Incidence of surgical site infection among appendectomy, herniorrhaphy and caesarean section patients in Qatar

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Abstract

Background: Surgical site infection is a frequently reported adverse outcome of surgical procedures worldwide, impacting the quality-of-care for patients.

Aim: To describe the incidence of surgical site infection among appendectomy, herniorrhaphy and caesarean section patients in Qatar and compare the rates with external benchmarks.

Methods: We conducted this retrospective observational study among all 5127 appendectomy, herniorrhaphy and caesarean section patients admitted at The Cuban Hospital, Qatar, from 2013 to 2023. We analysed the data using SPSS version 22 and MedCalc, we determined the relative risk ratios, 95% CI and *P*-values, and used Student's t-test for comparison. A 2-sided $\alpha < 0.05$ was considered statistically significant.

Results: Of the 5127 surgeries, 2463 were appendectomies, 751 were herniorrhaphies and 1913 were caesarean sections. Surgical site infections were 2.19% for appendectomy, 2.53% for herniorrhaphy and 2.56% for caesarean section. Surgical site infection decreased over the study period for appendectomy and herniorrhaphy, while it varied with no definite trend for caesarean section. Infection was higher for herniorrhaphy and appendectomy than reported by the National Healthcare Safety Network and the International Nosocomial Infection Control Consortium.

Conclusion: The higher incidence of surgical site infection in Qatar than the benchmark countries provides evidence for stricter hospital infection prevention and control programmes to improve patient safety in the country

Key words: surgical site infection, incidence, appendectomy, hernia, caesarean section, nosocomial infection, Qatar

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Introduction

Surgical site infections (SSIs) are the most frequent types of healthcare-associated infections in acute care hospitals worldwide, and have a significant impact on the quality and safety of patient care and the general efficiency of the healthcare system (*1*). Incidence varies according to factors such as type of surgical procedure, degree of contamination, patient and procedure factors, and compliance with infection prevention practices (*1–5*). The overall incidence of SSI is higher in developing (1.2%–23.6%) than in developed countries (1.2%–5.2%) (*1,5*). The global incidence has been reported as 7.0% (95% prediction interval: 1.0–17.6) for appendectomy, 5.6% [95% confidence interval (CI): 5.18–6.11%] for caesarean section and 0.1% (95% CI: 0.06–0.11) for hernia repair (*6–8*).

Up to 70% of SSIs could be averted using evidence-based prevention strategies; obviously having a further positive impact by reducing mortality and healthcare costs. Adopting safe practices and additional approaches is required for prevention (*9–12*).

The Cuban Hospital is a 75-bed facility, a part of Hamad Medical Corporation, providing care to the population living in the west of Qatar, and receiving referrals from other facilities. Data on the incidence of SSIs in Qatar are too limited to be used as a national benchmark by the national infection control programme, therefore, the programme used data from the National Healthcare Safety Network (NHSN, United States of America) 2003–2008 as an external benchmark (*4,13*). Studies published about SSI in Qatar include data from series of patients or procedures (e.g. neurosurgical, cardiac surgery, kidney transplant surgery, etc.) and single facility reports (14–20).

Considering the limited national data on SSIs, we conducted this study to describe the incidence of SSIs in selected surgical procedures at The Cuban Hospital, a public hospital in Dukhan, Qatar, during a 10-year follow-up period and compared this with external benchmarks.

Methods

Overview

We conducted a retrospective observational study of SSIs in appendectomy (laparoscopic and open procedures, $n = 2463$), hernia surgery (open procedures in abdominal wall hernia repair, $n = 751$), and caesarean section (both elective and non-elective procedures, $n = 1913$) performed over the period 01/01/2013 to 28/02/2023 at The Cuban Hospital. The study period includes the COVID-19 pandemic period (2020 and 2021) during which fewer surgical procedures were performed.

The sample excluded patients undergoing more than one surgical procedure during the same visit to the operating theatre (e.g. hernia surgery plus plastic surgery).

The Cuban Hospital is one of the 4 public healthcare facilities in which caesarean section is performed in Qatar. Patients requiring caesarean section represent the total number of pregnant women in the country, considering demographics, location/residence and clinical characteristics.

