Surgical site infection following abdominal cancer surgery: a retrospective study in a tertiary care cancer hospital

Shashank Shrestha[1], Binay Thakur[1], Yang Ming[1], Sun Zhenqing[1], Ashish Kharel[1], Deewash Neupane[1]

[1]Department of Surgical Oncology, BP Koirala Memorial Cancer Hospital, Bharatpur, Nepal

Abstract

Background: Surgical site infections (SSIs) are significant complications following abdominal cancer surgery, resulting in patient discomfort, prolonged hospitalization, and increased healthcare costs. Despite efforts to mitigate their occurrence, SSIs remain a challenge in healthcare settings, particularly in low- and middle-income countries**. Materials and Methods**: This retrospective cross-sectional study aimed to determine the incidence, risk factors, microbiological patterns, and impact of SSIs in patients undergoing open abdominal cancer surgery at a tertiary cancer hospital in Nepal. **Results:** A total of 206 patients were included in the study, with an SSI incidence of 35.4%. Superficial SSIs accounted for 87.7% of cases, while 12.2% were deep or organ/space infections. The study explored various risk factors, including patient demographics, wound classification, surgical type, and preoperative conditions, and although certain factors showed associations, none reached statistical significance. Notably, longer surgical duration was linked to a higher risk of SSIs. Patients with SSIs experienced significantly longer hospital stays compared to those without SSIs. The predominant pathogens isolated were Escherichia coli, Staphylococcus aureus, and Citrobacter freundii, many of which displayed multidrug resistance. **Conclusions:** These findings highlight the need for tailored prevention strategies, prudent antibiotic use, and enhanced infection control measures in this high-risk population undergoing abdominal cancer surgery.

Keywords: Surgical site infection, SSI, abdominal surgery, cancer surgery

Introduction

Surgical site infections (SSIs) are infections of the incision or organ or space that occur after surgery.[1] SSIs are one of the most common healthcare-associated infections, affecting patients undergoing abdominal cancer surgery.[2] These infections not only lead to patient discomfort and prolonged hospital stays but also result in increased morbidity, mortality, and financial burden on healthcare systems.[3-5] Abdominal surgeries in particular have been linked with high incidence of SSI ranging from 15%-25% in

Correspondence
Dr. Shashank Shrestha
Department of Surgical Oncology (Thoracic Unit), BP Koirala Memorial Cancer Hospital, Bharatpur, Nepal. Email: shashank920@gmail.com. Phone: +977-9841811335

several prospective studies.[2,6-8] Long-term effects of SSI on cancer patients have been linked to have worse outcomes, including shorter disease-free and overall survival.[9,10] Patients with SSI often experience a longer recovery period, which might cause the delivery of adjuvant therapy to be delayed or skipped altogether, leading to inadequate treatment.[11] Several previous studies have identified cancer as an important risk factor for SSI.[12,13] However, the incidence, risk factors, and implications of SSI in this high-risk population are unknown.

The aims of this study were to describe the incidence and risk factors associated with SSI in patients undergoing abdominal surgery, to study the microbiological pattern of SSI, and to study the effect of SSI on postoperative length of stay.

Methods

Study design

A retrospective cross-sectional study was conducted to investigate SSI rate in patients undergoing abdominal cancer surgery at Department of surgical oncology (Thoracic Unit), BP Koirala Memorial Cancer Hospital, Bharatpur, Nepal between February 2022 to February 2023.

All patients who underwent open abdominal cancer surgery or surgery involving opening of the peritoneum were included in the study. Patients who underwent laparoscopic surgery or non-cancer were excluded from the study. Ethical clearance was provided by Institutional Review Committee of BP Koirala Memorial Cancer Hospital and informed consent was waived off being retrospective study.

Data collection

Data was collected from prospectively maintained database and hospital records. Medical records of patients who underwent abdominal cancer surgery were reviewed to identify cases of surgical site infection. Demographic information, preoperative and postoperative details were collected. Surgical cases were classified according to the degree of contamination at the time of surgery into clean, clean-contaminated, contaminated, and dirty using the CDC wound class definitions.[1] Based on the depth of infection, these SSIs were subsequently categorized into superficial (affecting the skin and subcutaneous tissue), deep (involving muscle and fascia), and organ space infections.

