Cross-sectional Study

ANNALS OF MEDICINE & SURGERY

OPEN

Prevalence and risk factors of post-cholecystectomy surgical site infections

Ruba E. Masaod, MBBS[a,*], Mugahid A. Salih, MBBS, MSc, MRCSEd, MD[b,c]

Objectives: The objectives of this study were to measure the prevalence of post-cholecystectomy surgical site infection and identify the associated risk factors and their association with its prevalence.

Method: A cross-sectional analytical study including all patients who underwent cholecystectomy in the period from January 2021 to March 2022. The data sheet was filled with records of the patients, and some questions were asked of the patients directly. Many risk factors were assessed and measured in their association with the development of postoperative SSI.

Results: One hundred seventy-two patients with a mean age of 46.41 ± 13.37 participated in the study. Thirty-five (20.3%) of them were males, and 137 (79.7%) were females. Open cholecystectomy 121 (70.3%) was done more than laparoscopic cholecystectomy 51 (29.7%). The most common indication for cholecystectomy was found to be both cholecystitis and cholelithiasis (53.5%). Out of 172 patients, postoperative wound infection [surgical site infection (SSI)] developed in 29 (16.9%) patients. Of these, 8 (27.6%) were males, while 21 (72.4%) were females, with a mean age of 46.38 (SD = 14.12) years. Prophylactic antibiotics intraoperatively and therapeutic antibiotics postoperatively were found to decrease the risk of developing SSI [$P = 0.005$, odds ratio (OR) = 0.073] ($P = 0.012$, OR = 0.153), respectively. However, hospital stay after surgery (< 1 week) was also found to decrease the risk ($P = 0.001$, OR = 0.179).

Conclusions: The prevalence of post-cholecystectomy SSI is high despite a small sample size in comparison with other studies. Prophylactic antibiotics and short hospital stays have an important role in decreasing the risk of developing postoperative SSI.

Keywords: cholecystectomy, cholecystitis, postoperative, prevalence, risk factors, surgical site infection (SSI)

Introduction and background

Surgical site infections (SSIs) are an important cause of morbidity, mortality, and healthcare costs. They account for ~20% of hospital-acquired infections[1–3].

SSI is identified by the CDC's USA definition as an infection that would be considered a surgical site infection if it occurs within 30 days of the procedure and has at least one of the following: purulent drainage from the wound, pain or tenderness, localized swelling, redness, malodor, fever."[4]

Nosocomial (i.e. hospital-acquired) infections are defined as any infection that is not present or incubated at the time of admission and occurs 48 h or more after admission[5]. They are not only an important cause of morbidity and mortality, but they are also considered an economic burden throughout the world[6].

HIGHLIGHTS

- To decrease the prevalence of post-cholecystectomy surgical site infection, we need to act on the risk factors
- Antibiotic at induction should be given for each patient will undergo cholecystectomy.
- Postoperative antibiotics has significant value to decrease the risk of developing surgical site infection in some patients.
- It is better to decrease the presence of patients in the hospital to decrease their contact to the nosocomial pathogens.

When patients undergo invasive procedures, this increases the risk of these infections by providing an opportunity for nosocomial pathogens to find their way into the body[4]. The common endogenous pathogens isolated from the surgical site following gastrointestinal operations usually include gram-negative enteric pathogens (e.g. *E. coli*), Gram-positive cocci (e.g. *Enterococci*), and sometimes anaerobes (e.g., *Bacteroides fragilis*)[7].

The proportion of SSI gives an idea about the quality of surgical treatment and strongly affects its total cost[8]. Acute cholecystitis or obstruction was highly associated with an increased risk of SSI with laparoscopic but not open cholecystectomy[9]. Although open cholecystectomy has been consistently associated with a higher risk of SSI, other risk factors for SSI have not been as well established. Older age, male sex, longer duration of surgery, multiple surgical procedures, higher severity of illness, and wound class 3 have been considered independent risk factors for SSI after cholecystectomy[10–18].

[a]Faculty of Medicine, [b]Department of Anatomy, Faculty of Medicine and [c]Department of Surgery, Ibrahim Malik Teaching Hospital , University of Khartoum, Khartoum, Sudan

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

*Corresponding author. Address: Department of Surgery , Faculty of Medicine, University of Khartoum, Khartoum, Sudan. Tel.: +249 128 914 306, +249 992 271 972. E-mail: ruba.altigani99@gmail.com (R.E. Masaod).

