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Clinical Studies

Epidemiology of postoperative spinal wound infection in the Middle East and North Africa (MENA) region

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ABSTRACT

Background: Despite the extensive literature on postoperative spinal wound infection, yet to our knowledge, there is no previous study containing combined data from several sites in the Middle East and North Africa (MENA) region. This study aimed to estimate the incidence of surgical site infection (SSI) following spine surgeries, its associated factors, and management.

Methods: In a retrospective cohort study, medical records of all patients ≥18 years of age who underwent spine surgery at 6 tertiary referral centers in the MENA region between January 2014 to December 2019 (n=5,872) were examined to collect data on the following: (1) Patient's characteristics, (2) Disease characteristics, (3) Spine surgery approach, and (4) Characteristics of Postoperative SSI. The determinants of postoperative SSI were identified using logistic regression analysis. Receiver operating characteristic (ROC) curve was applied to identify the cut-off of the length of stay in the hospital postoperatively till the infection is likely to occur. Significance was set at p<.05.

Results: The overall incidence of SSI was 4.2% (95% CI: 3.72–4.77), in the form of deep (46.4%), superficial (43.1%), dehiscence (9.3%), and organ space (1.2%) infections. After adjusting for all possible confounders, significant predictors of postoperative SSI were; diabetes (OR=2.12, p<.001), smoking (OR=1.66, p=.002), revision surgery (OR=2.20, p<.001), open surgery (OR=2.73, p<.001), perioperative blood transfusion (OR=1.45, p=.033), ASA class III(OR=2.08, p=.002), and ≥4 days length of stay "LOS" (OR= 1.71, p=.001). A cut-off of 4 days was the optimum LOS above which postoperative SSI is more likely to occur, with 0.70 sensitivity, 0.47 specificity, and 0.61 area under the curve.

Conclusions: This is the first study that highlighted the incidence of postoperative SSI in spine surgery in the MENA region. Incidence figures are comparable to figures in different areas of the world. Identifying predictors of SSI might help high-risk patients benefit from more intensive wound management.

FDA device/drug status: Not applicable.

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Introduction

Surgical site infection (SSI) is among the most common postoperative complications associated with readmissions [1,2], morbidity, and mortality in surgical patients [3]. Its incidence in spine surgery has ranged from 0.7% to 12.0% [4,5]. Wound dehiscence was also among the most common complications in spinal fusion surgeries [6]. Infection places the patient at high risk for pseudoarthrosis, chronic pain, return to the operating room, adverse neurological sequelae, worsened long-term outcomes, and even death [7–12]. However, prompt diagnosis and aggressive treatment can lead to successful outcomes [7].

Postoperative spine infections can be classified by both the site and the duration of the infection. Infections can be identified as superficial or deep: Superficial infections are limited to the skin and subcutaneous layers without violating the fascial layer, while deep infections extend below the lumbodorsal fascia, ligamentum nuchae, anterior abdominal fascia, or platysma (depending on surgical site) [8–10]. Infection can be further classified based on the time interval from surgery. If the infection occurs within 3 weeks of the procedure, it is classified as an acute infection, and if it occurs >3 weeks since surgery, it is classified as delayed [8–10].

Several risk factors are associated with postoperative wound infection, including and not limited to obesity, smoking, malnutrition, lack of antibiotics, and extended hospitalization [13–16]. In a systematic review of 40 studies from 12 countries of the Eastern Mediterranean region, the overall prevalence of SSI in 137,452 patients was 7.9% (95% confidence interval (CI): 7.1, 8.8; I^2=96.7%) [17]. Considering this high prevalence of SSI in the Eastern Mediterranean region, timely diagnosis, proper prevention and postoperative control are necessary in the region using the same international guides in all countries. However, to our knowledge, despite the extensive literature on this topic, there is no clear statistics on the incidence rates, predictors or management of SSI in the Middle East and North Africa (MENA) countries, with their different patient characteristics, different health care systems, different access policies to health care, and different health insurance systems. Therefore, the aim of this study was to estimate the incidence of SSI following spine surgeries, its associated factors, and management in the MENA region.

Methods

In a multicenter retrospective cohort study, data were collected from the following 6 tertiary referral centers, in 5 countries out of the 20 countries in the region: Hamad General Hospital, Doha, Qatar (bed capacity 600); Saudi National Guard Hospitals, Riyadh, Saudi Arabia (bed capacity 1,500); Zagazig University Hospitals, Zagazig, Egypt (bed capacity 400); As-salam International Hospital, Cairo, Egypt (be capacity 300); and Ghirki Trust Teaching Hospital, Pakistan (bed capacity 600), Royal Private Hospital, Baghdad, Iraq (bed capacity 150). These hospitals were selected based on logistic reasons such as; availability of the same electronic record system of data management, and the ease of contact between surgeons in these hospitals.

