



**COMPARISON OF SURGICAL SITE INFECTION RATES BETWEEN EMERGENCY  
AND ELECTIVE APPENDECTOMY: A RETROSPECTIVE STUDY**

\*Moh' D. Obeidat, Mohammad Alsmadi, Samer Alshufiyyen, Osaid AL-Akhras, Mohammad Abuwandi, Wisam AL-Sukkar, Nedhal AL\_Qadhi, Ban SHA' Ban

India.



\*Corresponding Author: Moh' D. Obeidat

India.

<https://doi.org/10.5281/zenodo.18205921>

**How to cite this Article:** Moh' D. Obeidat, Mohammad Alsmadi, Samer Alshufiyyen, Osaid AL-Akhras, Mohammad Abuwandi, Wisam AL-Sukkar, Nedhal AL\_Qadhi, Ban SHA' Ban. (2026). Comparison of Surgical Site Infection Rates Between Emergency and Elective Appendectomy: A Retrospective Study. *European Journal of Biomedical and Pharmaceutical Sciences*, 13(1), 249–254.

This work is licensed under Creative Commons Attribution 4.0 International license.



Article Received on 05/12/2025

Article Revised on 25/12/2025

Article Published on 10/01/2026

**ABSTRACT**

**Background:** Surgical site infections (SSIs) are among the most common postoperative complications and significantly increase morbidity, length of stay, and healthcare costs. Appendectomy is frequently performed as an emergency procedure, and its infection risk may vary based on urgency and surgical approach. **Aim:** This study aimed to compare SSI rates between emergency and interval (elective) appendectomy and to identify independent risk factors for postoperative SSI. **Methods:** We conducted a retrospective cohort study of all appendectomy cases at King Hussein Medical Center between 2020 and 2023. Patients were categorized as emergency or interval appendectomy. Data on demographics, comorbidities, operative details, and postoperative outcomes were collected. SSI was defined per CDC criteria as any superficial, deep, or organ-space infection within 30 days. Group comparisons used Wilcoxon rank-sum and chi-squared tests, and multivariable logistic regression identified independent predictors of SSI. **Results:** Among all cases, laparoscopic surgery was more common in the interval group (90% vs. 74%), while open surgery was more frequent in emergencies (26% vs. 10%,  $p < 0.001$ ). Emergency cases more often involved perforation (20% vs. 4.2%,  $p < 0.001$ ) and had longer operative times (64 vs. 59 min,  $p < 0.001$ ) and length of stay (3.4 vs. 2.7 days,  $p < 0.001$ ). SSIs occurred predominantly after emergency appendectomy (86% vs. 67%,  $p < 0.001$ ). Independent predictors of SSI included emergency presentation (OR 1.99,  $p = 0.021$ ), open approach (OR 2.27,  $p < 0.001$ ), perforation (OR 2.19,  $p = 0.003$ ), diabetes (OR 2.67,  $p < 0.001$ ), and longer operative time (OR 1.01 per minute,  $p = 0.036$ ). **Conclusion:** Emergency appendectomy was associated with a significantly higher risk of SSI, especially with open surgery, perforation, diabetes, and prolonged operative duration. Targeted prevention and prioritization of laparoscopic techniques may reduce SSI risk.

**KEYWORDS:** Appendectomy, Surgical Site Infection, Emergency Surgery, Elective Surgery, Risk Factors.

**INTRODUCTION**

Surgical site infections (SSIs) are a postoperative complication particularly in abdominal procedures but can occur anywhere along the body including the site of incision, the surgically operated organs, or other places where surgical instruments were applied. They affect approximately 0.5% to 3% of surgical patients.<sup>[1]</sup> Studies have shown that approximately 11% of general surgical patients develop a SSI within 30 days postoperatively, with infection rates differing based on anatomical site, surgical technique, and urgency of the procedure.<sup>[2]</sup> Patients with SSIs experience hospital stays that are 7 to