Annals of Medicine & Surgery (2023) 85:5428–5432

Received 4 May 2023; Accepted 10 September 2023

Published online 15 September 2023

http://dx.doi.org/10.1097/MS9.0000000000001337

Cholecystectomy is one of the most commonly performed operations in general surgery. While it is a common surgery, it is still a major surgery with some serious risks and complications. SSI is a major infection control concern around the world, and it is a real problem for surgeons. For these reasons, this study was done.

There is limited data on risk factors for SSIs after open or laparoscopic cholecystectomy in our country. Hospitals need to improve the processes of care known to affect SSI rates. In many developing countries, including Sudan, there is no organized surveillance system to describe routine nosocomial infection rates. Therefore, the purpose of this study was to investigate the frequency of SSI and associated risk factors in patients admitted for post-cholecystectomy.

Patients and methods

We conducted a retrospective cross-sectional analytical study using the records of all patients who underwent cholecystectomy from January 2021 until April 2022, so we did not need to follow up with the patients. After getting ethical approval from the Khartoum state Ministry of Health Research and hospitals, data were collected from the well-structured medical records of patients who had undergone cholecystectomy at the time of data collection, including operational sheets and anaesthetic sheets, using a structured and well-prepared data sheet as a tool of data collection.

Inclusion criteria

All age groups, both males and females, who underwent cholecystectomy at the time of data collection were included in the study.

Exclusion criteria

Incomplete records, and patients who do not have access to them or refuse to answer.

We analyzed and described the data using SPSS version 26. Continuous data were presented as mean ± SD, and categorical data were presented as numbers (percentage). We used the Kolmogorov–Smirnov test to check the normality of the data. Risk factors for surgical site infection were initially assessed in univariate analysis using Mann–Whitney U after rejecting the null hypothesis of the Kolmogorov–Smirnov test of normal distribution. For categorical data, we used the Fisher exact test to find if there was a significant difference between groups. A multivariate analysis was conducted to determine independent risk factors using logistic regression. A P value less than 0.05 is considered significant. The work has been reported in line with the STROCSS criteria[19].

Results

Of a total of 172 patients, 137 (79.7%) were females, while 35 (20.3%) were males, with a mean age of 46.41 (SD = 13.37) years, with a minimum age of 19 years and a maximum age of 85 years. Ninety-six (55.8%) of the patients have a normal BMI, 23 (13.4%) have a low BMI, and 53 (30.8%) have a high BMI index.11 (6.4%) of the patients are smokers; most of them, 161 (93.6%), are nonsmokers. Regarding alcohol drinking, 1 (0.6%) is an alcohol drinker, and 171 (99.4%) are nondrinkers. Seventeen (9.9%) of the patients were diabetics, 27 (15.7%) were hypertensive, 3 (1.7%) had hepatitis B, 1 (0.6%) had HIV, 8 (4.7%) were asthmatics, 2 (1.2%) had malignancy, and the majority of patients (66.2%) had no illness.

Most of the cholecystectomies were done for both cholecystitis and cholelithiasis, accounting for 92 (53.5%) of the patients; 53 (30.8%) were done for cholelithiasis; and 3 (1.7%) were done for cholecystitis alone. In addition, 24 (14%) of the cholecystectomies

Table 1

Univariate analysis of risk factors of SSI after cholecystectomy.

	SSI development		
Variables	**Yes**	**No**	***P****
Age (year)	46.38±14.12	46.42±13.264	0.88
Sex			0.314
Male	8 (27.6)	27 (18.9)	
Female	21 (72.4)	116 (81.1)	
Smoking			0.09
Yes	4 (13.8)	7 (4.9)	
No	25 (86.2)	136 (95.1)	
BMI			0.373
Low	5 (17.2)	18 (12.6)	
Normal	13 (44.8)	83 (58)	
High	11 (37.9)	42 (24.4)	
Diabetes			0.493
Yes	4 (13.8)	13 (9.1)	
No	25 (86.2)	130 (90.9)	
HTN			1.000
Yes	4 (13.8)	23 (16.1)	
No	25 (86.2)	120 (83.9)	
Steroids			1.000
Yes	1 (3.4)	4 (2.8)	
No	28 (96.6)	139 (97.2)	
Type of cholecystectomy			0.827
Open	20 (69)	101 (70.6)	
Laparoscopic	9 (31)	42 (29.4)	
Cholecystitis			0.540
Yes	18 (62.1)	77 (53.8)	
No	11 (37.9)	66 (46.2)	
Cholelithiasis			1.000
Yes	25 (86.2)	120 (83.9)	
No	4 (13.8)	No: 23 (16.1)	
Malignant tumour (cholangiocarcinoma)			1.000
Yes	4 (13.8)	21 (14.7)	
No	25 (86.2)	122 (85.3)	
Time of operation			0.159
< 2 h	16 (55.2)	101 (70.6)	
2–4 h	11 (37.9)	30 (21)	
>4 h	2 (6.9)	11 (7.7)	
Intraoperative antibiotics induction			**0.002**
Yes	24 (82.8)	141 (98.6)	
No	5 (17.2)	2 (1.4)	
Hospital stay after surgery			**0.001**
< 1 week	18 (62.1)	128 (89.5)	
1–2 week	10 (34.5)	12 (8.4)	
>2 week	1 (3.4)	3 (2.1)	
Postoperative antibiotics			**0.045**
Yes	25 (86.2)	138 (96.5)	
No	4 (13.8)	5 (3.5)	

