

Original Research Article

Postoperative surveillance of port site infection in laparoscopic cholecystectomy: identification of pathogens and antibiotic resistance trends in tertiary care hospitals of Peshawar

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ABSTRACT

Background: Port-site infection (PSI) is a frequent but poorly defined post-laparoscopic cholecystectomy (LC) complication, the most common surgical procedure for the treatment of symptomatic cholelithiasis. Increasing antimicrobial resistance of the causative organisms poses a risk to postoperative outcomes, especially in resource-limited areas where there is limited local pathogen and resistance data.

Methods: The study was conducted in the tertiary care hospitals of Peshawar, Khyber Pakhtunkhwa, Pakistan for six months (May–November 2025) using a cross-sectional study design. A purposive sampling method was used to recruit 95 patients aged ≥ 18 years who developed PSI within 7 days after LC, excluding patients with pre-existing infections or immunocompromising conditions. Patients were followed up at 48 hours, 1 week and 2 weeks after surgery. Microbiological culture and sensitivity were done on wound swabs of suspected infections. The data were analyzed by chi-square test, Mann-Whitney U test and Kruskal-Wallis test in SPSS-25.

Results: The mean patient age was 50.5 ± 18.1 years (51 male, 44 female). PSI occurred in 85 patients (89.5%). The most common isolates were *Staphylococcus aureus* (36.5%), *E. coli* (27.1%), *Klebsiella pneumoniae* (21.2%), *Pseudomonas aeruginosa* (10.6%) and *Proteus mirabilis* (4.7%). High sensitivity was observed for levofloxacin, meropenem, vancomycin, linezolid and imipenem, and the highest resistance was observed for clindamycin (85.9%). There was no significant association between PSI and gender ($p=0.210$) or bile spillage ($p=0.083$). Patients with infection were significantly more likely to be hospitalized for longer than non-infected patients (median 6 days vs 2 days, $p<0.001$), and *Klebsiella* and *Pseudomonas* infections were associated with the longest hospital stay and the highest rates of persistent infection and re-intervention.

Conclusions: Gram-positive and gram-negative organisms make significant contributions to PSI following LC, and have different resistance patterns and clinical outcomes. To minimize morbidity, targeted antibiotic stewardship based on local resistance data is crucial.

Keywords: Port site infection, Laparoscopic cholecystectomy, Antibiotic resistance, Surgical site infection

INTRODUCTION

In hepatobiliary (HPB) surgical patients, surgical site infections (SSI) can extend the hospital stay, raise

morbidity, and impact the surgical patient outcome.¹ Surgical patients still have SSIs as their most frequently reported type of healthcare-associated infection. Surgical site infections are a problem that can affect individuals

who are receiving a complex hepatopancreatobiliary (HPB) procedure, as can factors before, during, and after the surgery.² Cholelithiasis is a very common disease in the adult population with an estimated prevalence of 10% to 15% in the world. Cholelithiasis was early considered as a disease of western countries, but there is a growing prevalence in developing countries, mainly because of the change in dietary habits.³

Surgical site infections (SSIs) can occur in 20-40% of hepatopancreatobiliary (HPB) surgeries. The most frequent microorganisms involved in those infections are *Staphylococcus aureus* (15-20%), Gram-negative bacilli, coagulase negative staphylococci, *Enterococcus spp.* and *Escherichia coli* (E. coli).⁴ In the world, about 4.95 million people die yearly because of multidrug-resistant (MDR) bacteria.⁵ The ECDC classify bacteria as being multidrug-resistant organisms (MDR-Os), extended-drug resistant organisms (XDR-Os) and pan-drug resistant organisms (PDR-Os) if they are resistant to one or two antibiotics, three or more antibiotics, and all known antibiotics respectively.⁶ Laparoscopic cholecystectomy is now accepted as the treatment of choice for symptomatic cholelithiasis. It has been shown in a number of clinical trials to be a safe procedure, although there is an acknowledged higher risk of injury to the bile duct.⁷

Although laparoscopic cholecystectomy (LC) is associated with fewer complications than open cholecystectomy, infectious complications, such as surgical site infection and intra-abdominal abscess, continue to represent an important cause of postoperative morbidity.⁸ Systemic prophylactic antibiotics are used preoperatively to achieve peak tissue levels at the start of surgery and during the procedure to ensure optimal tissue levels.⁹ In laparoscopic surgery, the surgeon makes a few small ports (incisions) in the skin away from the area where the surgery will be performed and introduces reusable metallic or single-use plastic tubes through the incisions. Special surgical instruments are inserted into these ports and a telescope is used for the operation.¹⁰