11 days longer than patients without infection which will affect later healthcare costs and increased mortality and morbidity.<sup>[3]</sup> They are the second most common cause of hospital acquired infections and pose a significant burden on healthcare systems.<sup>[4]</sup> SSIs are commonly caused by bacteria from the patient's own flora as well as community or hospital-acquired microorganisms. Infections of these types are hard to be treated due to the implication of biofilm-forming bacteria in up to 80% of SSIs.<sup>[5]</sup> Some reported key factors include the duration of surgery, patient immune status, presence of foreign

material, wound contamination and poor glycemic control.<sup>[6]</sup>

Some studies have investigated the incidence of SSI after appendectomy and found that it ranged from 1.2% to 20% but rates can be as high as 37.4% in some cases.<sup>[7]</sup> Incidence is higher in low-income countries compared to high income countries.<sup>[8]</sup> Open appendectomy is associated with higher SSI rates compared to laparoscopic appendectomy.<sup>[9]</sup> Some key risk factors contributing to SSI after appendectomy include obesity, diabetes mellitus, presence of fever, and comorbidities increase SSI risk. Surgery related factors include longer surgery duration, open surgical approach, and complicated appendicitis.<sup>[10]</sup>

We aim in this study to compare the incidence of surgical site infections in patients undergoing emergency vs. elective appendectomy.

## METHOD

### Study Design

This study employed a retrospective cohort design, reviewing the medical records of all patients who underwent appendectomy at King Hussein Medical Center between 2020 and 2023. Cases were identified through the hospital's electronic surgical database. Patients were categorized into two groups: those undergoing emergency appendectomy for acute appendicitis and those undergoing interval (elective) appendectomy. Inclusion criteria comprised patients of all ages who underwent either open or laparoscopic appendectomy within the specified time frame. Patients with incomplete records, concomitant abdominal procedures, or lost follow-up within 30 days were excluded.

### Data collection

Data collection was performed using a structured data extraction sheet. Variables collected included demographic characteristics (age, sex), clinical details (comorbidities, type of presentation, and operative findings), surgical factors (emergency vs. elective status, open vs. laparoscopic approach), and postoperative outcomes. The primary outcome was surgical site infection, defined according to the Centers for Disease Control and Prevention (CDC) criteria as any superficial, deep, or organ-space infection occurring within 30 days of surgery.

### Statistical Method

Categorical variables were compared using Pearson's Chi-squared test, while continuous variables were analyzed with the Wilcoxon rank-sum test. Results are presented as frequencies and percentages for categorical variables and as medians with interquartile ranges for continuous variables. To identify independent predictors of 30-day surgical site infection, multivariable logistic regression analysis was performed, and adjusted odds ratios with 95% confidence intervals were reported. A

two-sided p-value of less than 0.05 was considered statistically significant. All statistical analyses were done using R statistical language (version 4.3.0, Vienna, Austria).

## RESULT

The baseline characteristics between the interval and emergency groups showed several important differences. Age, sex, BMI, obesity, diabetes, smoking status, and ASA classification were broadly similar between groups, with no statistically significant differences (all  $p > 0.2$ ). However, surgical approach differed substantially: laparoscopic surgery was performed more frequently in the interval group (90% vs 74%), while open surgery was more common in the emergency group (26% vs 10%,  $p < 0.001$ ). Likewise, perforated or complicated cases were disproportionately higher in the emergency group (20% vs 4.2%,  $p < 0.001$ ). These findings suggest that although demographic and baseline health characteristics were comparable, the clinical presentation and surgical management diverged significantly.

Perioperative outcomes also varied. Operative time was shorter in the interval group (median 59 minutes vs 64 minutes,  $p < 0.001$ ), and length of stay was reduced (median 2.7 days vs 3.4 days,  $p < 0.001$ ). The timing of antibiotics showed no significant difference ( $p = 0.4$ ).

Patients who developed surgical site infection (SSI) within 30 days had several significantly different characteristics compared to those without SSI. Emergency presentation was strongly associated with SSI, with 86% of SSI cases occurring in the emergency group compared to 67% without SSI ( $p < 0.001$ ). Diabetes was also more common among patients with SSI (28% vs 12%,  $p < 0.001$ ). Surgical approach differed markedly, as open procedures accounted for 43% of SSI cases versus 19% in the no-SSI group ( $p < 0.001$ ). Similarly, perforated or complicated disease was more frequent among those with SSI (36% vs 13%,  $p < 0.001$ ). Operative time was longer in patients with SSI (median 73 vs 62 minutes,  $p < 0.001$ ), and length of stay was substantially increased (median 5.5 vs 3.0 days,  $p < 0.001$ ). By contrast, other baseline factors such as age, sex, BMI, obesity, smoking status, ASA classification, and timing of antibiotics did not differ significantly between the two groups (all  $p > 0.09$ ).