Statistical analysis

Data entry and analysis was done in Statistical software Package for Social Sciences (SPSS version 23). Descriptive statistics were used to summarize patient characteristics, infection rates, and outcomes. Chi square ($\chi 2$) and Fisher's exact tests were used to observe the association. P-value <0.05 was considered statistically significant. Independent sample T test was used to compare duration of surgery and hospital stay. Bivariate analysis was employed to compare risk factors for SSIs.

Results

In total, 206 patients were enrolled in the study, 122 females (59.2%) and 84 males (40.8%) with a mean age of 55 years. Thirty-eight patients were smokers and 43 patients had some sort of comorbidities. Eighty-five patients (41.3%) patients received preoperative chemotherapy.

Age distribution, wound class and type of SSI have been shown in tables 1-3.

Table 1: Age distribution				
Age (yrs)	No SSI	SSI	Total	*p value
<20	2	0	2 (1%)	*0.763
20-39	12	9	21 (10.2%)	
40-59	61	32	93 (45.1%)	
60-79	55	31	86 (41.7%)	
>80	3	1	4(1.9%)	
Total	133	73	206 (100%)	

*Chi-square test

In all, 41 wounds (19.9%) were defined as clean, 151 (73.3%) as clean contaminated, 11 (5.3%) as contaminated, and 3 (1.5%) as dirty. A total of 73 patients developed SSI, thus giving an overall infection rate of 35.4%. Among the 73 cases of SSI, 64 (87.7%) had superficial SSIs and 9 (12.2%) had deep or organ/space infections.

Upper gastrointestinal surgery was the most commonly performed surgery, which had relatively low rate of SSI (21.7%) compared to hepatobiliary and pancreatic surgery (51.8%) and colorectal surgery (42.8%). Palliative surgeries like feeding jejunostomy and palliative gastrojejunostomy had the lowest infection rate of 10.3%. (Table 4)

Table 2: Wound class				
	No SSI	SSI	Total	*p-value
Clean	28	13	41 (19.9%)	*0.341
Clean contaminated	99	52	151 (73.3%)	
Contaminated	5	6	11 (5.3%)	
Dirty	1	2	3 (1.5%)	
Total	133	73	206 (100%)	

*Chi-square test

Table 3: Surgical site infection		
	Frequency	Percent
No SSI	133	64.6
Superficial SSI	64	31.1
Deep SSI	3	1.5
Organ SSI	6	2.9
Total	206	100.0

The results showing the different factors associated with the surgical site infections (SSIs) are summarized in Table 5. The mean hospital stay was 17.86 days. The patients who had SSI had significantly higher hospital stay than those without SSI (15.7 versus 21.8 days). (Table 6) The most commonly isolated bacteria were Escherichia coli (27.4%) followed by Staphylococcus aureus (8.2%) and Citrobacter freundii (6.84%).

Table 4: Type of Surgery				
	No SSI	SSI	SSI rate	*p-value
Upper GI surgery	47	13	21.7%	*<0.001
Hepatobiliary and pancreatic surgery	27	29	51.8%	
Colorectal Surgery	16	12	42.8%	
Small bowel surgery	5	6	54.5%	

Palliative surgery	26	3	10.3%	
Others	12	10	45.5%	

*Chi-square test

Most E. coli isolates were multidrug resistant, and sensitivity mustly seen was Polymyxin B. Most of the isolated organisms were resistant to prophylactic antibiotics with only 3 out of 43 isolates sensitive to prophylactic antibiotics. (Table 7)

Table 5: Risk Factors

		No SSI	SSI	Total	p-value
Smoking	yes	26	12	38 (18.4%)	*0.582
	no	107	61	168 (81.6%)	
ASA grade	1	103	56	159 (77.2%)	*0.905
	2	30	17	47 (22.8%)	
Chemotherapy	yes	64	21	85 (41.3%)	*0.007
	no	69	52	121 (58.7%)	
Age	<60	82	48	130 (63.1%)	*0.560
	>60	51	25	76 (36.9%)	
Diabetes	No	124	68	192 (93.2%)	*0.982
	Yes	9	5	14 (6.8%)	
Comorbidities	No	104	59	163 (79.1%)	*0.722
	Yes	29	14	43(20.9%)	
Hemoglobin	<12 gm/dl	104	55	159 (77.2%)	*0.641
	>12 gm/dl	29	18	47 (22.8%)	
WBC count	<12000	110	59	169 (82%)	*0.850
	>12000	23	14	37 (18%)	
Albumin	<3.5 gm/dl	46	32	78 (37.9%)	*0.191
	>3.5 gm/dl	87	41	128 (62.1%)	
Duration of surgery	<3 hrs	94	39	133 (37.9%)	*0.013
	>3 hrs	39	34	73 (62.1%)	