Data collection

Data were collected from the infection control department records at The Cuban Hospital. Surveillance was conducted by infection control practitioners and a hospital epidemiologist. Data validation via a secondary review of electronic medical records was undertaken to minimize the potential effect on accuracy of the changes in surveillance staff during 2017–2019. Confirmation of an SSI was the responsibility of the infection control staff. Post-discharge surveillance was conducted through a review of the electronic medical records at 30 or 90 days, according to corporate procedures.

Data collected included the annual incidence of SSIs, aetiology, duration of the procedure, wound type and the American Society of Anaesthesiology score. The National Nosocomial Infection Surveillance System Risk Index was computed for each procedure (*4*). The time elapsed from the surgical procedure to the first evidence of the SSI was documented. The SSI was confirmed using the definitions of the United States Centers for Disease Control and Prevention (US CDC). The surveillance period was 30 days for appendectomy, caesarean section and hernia repair, and 90 days for hernia with mesh, using post-discharge surveillance methods in all cases (electronic medical record review, telephone interview) (*13*). For each procedure, the National Nosocomial Infection Surveillance System Risk Index was computed based on an American Society of Anesthesiology score > 2, a wound classed as contaminated or dirty/infected, and duration of the procedure > 81 minutes. One point was added to the index for each criterion met (13). Classification of the SSI was: superficial incisional, deep incisional or organ-space, in accordance with US CDC definitions (*13*).

Data analysis

Descriptive statistical methods were used to analyse the data. The SSIs according to risk index (RI) were presented as rates per 100 procedures and percentile distribution. The statistical packages SPSS, version 22, and MedCalc (www.medcalc.org/calc/) were used for analysis. Relative risk (RR) ratios, 95% CI and *P*-values were determined. The Student *t*-test was used for data comparison. A 2-sided α of < 0.05 was considered statistically significant.

The SSI rates were compared with reference data from the NHSN 2003–2008 and the International Nosocomial Infection Control Consortium (INICC) data 2005–2010 (*4,5*). INICC follows the procedures and definitions of US CDC surveillance, and constitutes the reference for low- and middle-income countries.

Ethics approval

This study was approved by the institutional review board and the Medical Research Centre at Hamad Medical Corporation, Doha, Qatar (MRC-01-23-172).

Results

During the study period, 2463 appendectomies (98% laparoscopic appendectomies), 751 hernia surgeries and 1913 caesarean sections were performed. The SSI rate for appendectomies RI 0,1 was similar to the NHSN rate (1.15%), with the pooled rate (1.58%) lower than the INICC rate (2.90%; $P = 0.05$) (Table 1). For hernia surgery RI 0, the SSI rate was higher (2.28%; $P < 0.001$) than the NHSN rate (0.74%) and similar to the INICC rate (1.8%) ($P = 0.38$). For caesarean section RI 0, it was higher (2.29%) than both the NSHN (1.46%; $P = 0.01$) and INICC (1.70%; $P = 0.004$) rates, and for RI 1 the SSI rate (3.00%) was similar to the NHSN rate (2.43%; $P = 0.45$).

The low number of appendectomies (RI 2,3), hernia surgery (RI 1 and 2,3) and caesarean section (RI 2,3) limited the analysis and data comparison. The low number of procedures (appendectomies 53, hernia surgery 35, caesarean section 44) limited the analysis of the 2013 data. In 2014, the SSI rate for appendectomy was 4.5%, with a reducing trend over the period 2014–2023 (Figure 1). For hernia surgery, the infection rate fluctuated from 2014 onward, with a high of 3.9% in 2018 and lows of 0.0% in 2020 and in Jan–Feb 2023. For caesarean section, the highest rate was observed in 2020 (5.5%). Over the period 2014–2022, the rate showed an increasing trend, but then dipped to 1.7% for Jan–Feb 2023 (Figure 1). During 2020 and 2021, when most of the surgical patients had associated COVID-19 infection, there was a high SSI rate but with no differences noted on comparing with the non-COVID-19 period (RR 1.47; 95% CI: 0.53–4.03) ($P = 0.45$).