In the multivariable analysis, several factors remained significantly associated with increased odds of developing a 30-day surgical site infection (SSI). Emergency presentation was an independent predictor, nearly doubling the risk compared to interval cases (OR 1.99, 95% CI 1.14–3.69,  $p = 0.021$ ). Open surgical approach was also strongly linked with SSI, with more than double the odds compared to laparoscopic procedures (OR 2.27, 95% CI 1.41–3.63,  $p < 0.001$ ). Patients with perforated or complicated disease had over twice the odds of infection (OR 2.19, 95% CI 1.30–3.66,  $p = 0.003$ ). Diabetes showed the strongest association,

conferring nearly a threefold increase in odds (OR 2.67, 95% CI 1.62–4.30,  $p < 0.001$ ). Operative time was also significant, with each additional minute associated with a small but measurable increase in SSI risk (OR 1.01, 95%

CI 1.00–1.03,  $p = 0.036$ ). Other patient characteristics, including BMI ( $p = 0.5$ ), smoking ( $p = 0.060$ ), and ASA  $\geq 3$  ( $p > 0.9$ ), were not independently associated with SSI after adjustment.

**Table 1: Baseline characteristics by exposure (Interval vs Emergency).**

Characteristic	Interval N = 448 <sup>1</sup>	Emergency N = 981 <sup>1</sup>	Overall N = 1,429 <sup>1</sup>	p-value <sup>2</sup>
<b>Age (years)</b>				0.8
Median [Q1, Q3]	36 [27, 45]	35 [28, 45]	36 [28, 45]	
<b>Sex</b>				0.2
Female	181 (40%)	435 (44%)	616 (43%)	
Male	267 (60%)	546 (56%)	813 (57%)	
<b>BMI (kg/m<sup>2</sup>)</b>				>0.9
Median [Q1, Q3]	26.7 [23.0, 30.9]	27.2 [23.2, 30.8]	27.0 [23.2, 30.8]	
<b>Obesity (BMI<math>\geq</math>30)</b>	147 (33%)	290 (30%)	437 (31%)	0.2
<b>Diabetes</b>	51 (11%)	138 (14%)	189 (13%)	0.2
<b>Current smoking</b>	233 (52%)	489 (50%)	722 (51%)	0.5
<b>ASA <math>\geq 3</math></b>	107 (24%)	234 (24%)	341 (24%)	>0.9
<b>Surgical approach</b>				<0.001
Laparoscopic	401 (90%)	725 (74%)	1,126 (79%)	
Open	47 (10%)	256 (26%)	303 (21%)	
<b>Perforated/complicated</b>				<0.001
Absent	429 (96%)	785 (80%)	1,214 (85%)	
Present	19 (4.2%)	196 (20%)	215 (15%)	
<b>Operative time (min)</b>				<0.001
Median [Q1, Q3]	59 [51, 70]	64 [54, 77]	63 [53, 75]	
<b>Antibiotic given late</b>	52 (12%)	133 (14%)	185 (13%)	0.4
<b>Length of stay (days)</b>				<0.001
Median [Q1, Q3]	2.70 [2.00, 3.60]	3.40 [2.40, 4.50]	3.10 [2.20, 4.20]	

<sup>1</sup> n (%) <sup>2</sup> Wilcoxon rank sum test; Pearson's Chi-squared test