Minimally invasive surgical techniques, such as laparoscopic and robotic-assisted surgery, involve using small incisions rather than the larger incisions previously necessary with traditional open surgery. The smaller diameters make it possible to insert special instruments in the opening and a camera, which allows the surgeon to conduct a procedure while causing little damage to the surrounding tissue.¹¹ This study aims to identify the most prevalent pathogens, assess their antibiotic resistance patterns, and evaluate their clinical impact. By providing evidence-based insights, the research will guide antimicrobial stewardship, improve infection management, and enhance patient outcomes.

METHODS

Study design

It was a cross-sectional study aiming to identify the most prevalent pathogens, assess the antibiotic resistance patterns of the pathogens and to investigate the correlation between the type of pathogen and clinical outcomes of the patient from post-surgical site infection.

Sampling technique

Purposive non probability sampling technique was used and the data were collected from tertiary care hospitals of Peshawar, Khyber Pakhtunkhwa, Pakistan. List of the hospitals: Kuwait Teaching Hospital, Mercy Teaching Hospital, Prime Teaching Hospital.

Sample size

The sample size was calculated for a prevalence study based on the Cochran formula: $n = Z^2 P(1-P)/d^2$ where Z is the level of confidence at 95%, P is the prevalence, and d is the degree of error at 0.05. This formula uses the following variables: n is the sample size needed, Z is the standard normal deviate for a 95% confidence level, P is the estimated prevalence of port-site infections based on the previous literature (6.7%), and d is the margin of error set at 5%. The parameters were then used in the formula to determine the required sample size to be 95.

Study population

The study included all patients aged ≥ 18 years underwent laparoscopic cholecystectomy who developed post-operative port site infections within 7 days of surgery during the study period. All the patients with pre-existing infections or immunocompromised conditions (e.g., HIV, chemotherapy) were excluded from the study.

Study duration

The study was conducted over a period of six months, from 1st May 2025 to 1st November 2025.

Data collection

The data was collected in a structured proforma providing demographic information like age, gender and comorbidities. Other factors that were documented were preoperative and operative factors that include operative time, spillage of bile, wound closure technique associated with the closure of the port and postoperative wound care practices. Port-site infections were monitored at 48 hours, one and two weeks following surgery in all patients. Clinical assessment of infection consisted of a combination of clinical signs such as erythema, tenderness, purulent discharge and wound dehiscence. Wound swabs were taken and microbiological culture and sensitivity were carried out to determine the pathogens in the wounds when infection was suspected.¹³

Analysis plan

SPSS-25 was used to find frequency, mean value and standard deviation. Inferential statistics were carried out by applying significance test, Chi square for associations and relationships by setting p value at 0.05.

RESULTS

The descriptive analysis included a total of 95 patients who underwent laparoscopic cholecystectomy. The mean age was 50.5(±18.1) years, median 51, IQR 38.5-65.0 with age range of 18-92 years comprising of 51 males (53.7%) and 44 females (46.3%). After surgery, PSI was present in 85(89.5%) patients and no post-surgery port site infection in 10(10.5%) patients (Table 1).

Five distinct organisms were isolated among infected patients. There was single organism from gram positive group yet most common; *Staphylococcus Aureus* was found in 31 patients (36.5%), remaining were from gram negative group; *Escherichia coli* in 23 patients (27.1%), *Klebsiella pneumoniae* in 18 (21.2%), *Pseudomonas aeruginosa* in 9 (10.6%) and *Proteus mirabilis* in 4 (4.7%). After *Staphylococcus aureus*, *E. coli* and *Klebsiella* are next most common in the group (Table 2).

Antibiotics resistance trends showed levofloxacin being most sensitive with low resistance and broad-spectrum coverage, Clindamycin with lowest sensitivity and

highest resistance with partial effect against *Staph Aureus* only. Augmentin show somewhat better sensitivity yet moderate to high resistance and has variable efficacy against pathogens. Linezolid and vancomycin showed moderate sensitivity and negligible resistance and with highest efficacy against MRSA and *S. Aureus* respectively (Table 3).

In inferential statistics, no significant association of PSI was found with gender ($\chi^2=1.569$, $p=0.210$) (Table 4).

