95% CI 1.31–53.18; $P = 0.02$). Several studies agree on the fact that longer operation time is associated with significantly higher incidence of SSI, with cut-off time varying from 2 to 4 h and a linear increase in SSI rates with increasing operation time.[14,21-23] Contaminated and dirty wounds were over 6.5 times more likely to develop an SSI (AOR 6.54; 95% CI 1.8–24; $P = 0.005$) with a linear increase in SSI rates with increasing wound class. Multiple studies have identified dirty wounds to be independently associated with SSI, with odd ratios ranging from 2 to 8.[9,17,22] For instance, Mekhla and Borle[22] reported a relative risk of 2.5. This difference in odds ratio can be explained by the fact that our study was focusing on abdominal surgeries, which further increases the likelihood of developing an SSI. GI perforation repair of any type was over nine times more likely to develop SSI (AOR 9.7; 95% CI 2.4–39.2; $P = 0.001$), similar to Horasan *et al.*[24] who identified GI surgery as an independent risk factor for SSI in Turkey. However, Li *et al.*[19] reported that GI perforation is not a risk factor for SSI. This could be explained by the fact that most cases of perforation recorded by Li *et al.* were upper GI perforations with a lower bacterial load as reported in their discussion, whereas most cases of perforation in our study were of lower GI origin from malignant causes with a higher bacterial load. Age was not independently associated with SSI just as reported in a previous study by Ntsama *et al.*[7] in Cameroon. Diabetes and obesity were not associated with SSI in our study. This is in contrast to previous data by Young *et al.*[3] and Aga *et al.*[9] This can be explained by the extremely low frequency of diabetes and obesity in our study (4/304 and 3/304, respectively).

Outcome in our study was assessed in terms of hospital stay, mortality, and case fatality. The length of hospital stay was significantly increased by SSI. We observed a longer median duration of hospital stay of 18.0 (9.5–25.5) days in participants with SSI when compared with 4.0 (3.0–6.0) days in those without SSI. Furthermore, length of hospital stay was further increased with increasing class of SSI. The median length of hospital stay ranged from 11.0 (8.5–15.5) days in superficial SSI to 20.0 (9.0–29.0) days in organ space SSI. Multiple previous studies reported similar findings with significantly longer hospital stay in patients with SSI.[25,26] For instance, Larmasalle *et al.*[25] reported an increase in median length of hospital stay in France from 7 days in the SSI-free patients to 22 days in patients who developed SSI, with the length of hospital stay increasing by at least two-fold for any given procedure if the patient developed SSI. Badia *et al.*[26] reported a longer stay for patients who developed deep SSI when compared with those who developed superficial SSI. The mortality in this study was similar to that observed by Bhangu *et al.*[11] (2% and 1.9%, respectively).

This study is limited based on its retrospective nature, and as such, its result should be applied with caution given that it might not be a true representative of the actual population. The absence of post-discharge information in the patient files may simplify the true magnitude of SSI at the Mbingo Baptist Hospital, given that some discharged patients might have developed SSI not requiring readmission or followed up in another health facility. The assumption therefore that 'patients discharged without developing an SSI and who were not readmitted for SSI, did not develop an SSI' might reduce the true prevalence of SSI in our sample population.

Conclusion

In conclusion, despite all the preventive measures in place, SSI remains a common complication of abdominal surgeries. In this study, it is predominantly a hospital-acquired infection occurring in over 12% of all abdominal surgeries and is independently associated with HIV, operatory time >4 h, wound class (contaminated/dirty), and GI perforation repair. It is also associated with longer hospital stay. Length of hospital stay is further increased by the severity of the SSI. Prompt recognition and control of potentially modifiable risk factors may improve the burden and outcomes in this high-risk population.

Acknowledgements

We acknowledge the Faculty of Health Sciences authorities for authorizing this study and the administration of Mbingo Baptist Hospital for authorizing us to use their databases and medical records for the purpose of this study.

Authors' contribution

TTNE: conceptualization, methodology, formal analysis, resources, review draft, validation. JRN: conceptualization, methodology, formal analysis, investigation, resources, writing original draft. NRN: methodology, editing. TEN: methodology, editing. LMN: methodology, editing. GRS: methodology, editing. TCP: review draft, validation, supervision.

Financial support and sponsorship

This study was funded by the authors and had no external funding.

Conflicts of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that be construed as a potential conflict of interest.