**Table 2: Patient characteristics by 30-day SSI.**

Characteristic	No SSI N = 1,322 <sup>1</sup>	SSI N = 107 <sup>1</sup>	Overall N = 1,429 <sup>1</sup>	p-value <sup>2</sup>
<b>Exposure (Emergency vs Interval)</b>				<0.001
Interval	433 (33%)	15 (14%)	448 (31%)	
Emergency	889 (67%)	92 (86%)	981 (69%)	
<b>Age (years)</b>				0.2
Median [Q1, Q3]	35 [28, 45]	37 [27, 46]	36 [28, 45]	
<b>Sex</b>				0.12
Female	578 (44%)	38 (36%)	616 (43%)	
Male	744 (56%)	69 (64%)	813 (57%)	
<b>BMI (kg/m<sup>2</sup>)</b>				0.2
Median [Q1, Q3]	27.0 [23.1, 30.7]	27.9 [23.9, 31.7]	27.0 [23.2, 30.8]	
<b>Obesity (BMI<math>\geq</math>30)</b>	397 (30%)	40 (37%)	437 (31%)	0.14
<b>Diabetes</b>	159 (12%)	30 (28%)	189 (13%)	<0.001
<b>Current smoking</b>	659 (50%)	63 (59%)	722 (51%)	0.090
<b>ASA <math>\geq 3</math></b>	311 (24%)	30 (28%)	341 (24%)	0.3
<b>Surgical approach</b>				<0.001
Laparoscopic	1,065 (81%)	61 (57%)	1,126 (79%)	
Open	257 (19%)	46 (43%)	303 (21%)	
<b>Perforated/complicated</b>				<0.001
Absent	1,145 (87%)	69 (64%)	1,214 (85%)	
Present	177 (13%)	38 (36%)	215 (15%)	
<b>Operative time (min)</b>				<0.001
Median [Q1, Q3]	62 [52, 74]	73 [61, 85]	63 [53, 75]	
<b>Antibiotic given late</b>	176 (13%)	9 (8.4%)	185 (13%)	0.2

<b>Length of stay (days)</b>				<b>&lt;0.001</b>
Median [Q1, Q3]	3.00 [2.10, 3.90]	5.50 [4.80, 6.90]	3.10 [2.20, 4.20]	
<sup>1</sup> n (%)				
<sup>2</sup> Pearson's Chi-squared test; Wilcoxon rank sum test				

**Table 3: Adjusted odds ratios for 30-day SSI (multivariable logistic regression).**

Characteristic	OR <sup>1</sup>	95% CI <sup>1</sup>		p-value
		Lower	Upper	
<b>Exposure (Emergency vs Interval)</b>				
Interval	—	—	—	
Emergency	1.99	1.14	3.69	<b>0.021</b>
<b>Surgical approach</b>				
Laparoscopic	—	—	—	
Open	2.27	1.41	3.63	<b>&lt;0.001</b>
<b>Perforated/complicated</b>				
Absent	—	—	—	
Present	2.19	1.30	3.66	<b>0.003</b>
<b>BMI (kg/m<sup>2</sup>)</b>	1.01	0.97	1.05	0.5
<b>Diabetes</b>				
No	—	—	—	
Yes	2.67	1.62	4.30	<b>&lt;0.001</b>
<b>Smoking</b>				
No	—	—	—	
Yes	1.50	0.99	2.28	0.060
<b>ASA <math>\geq</math>3</b>				
No	—	—	—	
Yes	1.01	0.61	1.63	>0.9
<b>Operative time (min)</b>	1.01	1.00	1.03	<b>0.036</b>

<sup>1</sup> OR = Odds Ratio, CI = Confidence Interval

## DISCUSSION

We discovered that surgical site infections (SSI) were significantly more common after emergency appendectomy than after interval (elective) appendectomy in this large single-center retrospective analysis. Although the groups' baseline demographics and comorbidities were quite similar, emergency procedures were more commonly carried out openly, were more frequently linked to difficult or perforated appendicitis, and were followed by longer hospital admissions and operating durations. Emergency surgery, open approach, intraoperative perforation, diabetes, and greater surgical duration were found to be independent risk factors for SSI on multivariable analysis.

These findings align closely with the broader literature on SSI in abdominal surgery. SSIs remain among the most common postoperative complications worldwide, with pooled rates in general surgery ranging from 5% to 20% depending on case complexity and patient factors.<sup>[1,3]</sup> Specific to appendectomy, meta-analytic data from over 500,000 cases report global SSI incidences between 6% and 10%.<sup>[7,8]</sup> although markedly higher rates have been described after emergency procedures, especially in the presence of perforation or gangrene.<sup>[11,13]</sup> Our observed excess SSI risk among emergency cases likely reflects the higher burden of

tissue contamination, delayed presentation, and physiologic instability commonly seen in this setting.<sup>[4,6]</sup>

In our population, the surgical method also showed a significant association with SSI risk. Although laparoscopic appendectomy was the most common method overall, it was significantly fewer prevalent in SSI cases, and open surgery raised the risk of infection on its own.<sup>[14]</sup> Large multicenter cohorts, Cochrane reviews, and recent meta-analyses have all consistently shown lower SSI rates with laparoscopy compared to open techniques.<sup>[15,17]</sup> This is largely due to smaller incisions, less tissue trauma, and a lower risk of wound contamination. Our findings highlight how crucial it is to prioritize minimally invasive procedures whenever possible, especially in certain emergency situations, in order to reduce the risk of infection.