The study targeted all patients operated at any of the above facilities who were 18 years of age and older, who underwent spine surgery secondary to degenerative or traumatic pathology (n=5,872), during 6 years [between January 2014 and December 2019], and had at least 3 months of follow-up, postoperatively. The spine surgeries included were; decompression surgeries, discectomies, and fusion surgeries through any approach (posterior, anterior, and lateral) in the cervical, the thoracic and the lumbar spine, regardless of the number of levels involved in the surgery. Patients who underwent spine surgeries for a tumor or infection pathology were excluded.

Data collection

Data were collected from the 6 tertiary referral centers. The following data were collected from the patient's medical records: (1) Patient's characteristics, (2) Disease characteristics, (3) Spine surgery approach, and (4) Characteristics of Postoperative SSI. Wound dehiscence is a partial or total separation of previously approximated wound edges, due to a failure of proper wound healing [18]. This scenario typically occurs 5 to 8 days following surgery when healing is still in the early stages. Organ Space SSI is an infection that can be in any area of the body other than skin, muscle, and surrounding tissue that was involved in the surgery. This includes a body organ or a space between organs [19].

Study subjects

In each hospital, data were extracted from the health system's electronic Datawarehouse, which host all medical information for patient care. Based on the study inclusion criteria, the data were extracted using a search engine within the Electronic Health Record (EHR) and collated in a structured format. All the data obtained are documented by the health care professionals who provided those services to patients. All hospitals provide uniform health care services. Therefore, data collected were consistent across hospitals. Additional validation for operational definitions of variables such as comorbidities was done by allocated research coordinators who performed independent review of all patient's medical charts.

Data analysis

Data were coded and analyzed using the (SPSS version 26.0; IBM Corporation). Categorical variables were presented as frequencies and percentages and their corresponding 95% CI; and numerical variables as mean and standard deviation (SD) and median and interquartile range (IQR). Data were tested for normality, and both qualitative and quantitative analyses were applied to investigate associations between SSI and different risk factors, using the appropriate statistical tests. Student *t* test and Mann-Whitney *U* test were used to compare numerical data. For categorical data, the Pearson chi-square test, chi-square test for linear trend, and Fisher exact test were applied. Odds ratios (ORs) and their corresponding 95% CIs were calculated.

Logistic regression analysis was applied to adjust for confounders of the association between variables and the incidence of postoperative spine surgery wound infection, with the significant variables in bivariate analyses as the independent variables. These independent variables were; history of diabetes mellitus, ischemic heart disease, smoking behavior, spine location, ASA class, pathology of the problem (traumatic or degenerative), revision versus primary surgery, open surgery or MISS, use of instruments, anatomical approach, number of levels fused, blood transfusion, and length of stay (LOS). The receiver operating characteristic (ROC) curve was applied to identify the cut-off of the length of stay in the hospital postoperatively beyond which the likelihood of infection was more likely. Significance was considered at $p<.05$.

This study received approval from the IRB committee at each of the 6 tertiary health centers. Informed consent was waived by all these IRB committees because of the retrospective nature of the study.

Results

Patients' characteristics

Overall, a total of 5,872 spine-operated patients were followed retrospectively; two-thirds were males (61.2%), their mean age was 44.06±15.22 years, mean BMI was 29.03±5.85 kg/m^2, 16.9% were smokers, with history of the following comorbidities; diabetics (22.2%), hypertension (26.7%), ischemic heart disease (9.9%), COPD (4.6%), rheumatoid arthritis/systemic lupus erythematosus (2%), cancer (0.5%), and steroid use (8.7%) (Table 1).

Table 1
Patient and disease characteristics of cases of spine surgery and cumulative incidence (CI) of postoperative surgical site infection (SSI).