P-value of $P < 0.05$ was considered to be significant and significant values are highlighted in bold.
Data were presented as Mean±SD and number (percentage).
HTN, hypertension; SSI, surgical site infection.
*Statistical tests performed: Mann–Whitney U test and Fisher's exact test.

were caused by malignant tumours (cholangiocarcinomas). The majority of the operations were open: 121 (70.3%) were open and 51 (29.7%) were laparoscopic. One hundred sixty-five (95.9%) got antibiotics intraoperatively, and 7 (4.1%) of them did not get intraoperative antibiotics. One hundred seventeen (68%) of the cholecystectomies lasted in less than 2 h, 41 (23.8%) lasted in 2–4 hs, and 13 (7.6%) lasted in > 4 h.

One hundred forty-six (84.9%) of the patients stayed at the hospital for less than 1 week, 22 (12.8%) for 1–2 weeks, and 4 (2.3%) for greater than 2 weeks. 163 (94.8%) of the patients were compliant with postoperative antibiotics, and 9 (5.2%) were not.

Out of 172, postoperative wound infection (SSI) developed in 29 (16.9%) patients; of these, 8 (27.6%) were males and 21 (72.4%) were females, with a mean age of 46.38 (SD = 14.12) years. 12 (41.4%) of the patients developed the infection in less than 1 week, 12 (41.4%) developed the infection in 1–2 weeks, and 5 (17.2%) developed the infection in greater than 2 weeks. Out of 9 SSIs from laparoscopic cholecystectomy, 5 (55.6%) developed at the umbilical hole, 3 (33.3%) at the midclavicular hole, and 1 (11.1%) at the epigastric hole (Table 1).

Direct logistic regression assessed the impact of several factors on the occurrence of post-cholecystectomy surgical site infection. This test shows that the factors that appear to be associated with the occurrence of SSI in the above test are considered risk factors; as demonstrated in Table 2, antibiotics either intraoperatively or postoperatively were found to decrease the risk of developing SSI [$P = 0.005$, odds ratio (OR) = 0.073] ($P = 0.012$, OR = 0.153), respectively. However, short hospital stays after surgery (< 1 week) were also found to decrease the risk ($P = 0.001$, OR = 0.179).

Discussion

There are few published data on risk factors for SSI after cholecystectomy. This cross-sectional study was designed to study the prevalence and risk factors of post-cholecystectomy SSIs at both the Ibn Sena specialized hospital and the Soba teaching hospital.

This study identified several risk factors for SSI. in particular, prophylactic antibiotics either intraoperatively or postoperatively. Some patients did not get the prophylactic antibiotics; this might be because of financial issues or because they are incompliant with their use. but they were found to decrease the risk of developing post-cholecystectomy SSI. It is reasonable to surmise that prophylactic antibiotics protect against the invasion of pathogens at the surgical site. These results were inconsistent with previous findings, which showed that the appropriateness of antibiotic prophylaxis showed no significant association with SSI incidence among patients undergoing cholecystectomy[18,20]. This difference may happen due to the setting of our country, Sudan; it lacks a good health system regarding the sterilization and disinfection of the hospitals and the operation room itself, so prophylactic antibiotics appear to be significantly important to decrease the risk of developing SSI in comparison with the developed countries[21].