Intraoperative perforation/complication was another major risk factor. Patients with perforated appendicitis had more than double the odds of SSI, consistent with prior multicenter data.<sup>[11]</sup> and risk prediction models.<sup>[12]</sup> that highlight perforation as one of the strongest SSI predictors. This likely reflects the intense bacterial burden and local inflammation in these cases, which impair wound healing and promote biofilm formation.<sup>[5]</sup> Additionally, we found that diabetes increased the adjusted chances of SSI and significantly increased SSI

risk. This result is consistent with other review.<sup>[13]</sup> and risk factor analyses.<sup>[11,18]</sup> which repeatedly demonstrate that immunological dysfunction brought on by hyperglycemia is a major cause of postoperative infections. Although previous studies have linked comorbidities including smoking, obesity, and a higher ASA class to SSI.<sup>[13,18,19]</sup>

Our cohort failed to identify an independent association between these characteristics and SSI, indicating that operational and disease-related factors may be more important in this population than baseline risk. Finally, longer operative time was a modest but significant predictor of SSI, consistent with evidence linking prolonged procedures to increased bacterial exposure and tissue handling.<sup>[13,20]</sup> Notably, our study echoes recent work showing that combining time-efficient operative techniques with standardized infection prevention bundles can meaningfully reduce SSI risk, particularly in emergency settings.<sup>[21]</sup>

## CONCLUSION

Emergency appendectomy carries a higher risk of surgical site infection, especially when performed via open approach, in the presence of perforation, or in patients with diabetes and longer operative times. Prioritizing minimally invasive techniques and targeted preventive measures in high-risk cases may help reduce SSI rates.