*Chi-square test

Discussion

SSIs are the most common Health care associated infections (HAIs) reported from low- and middle-income countries and they place a heavy burden on patients' death, morbidity, and additional expenditures on health care systems globally.[14]

Table 6: Hospital stay				
		N	Mean	§p-value
Hospital stays	No SSI	133	15.70	<0.001
	SSI	73	21.8	

§ Independent sample T test

SSI persists despite the measures and hygienic approach used to reduce its incidence and it is the most common postoperative complication. Because of their limited resources, impoverished populations, and high levels of antibiotic resistance, low-income countries may be particularly affected by this situation.[15] The incidence of SSI in this study was 35.4% which is higher than the previous studies. In the study conducted in Nepal by Giri et al had a SSI rate of 23% in abdominal surgery which is a bit lower than our study.[16] Several studies in Nepal has shown much lower infection rates but those studies considered all types of surgeries however this study considered only open abdominal cancer surgeries.[17-19] The incidence of SSI in abdominal surgeries is relatively higher than other surgeries.[7,15,20,21] The outcome might have been worsened by the combination of abdominal surgery and cancer surgery.

Table 7: Culture Isolates		
	Frequency	Percent
Escherichia coli	20	27.4%
Staphylococcus aureus	6	8.2%
Citrobacter freundii	5	6.84%
Pseudomonas aeruginosa	3	4.1%
Klebsiella pneumoniae	2	2.73%
Klebsiella oxytoca	1	1.4%
Enterobacter cloacae	1	1.4%
Acenitobacter sps	1	1.4%
Proteus mirabilis	1	1.4%
Coagulase negative staphylococcus	1	1.4%
Polymicrobial	2	2.73%
No growth	30	41%
Total	73	100.0

Cancer is an independent risk factor for SSI and it also has intraoperative risk factors like prolonged duration of surgery, higher blood loss, intraoperative transfusion etc. which may contribute to increased rate of SSI.[12,13]

Most of the wound was clean contaminated and the rate of SSI increased as the wound class increased from clean to dirty wound from 31% to 66%. The infection rate among different wound classes did not show significant differences ($p = 0.341$). Similar to this study, previous studies have demonstrated that the risk of SSI considerably rises with contamination level.[16,17,22]

Various risk factors were assessed for their association with surgical site infections. Smoking, ASA grade, diabetes, comorbidities, hemoglobin levels, white

blood cell count, and albumin levels were evaluated. However, statistical analysis did not show significant associations between these risk factors and the occurrence of SSIs. This may have been due to the sample size and the specific case mix at our institution. Patients who had received preoperative chemotherapy had lesser SSI, which may be due to response of the tumor and faster and safer surgery.

The longer surgical duration was associated with increased SSI risk ($p = 0.013$) in this study. The impact of longer operating time as a risk factor for SSI has also been examined in several previous studies.[20,23-25] Although it is unclear exactly how prolonged operating times increase the prevalence of SSIs, several studies provide logical explanations. Open incisions are exposed to the environment for a longer period of time during longer operations, increasing the chance of bacterial contamination. Longer operating times put incisions at risk for tissue desiccation, which may also increase the likelihood of contamination.[26,27] As the duration of surgery prolongs, the tissue concentration of antibiotics decreases if not readministered timely. Longer operative times may also mean increased surgical team fatigue resulting in more technical errors and break in aseptic techniques. Furthermore, higher blood loss from longer operations frequently causes tissue hypoxia and need for blood transfusion which is also associated with increased SSI.

Patients who developed SSIs experienced a significantly longer hospital stay compared to those without SSIs (21.8 days vs. 15.7 days, $p < 0.001$). The correlation between SSI development and longer hospital stays is well-established across many studies.[20,28,29] SSIs not only lead to increased healthcare costs but also prolong the recovery process and negatively impact patient satisfaction. Even though we did not assess the economic effects of SSI in our study, it is likely that prolonged hospital stays due to SSI results in greater patient care expenses.