The most frequent type of SSI in all procedures covered in this study was superficial incisional SSI (75.4%). The frequency for deep incisional SSI was 6.6% and for organ-space SSI 18.0%. The diagnosis of superficial incisional SSI was made primarily by the observation of purulent drainage from the superficial incision or the identification of an organism from an aseptically-obtained specimen (82.6%), while for deep incisional and organ space SSIs, an abscess or other evidence of infection was the most common diagnostic indicator (86.7%).

The mean time from a surgical procedure to onset of infection was up to 12.5 days [standard deviation (SD) 8.2] for caesarean section in comparison with appendectomy (mean 6.5, SD 4.0) days ($P = 0.02$) and hernia surgery (mean 9.9, SD 7.7) days ($P = 0.37$). No statistically significant difference was observed between appendectomy and hernia ($P = 0.2$). The interquartile range values for this period were 9.75 days, 9.00 days and 5.50 days respectively. In 25% of patients, the first evidence of infection was

Table 1 Distribution of surgical site infection rates in appendectomy, herniorrhaphy and caesarean section according to risk index category: National Healthcare Safety Network 2006–2008, International Nosocomial Infection Control Consortium 2005–2010 (4,5) and The Cuban Hospital 2013–2023

Procedure & reference	Risk index category	No. of procedures	No. of SSIs	Pooled mean[a]	Key percentile (%)				
					10	25	50[b]	75	90
Appendectomy									
NHSN 2006–2008	0,1	5 211	60	1.15	0.00	0.00	0.60	1.23	2.76
	2,3	663	23	3.47					
INICC 2005–2010	Pooled	13 668	395	2.90	0.12	1.50	2.00	5.30	8.20
The Cuban Hospital 2013–2023	0,1	2 283	36	1.58	0.00	0.00	1.60	2.35	6.28
	2,3	180	18	10.00	–	–	–	–	
	Pooled	2 463	54	2.19	0.00	0.75	1.65	3.07	12.69
Herniorrhaphy									
NHSN 2006–2008	0	2 852	21	0.74	0.00	0.00	0.00	1.08	–
	1	3 348	81	2.42	0.00	0.00	1.02	3.15	–
	2,3	1 277	67	5.25	–	–	–	–	–
INICC 2005–2010	Pooled	9 843	173	1.80	0.00	0.50	12.30	3.10	4.90
The Cuban Hospital 2013–2020,2022[c]	0	701	16	2.28	0.00	0.70	1.90	3.80	–
	1	47	3	6.30	–	–	–	–	–
	2,3	3	0	0.00	–	–	–	–	–
	Pooled	751	19	2.53	0.00	0.85	2.40	3.90	–
Caesarean section									
NHSN 2006–2008	0	20 743	303	1.46	0.00	0.31	1.07	2.69	4.07
	1	8 995	219	2.43	0.00	0.00	1.82	4.32	6.45
	2,3	1 256	48	3.82	–	–	–	–	–
INICC 2005–2010	Pooled	85 254	606	1.70	–	–	–	–	–
The Cuban Hospital 2013–2023	0	1 439	33	2.29	0.00	0.71	2.27	3.90	–
	1	433	13	3.00	–	–	–	–	–
	2,3	41	3	7.32	–	–	–	–	–
	Pooled	1 913	49	2.56	0.63	1.01	3.39	4.27	–

[a]Per 100 surgical procedures; [b]Median; [c]2021 data not included due to low number of procedures.

reported after 16.5 days for caesarean section, 14.0 days for hernia surgery and 8.7 days for appendectomy.