	Surgical-site Infection (SSI)		
	No	Incidence (%)	OR (95% CI)
Total (n=5,872)	248	4.22	
Patient's characteristics			
Country			
Egypt (n=1,903, 32.4%)	92	4.8	1
Pakistan (n=2,081, 35.4%)	83	4.0	0.82 (0.60–1.11)
Qatar (n=947, 16.1%)	46	4.9	1.0 ((0.70–1.45)
Saudi Arabia (n=558, 9.5%)	19	3.4	0.69 (0.42–1.15)
Iraq (n=383, 6.5%)	8	2.1	0.42 (0.20–0.87)
χ^2=8.22, p value=.084			
Gender			
Male (n=3,596, 61.2%)	156	4.3	
Female (n=2,276, 38.8%)	92	4.0	0.93 (0.71–1.21)
χ^2=0.30, p value=.58			
Age group (years)			
Age<45 (n=3,061, 52.2%)	115	3.8	1
45≤Age<55 (n=1,175, 20.0%)	59	5.0	1.35 (0.98–1.87)
≤Age<65 (n=1,027, 17.5%)	48	4.7	1.26 (0.89–1.77)
Age≥65 (n=605, 10.3%)	26	4.3	1.15 (0.75–1.78)
χ^2_{LT}=1.52, p=.22			
BMI			
≤BMI<30 (n=1,510, 57.6%)	63	4.2	
BMI≥30 (n=1,112, 42.4%)	63	5.7	1.38 (0.96–1.97)
χ^2=3.12, p=.08			
DM			
Yes (n=1,302, 22.2%)	100	7.7	
No (n=4,570, 77.8%)	148	3.2	2.49*(1.91–3.23)
χ^2=49.43, p<.001*			
HTN			
Yes (n=1,565, 26.7%)	74	4.7	
No (n=4,307, 73.3%)	174	4.0	1.18 (0.89–1.56)
χ^2=1.35, p=.25			
IHD			
Yes (n=579, 9.9%)	34	5.9	
No (n=5,293, 90.1%)	214	4.0	1.48* (1.02–2.15)
χ^2=4.32, p=.038*			
COPD			
Yes (n=268, 4.6%)	13	4.9	
No (n=5,604, 95.4%)	235	4.2	1.17 (0.66–2.06)
χ^2=0.27, p=.60			
RA/SLE			
Yes (n=120, 2.0%)	9	7.5	
No (n=5,752, 98.0%)	239	4.2	1.87 (0.94–3.74)
χ^2=3.25, p=.071			
Smoking			
Yes (n=993, 16.9%)	54	5.4	
No (n=4,879, 83.1%)	194	4.0	1.39* (1.02–1.89)
χ^2=4.36, p=.037*			
Hx steroid use			
Yes (n=508, 8.7%)	24	4.7	
No (n=5,364, 91.3%)	224	4.2	1.14 (0.74–1.75)
χ^2=0.35, p=.56			
Hx cancer			
Yes (n=31, 0.5%)	0	0.0	0.96 (0.95–0.96)
No (n=5,841, 99.5%)	248	4.2	
FET[@], p=.64			
Disease characteristics			
Spine location			
Cervical (n=943, 16.1%)	40	4.2	1
Thoracic (n=545, 9.3%)	36	6.6	1.6* (1.01–2.54)
Lumber (n=4,384, 74.7%)	172	3.9	0.92 (0.65–1.31)
χ^2=8.62, p=.013*			
Primary vs. revision			
Primary (n=5,475, 93.2%)	215	3.9	
Revision (n=397, 6.8%)	33	8.3	2.22* (1.51–3.25)
χ^2=17.60, p<.001*			
Instrumentation			
Yes (n=3,755, 63.9%)	184	4.9	
No (n=2,117, 36.1%)	64	3.0	1.65* (1.24–2.21)
χ^2=11.79, p<.001*			
No. of levels			
One (n=3,681, 62.7%)	143	3.9	1
Two (n=1,304, 22.2%)	44	3.4	0.86 (0.61–1.22)
Three (n=499, 8.5%)	37	7.4	1.98* (1.36–2.88)

(*continued on next page*)

Table 1 (*continued*)

	Surgical-site Infection (SSI)		
	No	Incidence (%)	OR (95% CI)
Four (n=282, 4.8%)	12	4.3	1.1 (0.60–2.01)
Five or more (n=106, 1.8%)	12	11.3	3.16* (1.69–5.89)
χ^2_{LT}=12.06, p<.001*			
Approach			
Posterior (n=5,175, 88.2%)	224	4.3	1
Lateral (n=19, 0.3%)	0	0.0	0.96 (0.95–0.96)
Anterior (n=634, 10.8%)	19	3.0	0.86 (0.42–1.10)
Combined (n=41, 0.7%)	5	12.0	3.07* (1.19–7.90)
χ^2=9.77, p=.021*			
Pathology			
Trauma (n=1,413, 24.1%)	77	5.4	
Degenerative (n=4,458, 75.9%)	171	3.8	1.42* (1.09–1.85)
χ^2=6.91, p=.009*			
Open vs. MISS			
Open (n=4,760, 81.2%)	233	4.9	
MISS (n=1,104, 18.8%)	15	1.4	3.74* (2.21–6.33)
χ^2=27.67, p<.001*			
Perioperative blood transfusion			
Yes (n=1,374, 23.4%)	90	6.6	
No (n=4,495, 76.6%)	158	3.5	1.92* (1.47–2.51)
χ^2=23.96, p<.001*			
Use of ESI			
Yes (n=536, 9.1%)	22	4.1	
No (n=5,327, 90.9%)	226	4.2	1.03 (0.67–1.59)
χ^2=0.023, p=.88			
ASA class			
Class I (n=3,535, 60.9%)	121	3.4	1
Class II (n=1,747, 30.1%)	80	4.6	1.35* (1.02–1.81)
Class III (n=520, 9.0%)	47	9.0	2.8* (1.98–3.98)
χ^2_{LT}=29.57, p<.001*			
Operative time			
<3 hours (n=4,213, 75.3%)	161	3.8	
≥3 hours (n=1,383, 24.7%)	77	5.6	1.48* (1.12–1.96)
χ^2=7.80, p=.005*			
LOS			
<4 days (n=2,718, 46.5%)	74	2.7	
≥4 days (n=3,131, 53.5%)	173	5.5	2.09* (1.58–2.76)
χ^2=28.26, p<.001*			