Escherichia coli was the most frequently isolated bacteria in our study, which was consistent with previous studies.[17,20,24] Most of the isolated bacteria were multidrug resistant to commonly prescribed antibiotics which is alarming and judicious use of proper antibiotics is required to fight against antimicrobial resistance. This emphasizes the importance of studying the local sensitivity patterns of bacteria isolated from SSIs in order to guarantee their appropriate treatment. Further consideration regarding selection of proper prophylactic antibiotics will be required. In this study, the majority of pus cultures showed no growth (41%). This might be due to infection by anaerobic bacteria or some fastidious bacteria for which culture facilities are not available at our institution. Also, inappropriate transport or delayed processing of samples may be contributory.

This study had several limitations. It was a retrospective analysis with a relatively small sample size. The study cohort was restricted to abdominal cancer surgery only. Data regarding the method and timing of hair removal at a surgical site, glucose management, hypothermia, duration of pre-operative hospital stay, blood transfusions, timing of chemotherapy and prophylactic antibiotics were not included.

Conclusion

This retrospective study sheds light on the incidence and risk factors associated with SSIs in a cohort of patients undergoing open abdominal cancer surgery. While the overall SSI rate of 35.4% is concerning, further investigation is warranted to identify effective interventions for reducing this burden. The results emphasize the importance of vigilant infection control practices, judicious antibiotic use, and meticulous surgical techniques to minimize the risk of SSIs. The correlation between longer surgical duration and increased SSI risk emphasizes the necessity of efficient operating protocols to mitigate prolonged exposure of surgical sites. Additionally, the identification of multidrug-resistant pathogens highlights the urgency of implementing antimicrobial stewardship programs and tailoring prophylactic antibiotic regimens to local susceptibility patterns. Addressing these challenges is crucial to enhance patient outcomes, optimize healthcare resources, and alleviate the burden of SSIs on patients and healthcare systems alike. Further research involving larger sample sizes and comprehensive data collection is warranted to develop targeted strategies for preventing SSIs in this high-risk population.

References

1. Berríos-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR, et al. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. JAMA Surg. 2017 Aug 1;152(8):784.
2. Azoury SC, Farrow NE, Hu QL, Soares KC, Hicks CW, Azar F, Rodriguez-Unda N, Poruk KE, Cornell P, Burce KK, Cooney CM. Postoperative abdominal wound infection–epidemiology, risk factors, identification, and management. Chronic wound care manag. res. 2015 Sep 22:137-48.
3. Ban KA, Minei JP, Laronga C, Harbrecht BG, Jensen EH, Fry DE, et al. American College of Surgeons and Surgical Infection Society: Surgical Site Infection Guidelines, 2016 Update. J Am Coll Surg. 2017 Jan;224(1):59.
4. Allegranzi B, Nejad SB, Combescure C, Graafmans W, Attar H, Donaldson L, et al. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. The Lancet. 2011 Jan 15;377(9761):228–41.
5. Kirkland KB, Briggs JP, Trivette SL, Wilkinson WE, Sexton DJ. The impact of surgical-site infections in the 1990s: attributable mortality, excess length of hospitalization, and extra costs. Infection Control & Hospital Epidemiology. 1999 Nov;20(11):725-30.
6. Legesse Laloto T, Hiko Gemeda D, Abdella SH. Incidence and predictors of surgical site infection in Ethiopia: prospective cohort. BMC Infect Dis. 2017 Feb 3;17(1):119.
7. 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. 2015 Nov 2;47(11):761–7.
8. 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 surgery. 2011 Dec;11(1):1-7.
9. Nespoli A, Gianotti L, Bovo G, Brivio F, Nespoli L, Totis M. Impact of postoperative infections on survival in colon cancer patients. Surgical infections. 2006 Jun 1;7(Supplement 2):s-41.
10. Tsujimoto H, Ichikura T, Ono S, Sugasawa H, Hiraki S, Sakamoto N, et al. Impact of Postoperative Infection on Long-Term Survival After Potentially Curative Resection for Gastric Cancer. Ann Surg Oncol. 2009 Feb 1;16(2):311–8.
11. Aloia TE, Lee JE, Vauthey JN, Abdalla EK, Wolff RA, Varadhachary GR, Abbruzzese JL, Crane CH, Evans DB, Pisters PW. Delayed recovery after pancreaticoduodenectomy: a major factor impairing the delivery of adjuvant therapy?. J Am Coll Surg. 2007 Mar 1;204(3):347-55.