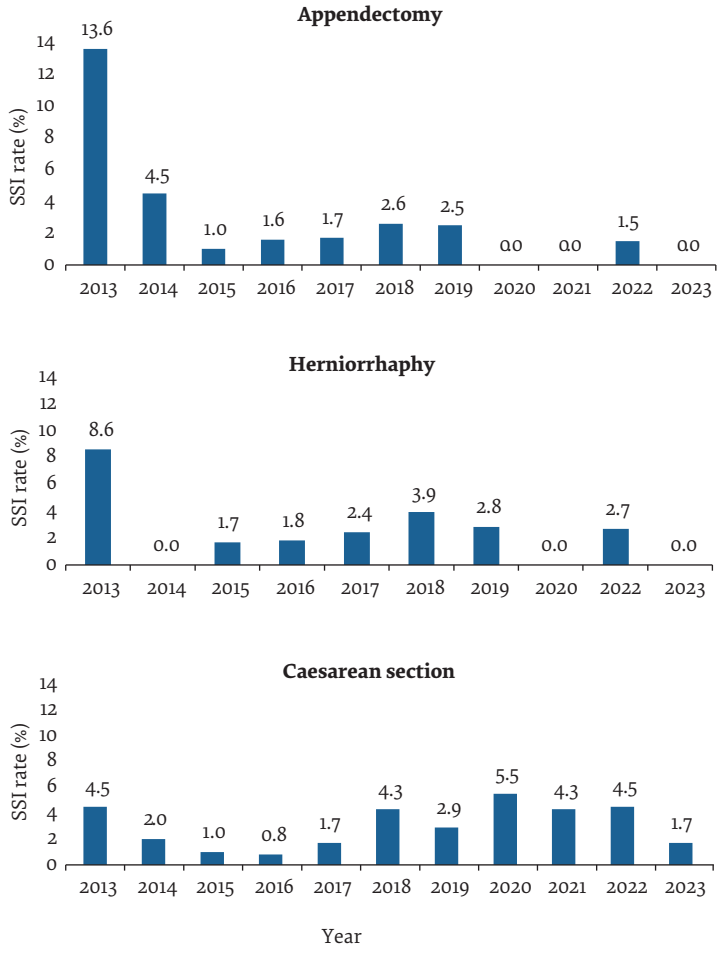
Escherichia coli extended-spectrum beta-lactamase producer was identified in 18 SSI cases (56.3%) after appendectomy surgery. In 5 cases, non-multidrug-resistant *E. coli* was isolated and *Pseudomonas aeruginosa* was identified in 5 cases (Table 2). *Staphylococcus aureus* was identified in 53.8% of isolates from SSIs after caesarean section, mainly methicillin-sensitive strains, with *Klebsiella* spp. (3 multidrug-resistant of 8 isolates) in 28.5% of the SSIs. In hernia surgery, *Streptococcus* spp., *S. aureus* and *Corynebacterium amycolatum* were identified (Table 2).

Discussion

The pooled infection rate was 2.19% for appendectomy (similar to the benchmark), 2.53% for hernia surgery and 2.56% for caesarean section (higher than the benchmark). The SSI rates for appendectomy were similar to the NHSN 2006–2008 values but lower than the reported values worldwide, with a higher incidence reported for open appendectomies than for laparoscopy (*20–24*). The INICC report of 2005–2010, covering summary data from 82 hospitals in 30 countries, reported a 2.90% incidence of SSIs for appendectomy (5). Koumu et al. reported an SSI incidence of 6.9% in a hospital in Saudi Arabia, mainly for open appendectomies (43.8% of cases; 77.4% of SSI cases) (*25*). In contrast, in Qatar, most appendectomies are performed using laparoscopic methods: less than 5% are open surgeries (*18*).

Farid-Mojtahedi et al. estimated the global SSI incidence for caesarean section at 5.63% (95% CI: 5.18–6.11%) (7), while INICC reported an SSI rate of 1.70% (5). We found high SSI rates in 2018 (4.3%) and 2020–2022 (5.5%), without any clear cause. Some factors (in combination or individually) may offer an explanation for these rates, e.g. gaps in the infection control practices during the hospital stay and the potential contribution of postoperative factors (*26–29*). A longer time between the surgical procedure and the first evidence of infection may be

Figure 1 Pooled surgical site infection rates for appendectomy, herniorrhaphy and caesarean section (per 100 procedures), The Cuban Hospital 2013–2023 (SSI rate for hernia surgery 2021 not presented because of the low number of surgical procedures)



related to postoperative factors such as wound care and glycaemic control in diabetic patients.

According to a number of recent reports, the incidence of infection in hernia surgery ranges from 1.6% to 4.2%, with high rates for open vs laparoscopic or minimally invasive procedures in diabetic and obese patients and in smokers (*30–32*). In low-income countries, the SSI rate was 1.80%, lower than our findings (*5*) [it is important to note that the procedures in that study were open surgeries (with or without mesh)].