The study also shows that a short hospital stay decreases the risk of developing postoperative SSI, which is consistent with previous studies[20]. It is reasonable to surmise that a longer postoperative stay would have repercussions in the form of higher SSI incidence due to the risks associated with hospitalization, increased contact with other ill patients, and increased risk for the invasion of pathogens into the surgical site.

Sex and type of cholecystectomy appeared not to be significant when analyzing the data; other previous studies showed that the male gender carried a slight increase in SSI risk[9,10]. However, most of the studies showed that the risk of SSI was significantly lower for laparoscopic cholecystectomy than for open cholecystectomy[9,10,19–22].

Previous studies found that cholecystectomies following either acute cholecystitis or a related neoplasm had a risk of developing postoperative SSI[9,18,20]. We could not capture these associations, and they appeared non-significant. This may result from a variety of causes that led to cholecystectomies, resulting in a small number of patients who had acute cholecystitis and related neoplasms. Other factors that we assessed (age, smoking, obesity, diabetes mellitus, hypertension, steroids use, cholecystitis, cholelithiasis, neoplasm, and operation time) appeared not to be significant; however, they were inconsistent with other previous

Table 2

Multivariate analysis of risk factors of SSI after cholecystectomy ($n = 172$).

Variables in the equation							95% CI for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Step 1[a]								
The hospital stay after surgery			10.502	2	0.005			
The hospital stay after surgery	– 1.720	0.540	10.134	1	0.001	0.179	0.062	0.516
Postoperative antibiotics (1)	– 1.879	0.744	6.371	1	0.012	0.153	0.036	0.657
Induction of antibiotics (1)	– 2.620	0.923	8.066	1	0.005	0.073	0.012	0.444
Constant	2.279	0.293	60.454	1	0.000	9.763		

[a]Variable(s) entered on step 1: hospital stay after surgery, postoperative antibiotics, induction of antibiotics.
B = coefficient for the constant in the null model.
SE = standard error.
Wald = χ^2 test.
df = degree of freedom for χ^2 test.
sig = P value.
Exp(B) = odd ratio.

studies[18,20,21]. We could not elicit these associations in the current study. This might be because the sample size was not large enough to capture these associations.

As far as we know, this is the first study on the prevalence and risk factors of post-cholecystectomy surgical site infection in Sudan. Despite this, we found several limitations. Some of the data were collected from an existing recording system, so a certain percentage of patients with SSI dropped out of the database. The development of the SSI was assessed by asking the patients after they developed the infection (subjective measurement) not to reflect a 30-day follow-up as required by the Centers for Disease Control and Prevention guidelines. There are certain factors covered in previous studies that could potentially influence the SSI rate, but we did not investigate them, which is one of our study's limitations.

Conclusions

Surgical site infection is one of the most serious events that happen after surgery. The prevalence of post-cholecystectomy is high in comparison with other similar studies, despite the small sample size in our study. Prophylactic antibiotics, either intraoperatively at induction or postoperatively, were found to decrease the risk of developing post-cholecystectomy SSI. In addition, a short hospital stay was also found to decrease the risk.

Ethical approval

Ethical approval was obtained from university of Khartoum, Khartoum state ministry of the health Research department, and from hospitals.

Consent

The data were taken from the data sheets of the patients which found in the hospital, some information was taken from them after taking their verbal consent after explanation of the research purpose and the objectives of the research(all the communication was done using phone calls and patient's hospital files because of the corona pandemic. Research purpose and objectives were explained to participants in clear simple words and they have the right to voluntary informed consent. Participant has the right to withdraw at any time without deprivation and to no harm (privacy and confidentiality by using a coded questionnaire) and to benefit from the researcher's knowledge and skill.

Sources of funding

None.

Author contribution

Study concept, data collection, data analysis and interpretation, writing the paper—all of these were done by R.E.M. R.E.M. took the advices from the co-author M.A.S.

Conflicts of interest disclosure

There are no conflicts of interest.

Research registration unique identifying number (UIN)

N/A, it is primary descriptive study not clinical trial so I didn't register the research.

Guarantor

Ruba E Masaod.

Data availability statement

Yes, the authors have all the data that used in the research.

Provenance and peer review

None.