## REFERENCES

- Gouda NS. Surgical Site Infection. *Journal of Pioneering Medical Sciences* [Internet]. 2025 [cited 2025 Jun 23]; Available from: <https://consensus.app/papers/surgical-site-infection-gouda/5d488159c13c55af96498d86766af133/>
- M GB, Bronwyn G, Wendy C, Rhea L, Robert W, Megan R, et al. Worldwide incidence of surgical site infections in general surgical patients: A systematic review and meta-analysis. *International journal of surgery* [Internet]. 2021 [cited 2025 Jun 23]; Available from: <https://consensus.app/papers/worldwide-incidence-of-surgical-site-infections-in-m-bronwyn/07e530034eb25e0daddcc7901f9444a8/>
- Bayles A, Liston J. Surgical site infections. *Surgery (Oxford)* [Internet]. 2023 [cited 2025 Jun 23]; Available from: <https://consensus.app/papers/surgical-site-infections-bayles-liston/89c81ae8fc9c5a329dc4e793bdeea849/>
- Bott A, McDonald S. Surgical site infections. *Surgery (Oxford)* [Internet]. 2020 [cited 2025 Jun 23]; Available from: <https://consensus.app/papers/surgical-site-infections-bott-mcdonald/7ea4ea8003a5531d9f919dec61beb33/>
- Simões M, Hrynshyn A, Borges A. Biofilms in Surgical Site Infections: Recent Advances and Novel Prevention and Eradication Strategies. *Antibiotics* [Internet]. 2022 [cited 2025 Jun 23]; Available from: <https://consensus.app/papers/biofilms-in-surgical-site-infections-recent-advances-and-sim%C3%B5es-hrynshyn/f2f662962a82538785c6d4f837c52211/>
- Anderson D, Mantyh C, Seidelman JL. Surgical Site Infection Prevention: A Review. *JAMA*. 2023; 329(3): 244–52.
- Bigna J, Guifo M, Mbanga C, Danwang C, Mbonda A, Tochie J, et al. Global incidence of surgical site infection after appendectomy: a systematic review and meta-analysis. *BMJ Open* [Internet]. 2020 [cited 2025 Jun 23]; 10. Available from: <https://consensus.app/papers/global-incidence-of-surgical-site-infection-after-bigna-guifo/27f01ec1a4cc5dbd8afe1200c3d0f18/>
- Chen H, Yang L, Ren Y yan, Zheng R, Li H. The burden of appendicitis and surgical site infection of appendectomy worldwide. *Journal of infection in developing countries*. 2023; 17(3): 367–73.
- Li Z, Wang H, Liu L jun, Shi G, Zhang J, Cao J guo, et al. Surgical site infection after laparoscopic and open appendectomy: a multicenter large consecutive cohort study. *Surgical Endoscopy*. 2015; 29: 1384–93.
- Wahid A, Ullah F, Hassnain, Akbar K, Jamil T. Risk factors associated with surgical site infection post-appendectomy. *Khyber Journal of Medical Sciences* [Internet]. 2022 [cited 2025 Jun 23]; Available from: <https://consensus.app/papers/risk-factors-associated-with-surgical-site-infection-wahid-ullah/d621d39bc97a55459d406088cd54fb2c/>
- Giesen LJX, van den Boom AL, van Rossem CC, den Hoed PT, Wijnhoven BPL. Retrospective Multicenter Study on Risk Factors for Surgical Site Infections after Appendectomy for Acute Appendicitis. *Dig Surg*. 2017; 34(2): 103–7.
- Clinical prediction score for superficial surgical site infection after appendectomy in adults with complicated appendicitis | *World Journal of Emergency Surgery* | Full Text [Internet]. [cited 2025 Sep 17]. Available from: [https://wjeb.biomedcentral.com/articles/10.1186/s13017-018-0186-1?utm\\_source=chatgpt.com](https://wjeb.biomedcentral.com/articles/10.1186/s13017-018-0186-1?utm_source=chatgpt.com)
- Fayraq A, Alzahrani SA, Alsayaf Alghamdi AG, Alzhrani SM, Alghamdi AA, Abood HB. Risk Factors for Post-appendectomy Surgical Site Infection in Laparoscopy and Laparotomy - Retrospective Cohort Study. *Cureus*. 15(8): e44237.
- Danwang C, Bigna JJ, Tochie JN, Mbonda A, Mbanga CM, Nzalie RNT, et al. Global incidence of surgical site infection after appendectomy: a systematic review and meta-analysis. *BMJ Open*. 2020 Feb 1; 10(2): e034266.
- Laparoscopic versus open surgery for suspected appendicitis - Jaschinski, T - 2018 | *Cochrane Library* [Internet]. [cited 2025 Sep 17]. Available from: [https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD001546.pub4/full?utm\\_source=chatgpt.com](https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD001546.pub4/full?utm_source=chatgpt.com)

16. Zhang G, Wu B. Meta-analysis of the clinical efficacy of laparoscopic appendectomy in the treatment of acute appendicitis. *World Journal of Emergency Surgery*. 2022 May 26; 17(1): 26.
17. Roghani AS, Shahzad F, Roghani FS, Roghani M, Khan Z, Ullah A, et al. Comparison of Surgical Site Infections in Laparoscopic Versus Open Appendectomy: A Prospective Cohort Study. *Cureus*. 17(3): e80530.
18. Deshpande A, Khade S. Retrospective Analysis of Operative Outcome of Appendectomy. *General Surgery*.
19. Azmeraw M, Temesgen D, Kitaw TA, Feleke SF, Haile RN, Kassaw A, et al. Surgical site infection following appendectomy in children. *Sci Rep*. 2025 Feb 21; 15(1): 6321.
20. Kasatpibal N, Nørgaard M, Sørensen HT, Schönheyder HC, Jamulitrat S, Chongsuvivatwong V. Risk of surgical site infection and efficacy of antibiotic prophylaxis: a cohort study of appendectomy patients in Thailand. *BMC Infectious Diseases*. 2006 Jul 12; 6(1): 111.
21. Jurt J, Floquet L, Hübner M, Moulin E, Senn L, Demartines N, et al. Implementing a surgical site infection prevention bundle for emergency appendectomy: Worth the effort or waste of time? *Surgery*. 2022 Jul 1; 172(1): 11–5.