Bile spillage showed non-significant trend towards increase PSI as all patients with bile spillage got PSI yet it remains one of the most important risk factors ($\chi^2=3.014$, $p=0.083$) (Table 5).

Staphylococcus aureus PSI patients recovered mostly followed by *E. coli*, Patients with *P. aeruginosa* and *Klebsiella* suffered from persistent infection with rates of 3 and 4 out of 9 and 18 respectively. High admission rates with *Klebsiella* and complications with *S. aureus* and *Klebsiella* (2 and 2 out of 31 and 18 respectively). High re-intervention with *Klebsiella* (9 out of 18) (Table 6).

Length of stay of patients with PSI was longer of median 6 days in contrast to non-PSI patients of 2 days. PSI with *E coli* had median stay of 5 days which was shortest and *Klebsiella* and *Pseudomonas* has median 7 days of longest duration (Table 7).

Table 1: Demographics and clinical characteristics.

Characteristics	Values	Percentage
Total patients	95	100
Age (mean±SD)	50.5±18.1	
Age (median, IQR)	51.0 (38.5-65.0)	
Age range	18-92	
Male	51	53.7
Female	44	46.3
PSI present	85	89.5
No PSI	10	10.5

Table 2: Frequency distribution of isolated organisms.

Organisms	Numbers	% of Infected	Classification
<i>S. aureus</i>	31	36.5	Gram positive
<i>E. coli</i>	23	27.1	Gram negative
<i>K. pneumoniae</i>	18	21.2	Gram negative
<i>P. aeruginosa</i>	09	10.6	Gram negative
<i>P. mirabilis</i>	04	4.7	Gram negative

Table 3: Antibiotics resistance trends.

Antibiotics	Sensitive (N)	Resistance (N)	Resistance category	Most effective against
Levofloxacin	50	09	Low	Broad spectrum
Meropenem	47	09	Low	Gram negatives
Tazocin	35	03	Very low	<i>Klebsiella, Pseudomonas</i>
Nitrofurantoin	35	03	Very low	<i>E. Coli</i>

Continued.

Antibiotics	Sensitive (N)	Resistance (N)	Resistance category	Most effective against
Vancomycin	34	00	Negligible	<i>S. Aureus</i>
Methicillin	32	01	Very low	<i>S. Aureus</i>
Linezolid	31	00	Negligible	<i>S. Aureus</i>
Imipenem	38	04	Very low	<i>Klebsiella, Pseudomonas</i>
Augmentin	27	34	Moderate-High	Mixed
Clindamycin	12	73	Very High	<i>S. Aureus</i> (partial)

Table 4: Gender association with PSI.

Variables	PSI	No PSI	Total
Male	48	03	51
Female	37	07	44
Total	85	10	95

 $\chi^2(1)=1.569$, $p=0.2103$ ns

Table 5: Bile spillage association with PSI.

Variables	PSI	No PSI	Total
Yes	27	00	27
No	58	10	68
Total	85	10	95

 $\chi^2(1)=3.014$, $p=0.0826$ ns

Table 6: Specific organism effect on outcome of PSI.

Organism	Recovered	Persistent Infection	Readmitted	Complications	Reintervention	N
<i>S. aureus</i>	27	01	01	02	04	31
<i>E. coli</i>	20	01	01	01	03	23
<i>K. pneumoniae</i>	08	04	04	02	09	18
<i>P. aeruginosa</i>	05	03	00	01	01	09
<i>P. mirabilis</i>	03	00	01	00	00	04
Total	63	09	07	06	17	85

Table 7: Summary of non-parametric test results.

Tests and variable	Statistics	p value	Interpretation
Mann-Whitney U: LOS by PSI status	U=0.0	<0.001 ***	Infected patients: significantly longer LOS (Median 6 vs 2 day)
Mann-Whitney U: Op. Time by PSI	U=285.5	0.0888(ns)	No significant difference in operative time
Kruskal-Wallis: LOS by organism	H= 23.409	<0.001 ***	LOS significantly varies by organism type

Table 8: Length of hospital stay (LOS) with respect to specific organism- Kruskal-Wallis.