References

[1] Moreno Elola-Olaso A, Davenport DL, Hundley JC, *et al*. Predictors of surgical site infection after liver resection: a multicenter analysis using National Quality Improvement Program data. HPB (Oxford) 2012;14: 136–41.
[2] Perencevich EN, Sands KE, Cosgrove SE, *et al*. Health and economic impact of surgical site infections diagnosed after hospital discharge. Emerg infects Dis 2003;9:196–203.
[3] Dimick JB, Weeks WB, Karia RJ, *et al*. Who pays for poor surgical quality? Building a business case for quality improvement. J Am Coll Surg 2006;202:933–7.
[4] Bili S, Asghar G, Ruba T, *et al*. Frequency and risk factors of surgical site infections in general surgery ward of a tertiary care hospital of Karachi, Pakistan. Int J Infect Control 2011;7.
[5] Horan TC, Gaynes RP, Martine WJ, *et al*. CDC definitions of nosocomial surgical site infections, 1992: a modification of CDC definitions of surgical wound infections. Am J infect control 1992;20:271–4.
[6] Emori TG, Gaynes RP. An overview of nosocomial infections, including the role of the microbiology laboratory. Clin Microbiol Rev 1993;6: 428–42.
[7] Mangram AJ, Horan TC, Pearson ML, *et al*. Guidelines for prevention of surgical site infection. Infect Control Hosp Epidemiol 1999;20: 217–78.
[8] Kusachi S, Kashimura N, Konishi T, *et al*. Length of stay and cost for surgical site infection after abdominal and cardiac surgery in Japanese hospitals: multi-center surveillance. Surg Infect (Larchmt) 2012;13:257–65.
[9] Warren D, Nickel K, Wallace A, *et al*. (2017) Risi: factors for surgical site infection after cholecystectomy. Open forum 9- Stanislawek A, Wyroslak B, Solowiej K, et al. Surgical Site Infection Risk Factors and the Most Frequent Pathogens in Patients with Neoplastic Disease_ preliminary report. J Health Sci 2013;3:399–406.
[10] Richards C, Edwards J, Culver D, *et al*. Does the use of a laparoscopic approach to cholecystectomy decrease the risk of surgical site infection? Ann Surg 2003;237:358–62.
[11] Rotermann M. Infection after cholecystectomy, hysterectomy, or appendectomy. Health Rep 2004;15:11–23.
[12] Brandt C, Sohr D, Behnke M, *et al*. Reduction of surgical site infection rates associated with active surveillance. Infect Control Hosp Epidemiol 2006;27:1347–51.
[13] Romy S, Eisenring MC, Betts Chart V, *et al*. Laparoscope use and surgical site infections in digestive surgery. Ann Surg 2008;247: 627–32.
[14] Bogdanic B, Bosnjak Z, Budimir A, *et al*. Surveillance of surgical site infection after cholecystectomy using the hospital in Europe link for infection control through surveillance protocol. Surg Infect (Larchmt) 2013;14:283–7.
[15] Biscione FM, Couto RC, Pedrosa TM. Accounting for incomplete post-discharge follow-up during surveillance of surgical site infection by use of the National Nosocomial Infections Surveillance

system's risk index. Infect Control Hosp Epidemiol 2009;30: 433–9.
[16] Mu Y, Edwards JR, Horan TC, *et al*. Improving risk-adjusted measures of surgical site infection for the national health-care safety network. Infect Control Hosp Epidemiol 2011;32: 970–86.
[17] Olivier M, Grand Bastien B, Astagneau P. Is targeted surveillance effective for surgical site infection control? Results in digestive tract surgery from the incidence des Infections du site operator network. Infect Control Hosp Epidemiol 2007;28:883–5.
[18] Fahrner R, Malinka T, Klasen J, *et al*. Additional surgical procedures are a risk factor for surgical site infections after Laparoscopic cholecystectomy. Langenbecks Arch Surg 2014;399:595–9.
[19] Mathew G, Agha R. for the STROCSS Group. STROCSS 2021: strengthening the reporting of cohort, cross-sectional and case-control studies in Surgery. Int J Surg 2021;96:106165.
[20] Rodríguez-Caravaca G, Gil-Yonte P, Del-Moral-luque JA, *et al*. Rates of surgical site infection in cholecystectomy: comparison between a University Teaching hospital, Madrid Region, Spain, and USA rates. Rev Investig Clin 2017;69:336–43.
[21] Elbur AI, Yousif MA, ElSayed AS, *et al*. An audit of prophylactic surgical antibiotic use in a Sudanese Teaching Hospital. Int J Clin Pharm 2013;35: 149–53.
[22] Chen LF, Anderson DJ, Hartwig MG, *et al*. Surgical site infections after laparoscopic and open cholecystectomies in community hospitals. Infect Control Hosp Epidemiol 2008;29:92–4.