References

1. European Centre for Disease Prevention and Control. 2022. Surveillance of surgical site infections in European hospitals—HAISSI protocol. [Online] Available from: https://data.europa.eu/doi/10.2900/12819. [Last accessed on February 20, 2022].
2. Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG. CDC definitions of nosocomial surgical site infections, 1992: A modification of CDC definitions of surgical wound infections. Infect Control Hosp Epidemiol 1992;13:606-8.
3. Young H, Knepper B, Vigil C, Miller A, Carey JC, Price CS. Sustained reduction in surgical site infection after abdominal hysterectomy. Surg Infect (Larchmt) 2013;14:460-3.
4. Padilla JDV, Reyes JDS, Pineda DR, Muñoz EAB, Rodríguez FAO, Yepes RMB. Surgical site infection. Gen Surg 2019;2:1-3.
5. Bsisu I, Altibi A. Epidemiology of surgical site infections after gastrointestinal resection surgery in Jordan. The 3rd Jordanian Annual Surgical Clinical Congress; 2028.
6. Yaouba D, Ngaroua, Ngah JE, Perpoint T, Mbo Amvene J, Vanhems P, *et al*. Incidence and risk factors for surgical site infections in N'Gaoundéré Regional Hospital, Cameroon. Am J Infect Control 2016;44:1195-6.
7. Ntsama EC, Avomo J, Esiene A, Leme BL, Abologo AL, Masso MP, *et al*. Prevalence of surgical site infections and evaluation of risk factors after surgery, case of three public hospitals in Cameroon. J Med Sci 2013;4:241-6.
8. Agrawal A, Singh RP. Surgical site infection in abdominal surgeries: A clinical study. J Evol Med Dent Sci 2014;3:10188-93.
9. Aga E, Keinan-Boker L, Eithan A, Mais T, Rabinovich A, Nassar F. Surgical site infections after abdominal surgery: Incidence and risk factors. A prospective cohort study. Infect Dis (Lond) 2015;47:761-7.
10. Dündar HZ, Işık O, Kaya E, Sarkut P. Surgical site infection: Re-assessment of the risk factors. Chirurgia 2015;110:457-61.
11. Bhangu A, Ademuyiwa AO, Aguilera ML, Alexander P, Al-Saqqa SW, Borda-Luque G, *et al*. Surgical site infection after gastrointestinal surgery in high-income, middle-income, and low-income countries: A prospective, international, multicentre cohort study. Lancet Infect Dis 2018;18:516-25.
12. Nwankwo E, Ibeh I, Enabulele O. Incidence and risk factors of surgical site infection in a tertiary health institution in Kano, Northwestern Nigeria. Int J Infect Control 2012;8:8-13.
13. Alkaaki A, Al-Radi OO, Khoja A, Alnawawi A, Alnawawi A, Maghrabi A, *et al*. Surgical site infection following abdominal surgery: A prospective cohort study. Can J Surg 2019;62:111-7.
14. Razavi SM, Ibrahimpoor M, Sabouri Kashani A, Jafarian A. Abdominal surgical site infections: Incidence and risk factors at an Iranian teaching hospital. BMC Surg 2005;5:2.
15. Aghdassi SJS, Schröder C, Gastmeier P. Gender-related risk factors for surgical site infections. Results from 10 years of surveillance in Germany. Antimicrob Resist Infect Control 2019;8:95.
16. Zhang L, Liu BC, Zhang XY, Li L, Xia XJ, Guo RZ. Prevention and treatment of surgical site infection in HIV-infected patients. BMC Infect Dis 2012;12:115.
17. Akoko LO, Mwanga AH, Fredrick F, Mbembati NM. Risk factors of surgical site infection at Muhimbili National Hospital, Dar es Salaam, Tanzania. East Central Afr J Surg 2012;17:12-7.
18. Mawalla B, Mshana SE, Chalya PL, Imirzalioglu C, Mahalu W. Predictors of surgical site infections among patients undergoing major surgery at Bugando Medical Centre in Northwestern Tanzania. BMC Surg 2011;11:21.
19. Li Z, Li H, Lv P, Peng X, Wu C, Ren J, *et al*. Prospective multicenter study on the incidence of surgical site infection after emergency abdominal surgery in China. Sci Rep 2021;11:7794.
20. Gaynes RP, Culver DH, Horan TC, Edwards JR, Richards C, Tolson JS, *et al*. Surgical site infection (SSI) rates in the United States, 1992–1998: The National Nosocomial Infections Surveillance System Basic SSI risk index. Clin Infect Dis 2001;33:S69-77.
21. Cheng H, Chen BP, Soleas IM, Ferko NC, Cameron CG, Hinoul P. Prolonged operative duration increases risk of surgical site infections: A systematic review. Surg Infect (Larchmt) 2017;18:722-35.
22. Mekhla, Borle FR. Determinants of superficial surgical site infections in abdominal surgeries at a Rural Teaching Hospital in Central India: A prospective study. J Fam Med Prim Care 2019;8:2258.
23. Korinek AM. Risk factors for neurosurgical site infections after craniotomy: A prospective multicenter study of 2944 patients. The French Study Group of Neurosurgical Infections, the SEHP, and the C-CLIN Paris-Nord. Service Epidémiologie Hygiène et Prévention. Neurosurgery 1997;41:1073-9; discussion 1079-81.
24. Horasan ES, Dağ A, Ersoz G, Kaya A. Surgical site infections and mortality in elderly patients. Med Mal Infect 2013;43:417-22.
25. Lamarsalle L, Hunt B, Schauf M, Szwarcensztein K, Valentine WJ. Evaluating the clinical and economic burden of healthcare-associated infections during hospitalization for surgery in France. Epidemiol Infect 2013;141:2473-82.
26. Badia JM, Casey AL, Petrosillo N, Hudson PM, Mitchell SA, Crosby C. Impact of surgical site infection on healthcare costs and patient outcomes: A systematic review in six European countries. J Hosp Infect 2017;96:1-15.