Time elapsed between the surgical procedure and the first evidence of an SSI showed a similar pattern for caesarean section and hernia surgery, i.e. longer time and data dispersion. In contrast, for appendectomy, the SSI was reported within a shorter time of the procedure. It should be taken into consideration that caesarean section and hernia surgery are open surgeries while appendix surgeries are mostly performed using laparoscopic techniques, which affects the intraoperative risk of infection and the postoperative risk vis-à-vis inadequate wound care, etc. (*33,34*). The risk during the postoperative period, which has been estimated to account for 5–10% of infections, must be considered in selected cases. Empirical evidence from postoperative clinics suggest a likely greater contribution of postoperative factors to the risk of infection than estimated, especially where there has been improper wound care. It has been recommended that post-procedure prevention schedules should also include the rational use of drainage and glycaemic control. Whenever new evidence becomes available, it is recommended to strengthen preventive actions on patient discharge, including patient and family education focusing on personal hygiene and wound care (*9,33,34*).

In appendectomy, the high incidence of infection by multidrug-resistant enteropathogens points to the likelihood of previous intestinal colonization, especially by extended-spectrum-beta-lactamase producer organisms, which results in the limited efficacy of current antibiotic prophylaxis (cefuroxime plus metronidazole) (*35,36*).

Our study had several limitations, including the retrospective observational nature of the survey. During the period covered by the study, mainly during 2017–2019, some changes were made to the infection control team responsible for surveillance. To minimize the impact of this issue on data accuracy, data validation was carried out via a review of the electronic medical records for those 3 years. The low number of procedures performed in a

Table 2 Aetiology of surgical site infection in appendectomy, hernia surgery and caesarean section, The Cuban Hospital, Dukhan, 2013–2023

Isolate	Appendectomy (*n* = 32) No. (%)	Caesarean section (*n* = 28) No. (%)	Herniorrhaphy (*n* = 5) No. (%)
Escherichia coli	5 (15.6)	2 (7.1)	
Escherichia coli ESBL	18 (56.3)	3 (7.1)	
Pseudomona aeruginosa	5 (15.6)		
Klebsiella spp. (pneumoniae, oxytoca)	1 (3.1)	5 (17.8)	
Klebsiella pneumoniae multidrug resistant (ESBL, carbapenem resistance)	1 (3.1)	3 (10.7)	
Streptococcus spp.	1 (3.1)		2 (40.0)
Enterococcus faecalis	1 (3.1)		
Serratia spp.		1 (3.5)	
MSSA		10 (35.7)	1 (20.0)
MRSA		5 (17.8)	1 (20.0)
Anaerobes		1 (3.5)	
Staphylococcus lugdunensis		2 (3.5)	
Proteus spp.		3 (3.5)	
Morganella morganii		4 (3.5)	
Corynebacterium amycolatum			1 (20.0)

ESBL = extended-spectrum beta-lactamase producer.
MSSA = methicillin sensitive Staphylococcus aureus.
MRSA = methicillin-resistant Staphylococcus aureus.

single centre in selected years and risk index categories constituted a limitation for data analysis.

Conclusion

The incidence of SSIs and the comparison with the benchmarks provide evidence to support the need for stricter hospital infection control programme that will improve patient safety and quality of care. Additional research is required to identify risk factors for SSIs, the potential contribution of postoperative factors to SSIs and quality improvement interventions to reduce SSI rates.

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Incidence de l'infection du site chirurgical chez les patients ayant subi une appendicectomie, une herniorraphie et une césarienne au Qatar

Résumé

Contexte : L'infection du site chirurgical est une issue indésirable fréquemment rapportée suite à des interventions chirurgicales dans le monde entier, qui a un impact sur la qualité des soins prodigués aux patients.

Objectifs : Décrire l'incidence des infections du site chirurgical chez les patients ayant subi une appendicectomie, une herniorraphie et une césarienne au Qatar et comparer les taux à des critères externes.