12. Bot J, Piessen G, Robb WB, Roger V, Mariette C. Advanced tumor stage is an independent risk factor of postoperative infectious complications after colorectal surgery: arguments from a case-matched series. Dis Colon Rectum. 2013 May 1;56(5):568-76.
13. Kerin Povšič M, Ihan A, Beovič B. Post-operative infection is an independent risk factor for worse long-term survival after colorectal cancer surgery. Surgical Infections. 2016 Dec 1;17(6):700-12.
14. Bardossy AC, Zervos J, Zervos M. Preventing hospital-acquired infections in low-income and middle-income countries: impact, gaps, and opportunities. Infectious Disease Clinics. 2016 Sep 1;30(3):805-18.
15. Zhang J, Xue F, Liu SD, Liu D, Wu YH, Zhao D, Liu ZM, Ma WX, Han RL, Shan L, Duan XL. Risk factors and prediction model for inpatient surgical site infection after elective abdominal surgery. World J Gastrointest Surg. 2023 Mar 27;15(3):387-97.
16. Giri S, Kandel BP, Pant S, Lakhey PJ, Singh YP, Vaidya P. Risk factors for surgical site infections in abdominal surgery: a study in Nepal. Surgical infections. 2013 Jun 1;14(3):313-8..
17. Shrestha S, Wenju P, Shrestha R, Karmacharya R. Incidence and Risk Factors of Surgical Site Infections in Kathmandu University Hospital, Kavre, Nepal. Kathmandu Univ Med J KUMJ. 2016 Apr 1;14:107–11.
18. Adhikari S, Khadka S, Sapkota S, Adhikaree N, Shrestha B, Parajuli A. Surgical Site Infections are the Pool of Antibiotic Resistant Bacteria: Evidence from a Tertiary Hospital in Nepal. Anti-Infect Agents. 2021 Oct 1;19(5):22–9.
19. Chaudhary R, Thapa SK, Rana JC, Shah PK. Surgical Site Infections and Antimicrobial Resistance Pattern. J. Nepal Health Res. Counc. 2017 Sep 8;15(2):120-3.
20. 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 Apr 1;62(2):111–7.
21. Ejaz A, Schmidt C, Johnston FM, Frank SM, Pawlik TM. Risk factors and prediction model for inpatient surgical site infection after major abdominal surgery. J Surg Res. 2017 Sep 1;217:153–9.
22. Giri BR, Pant HP, Shankar PR, Sreeramareddy CT, Sen PK. Surgical site infection and antibiotics use pattern in a tertiary care hospital in Nepal. JPMA J Pak Med Assoc. 2008 Mar 1;58(3):148–51.
23. Cheng H, Chen BPH, Soleas IM, Ferko NC, Cameron CG, Hinoul P. Prolonged Operative Duration Increases Risk of Surgical Site Infections: A Systematic Review. Surg Infect. 2017 Aug;18(6):722–35.
24. Al-hajri A, Ghabisha S, Ahmed F, Al-wageeh S, Badheeb M, Alyhari Q, et al. Identification of predictive factors for surgical site infections in gastrointestinal surgeries: A retrospective cross-sectional study in a resource-limited setting. F1000Research. 2023 Jun 23;12:733.
25. Misha G, Chelkeba L, Melaku T. Incidence, risk factors and outcomes of surgical site infections among patients admitted to Jimma Medical Center, South West Ethiopia: Prospective cohort study. Ann Med Surg. 2021 May 1;65:102247.
26. Nguyen TJ, Costa MA, Vidar EN, Shahabi A, Peric M, Hernandez AM, et al. Effect of Immediate Reconstruction on Postmastectomy Surgical Site Infection. Ann Surg. 2012 Aug;256(2):326.
27. Haridas M, Malangoni MA. Predictive factors for surgical site infection in general surgery. Surgery. 2008 Oct 1;144(4):496–503.
28. Monahan M, Jowett S, Pinkney T, Brocklehurst P, Morton DG, Abdali Z, et al. Surgical site infection and costs in low- and middle-income countries: A systematic review of the economic burden. PLOS ONE. 2020 Jun 4;15(6):e0232960.
29. Kolasiński W. Surgical site infections- review of current knowledge, methods of prevention. Pol J Surg. 2018 Nov 6;90(5):1–7.