Organisms	N	Mean LOS	Median LOS	Min	Max
<i>E. coli</i>	23	5.3 days	5.0 days	04	10
<i>K. pneumoniae</i>	18	7.2 days	7.0 days	05	12
<i>P. mirabilis</i>	04	6.0 days	6.0 days	05	07
<i>P. aeruginosa</i>	09	7.3 days	7.0 days	06	08
<i>S. aureus</i>	31	5.8 days	6.0 days	04	10

DISCUSSION

In general, our results correspond with several recent studies investigating infection after laparoscopic cholecystectomy. Haider et al. conducted a study in 374 patients (287 female, 76.74% and 87 males, 23.26%) who were undergoing laparoscopic cholecystectomy, comparing the effectiveness of a single antibiotic dose with multiple doses. They reported a postoperative infection rate of 4.28% (8 patients) for the single-dose group and 9.63% (18 patients) for the multiple-dose group. Their reported overall infection rates were significantly lower than the port-site infection rates of 89.5% identified in our study, as they did not report on the specific site of infection. However, their results show that infection is still a measurable and clinically important result after this procedure, which is the same as our results.³

Călina et al identified 209 bacterial strains in 165 patients with surgical site infections in a study in 2017. *S. aureus* was the most common organism (50.72%) followed by *E. coli* (17.22%) and *P. aeruginosa* (10.05%). Other organisms, such as *Proteus mirabilis*, *Klebsiella pneumoniae*, *Enterobacter aerogenes*, *Proteus vulgaris* and other non-fermenting gram-negative rods were found in a smaller number. This was echoed in our microbiology results, where *S. aureus* was the most common organism, and *E. coli* the next, but the percentages were different in each of the two study groups.⁴

Sheikh et al found umbilical port-site infection after laparoscopic surgery was 8 per cent, 89 per cent of which were after cholecystectomy and 11 per cent after appendectomy. They also were able to isolate *S. aureus* as the main cause. This finding is similar to our findings which showed that *S. aureus* was also the predominant organism among patients with postlaparoscopic cholecystectomy port infection.¹⁰

A systemic review and metanalysis that was done in China showed the effectiveness of different types of antibiotics was investigated. The results of subgroup analysis indicated that first, second, and third-generation antibiotics works similar in reducing the incidence of surgical site infections which coincides with our findings. However, first-generation antibiotics significantly reduced the incidence of distant and overall infections compared with second and third-generation antibiotics. The results indicate that 2–3 doses of antibiotics before and after LC significantly reduced the incidence of surgical site infections, distant infections and overall infections, but there was no difference where only one dose of antibiotics was administered prior to LC.¹²

The overall prevalence of umbilical port-site infection was 14.0% (13 of 93 patients) and majority of infections (69.2%) were diagnosed in the first week post-op. The most prevalent was *S. aureus* (50.0%) and followed by *E.*

coli (30.0%) and *Pseudomonas aeruginosa* (20.0%). These figures agree with our findings, and confirm *S. aureus* as the organism found most consistently in port-site infections after laparoscopic cholecystectomy, both between populations and across different settings.¹³

When viewed collectively, these comparisons situate our observations in a fairly consistent regional and international trend: *S. aureus* and *E. coli* are the most common microorganisms identified in the port-site after laparoscopic cholecystectomy, with gram-negative bacteria (*K. pneumoniae*, *P. aeruginosa*) making up a smaller but clinically significant proportion. Our data contribute to this picture by providing a link between infecting organism and clinical course with *Klebsiella* and *Pseudomonas* infection associated with more prolonged hospital stays and a higher incidence of persistent infection and re-intervention, whereas *S. aureus* and *E. coli* infection tended to have more predictable clinical courses. Our data on the resistance profile of *S. aureus* confirms that, on the one hand, *S. aureus* is generally resistant to clindamycin (85.9%) and on the other hand, the level of resistance of *S. aureus* to augmentin would not be assumed to be low, but rather moderate or high, as is the case in our cohort. Organisms isolated were sensitive to all of the following antibiotics: levofloxacin, meropenem, vancomycin, linezolid and imipenem and these are all suitable for empirical or targeted therapy until the results of culture and sensitivity are available.

CONCLUSION

Gram-positive and Gram-negative organisms play a significant role in the development of port-site infection following L.C. *S. aureus*, *E. coli* and *Klebsiella pneumoniae* are the most common pathogens isolated. There are differences in resistance patterns and clinical outcomes with respect to organism, with *Klebsiella* and *Pseudomonas* infections in particular being linked to increased duration of hospitalisation and persistent infection and re-intervention. To limit the morbidity associated with this common complication, antibiotic stewardship based on local resistance patterns, rather than generic or imported patterns of use, is key to ensure that patients receive the most appropriate antibiotic treatment.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

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