Méthodes : Nous avons mené la présente étude observationnelle rétrospective auprès de 5127 patients hospitalisés au Cuban Hospital au Qatar pour une appendicectomie, une herniorraphie et une césarienne, entre 2013 et 2023. Nous avons analysé les données à l'aide du logiciel SPSS version 22 et de Med*Calc*, déterminé les rapports de risque relatif, l'IC à 95 % et les valeurs *p*, et utilisé le *t*-test de Student pour la comparaison. Un α bilatéral inférieur à 0,05 a été considéré comme statistiquement significatif.

Résultats : Sur les 5127 interventions chirurgicales, 2463 étaient des appendicectomies, 751 des herniorrhaphies et 1913 des césariennes. Les infections du site opératoire étaient de 2,19 % pour l'appendicectomie, de 2,53 % pour l'herniorrhaphie et de 2,56 % pour la césarienne. L'infection du site chirurgical a diminué au cours de la période d'étude pour l'appendicectomie et l'herniorrhaphie, tandis qu'elle variait sans tendance définie pour la césarienne. Le taux d'infection associé à l'herniorrhaphie et à l'appendicectomie était plus élevé que celui rapporté par le National Healthcare Safety Network [Réseau national de sécurité des soins de santé] et le Consortium international de lutte contre les infections nosocomiales.

Conclusion : Le fait que l'incidence des infections du site opératoire soit plus élevée au Qatar que dans les pays de référence fournit des données factuelles en faveur de la mise en place de programmes de prévention et de lutte contre les infections hospitalières plus strictes dans le pays afin d'améliorer la sécurité des patients.

معدَّل الإصابة بعدوى في موضع الجراحة بين مرضى استئصال الزائدة الدودية ورأب الفتق والجراحة القيصرية في قطر

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الخلاصة

الخلفية: كثيرًا ما يجري الإبلاغ عن العدوى في موضع الجراحة بوصفها أثرًا سلبيًّا للإجراءات الجراحية في العالم، وهو ما يؤثر في جودة الرعاية الصحية التي يتلقاها المرضى.

الأهداف: هدفت هذه الدراسة الى وصف معدل الإصابة بعدوى في موضع الجراحة بين مرضى استئصال الزائدة الدودية ورأب الفتق والجراحة القيصرية في قطر، ومقارنة تلك المعدلات بالمعايير المرجعية الخارجية.

طرق البحث: أجرينا هذه الدراسة الرصدية الاسترجاعية على جميع مرضى استئصال الزائدة الدودية ورأب الفتق والجراحة القيصرية البالغ عددهم 5127 مريضًا، الذين أُدخلوا إلى المستشفى الكوبي بقطر، من عام 2013 إلى عام 2023. وحلَّلنا البيانات بالإصدار 22 من برمجية SPSS و MedCalc. وحدَّدنا كذلك نِسَب المخاطر النسبية وفاصل الثقة 95٪ وقيم الاحتمال، واستخدمنا اختبار "تي" (Student's t-test) للمقارنة. وقد عُدَّت قيمة α <0.05 الثنائية الجانب ذات دلالة إحصائية.

النتائج: من 5127 عملية جراحية، كانت 2463 عملية منها لاستئصال الزائدة الدودية، و751 لرأب فتق، و1913 عملية قيصرية. وبلغت نسبة الإصابة بعدوى في موضع الجراحة 2.19٪ عند استئصال الزائدة الدودية، و2.53٪ في عمليات رأب الفتق، و2.56٪ عند الجراحة القيصرية. وانخفضت معدَّلات العدوى في موضع الجراحة في أثناء الدراسة لجراحات استئصال الزائدة الدودية ورأب الفتق، بينما تباينت هذه المعدلات مع عدم وجود نمط محدَّد للعمليات القيصرية. وكانت العدوى أيضًا في حالة رأب الفتق واستئصال الزائدة الدودية أعلى مما أبلغت عنه الشبكة الوطنية للسلامة في الرعاية الصحية والاتحاد الدولي لمكافحة العدوى المكتسبة بالمستشفيات.

الاستنتاجات: يُعد معدل الإصابة بعدوى في موضع الجراحة في قطر أعلى من معدلاته في البلدان القياسية، وهو دليل على الحاجة إلى تنفيذ برامج أكثر صرامة للوقاية من العدوى ومكافحتها في مستشفيات ذلك البلد من أجل زيادة سلامة المرضى.

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