SSI, surgical site infection; CI, confidence interval; OR, odds ratio; *, statistical significance; LOS, length of stay; Hx, past history; RA/SLE, rheumatoid arthritis/ systemic lupus erythematosus; ASA, American Society of Anesthesiologists; HTN, hypertension; IHD, ischemic heart disease; COPD, chronic obstructive pulmonary disease; BMI, body mass index; ESI, epidural steroid injection; MISS, minimal invasive spine surgery; @, Fisher exact test; χ^2_{LT}, chi square test for linear trend.

Disease characteristics

Of 5,872 spine problems, the majority were degenerative (75.9%), in the lumbar spines (74.7%), of one level (62.7%), of ASA class ≥II (39.1%), primary (93.2%), fixed with instrumentation (63.9%), approached with an open surgery (81.2%), and with a posterior procedure (88.1%) (Table 1). The median operative time was 100 minutes (IQR, 75–175 minutes), with ≥3 hours for 12.4% of patients. The median length of stay was 5 days (IQR, 3–10), with ≥4 days for 53.5% of patients (Table 1).

Postoperative wound infection

Incidence: The overall incidence of postoperative SSI is 4.2 (95% CI: 3.72–4.77), with the lowest incidence in Iraq (2.1%, 95% CI: 1.05–4.15) and the highest one in Qatar (4.9%, 95% CI: 3.66–6.44), with no statistically significant difference between countries (Table 1). Postoperative wound infection was in the form of deep (n=115, 46.4%), superficial (n=107, 43.1%), dehiscence (n=23, 9.3%) and organ space (n=3, 1.2%) infections. The median postoperative day of diagnosis of SSI was the 13th day (IQR, 7–27 days). Wound infection was treated with oral antibiotics (32, 12.9%), oral and intravenous antibiotics (81, 32.7%), and debridement (119, 48.0%). Implant removal was done for 16 cases, and those constituted 8.7% of instrumented 184 cases with postoperative infection, and 6.4% of all cases with infection (Table 2).

Risk factors. This incidence was significantly higher among patients with a history of diabetes (χ^2=49.43, p<.001), ischemic heart disease (χ^2=4.32, p=.038), and those who are smokers (χ^2=4.36, p=.037). With regard to the disease characteristics, the incidence of infection was significantly higher in thoracic spine surgery (χ^2=8.62, p=.013), revision surgery (χ^2=17.60, p<.001), surgery with instrumentations (χ^2=11.79, p<.001), surgery of more levels (χ^2_{LT}=12.06, p<.001), surgery for traumatic pathology (χ^2=6.91, p=.009), open surgery (χ^2=27.67, p<.001), combined approach (χ^2=9.77, p=.021), higher ASA class (χ^2_{LT}=29.57, p<.001), surgery with perioperative blood transfusion (χ^2=23.96, p<.001), ≥3 hours operative time (χ^2=4.22, p=.04), and ≥4 days LOS (χ^2=28.26, p<.001) (Table 1).

However, after adjusting for all possible confounders using logistic regression analysis, significant predictors of postoperative infection were; diabetes (OR=2.12, p<.001), smoking (OR=1.66, p=.002), revision surgery (OR=2.20, p<.001), open surgery (OR=2.73, p<.001), perioperative blood transfusion (OR=1.45, p=.033), ASA class III(OR=2.08, p=.002), and ≥4 days LOS (OR=1.71, p=.001) (Table 3). Multilevel fusion surgeries were no longer significantly associated with postoperative infection (OR=1.13, p=.116).

The ROC curve was applied to identify the cut-off of the length of stay in the hospital postoperatively till the infection is likely to occur.

Table 2
Characteristics of 248 cases of postoperative infection following spine surgery.

Characteristics of SSI	
Age in years [mean, SD]	45.6 (14.9)
Gender [M/F ratio]	156/92 (1.7:1)
Surgical time in minutes [median, IQR]	120 (75–180)
LOS in days [median, IQR]	5 (3–10)
Type of wound infection	
• Superficial [no, %]	107, 43.1
• Deep [no, %]	115, 46.4
• Organ space SSI [no, %]	3, 1.2
• Dehiscence [no, %]	23, 9.3
Management[@]	
• Oral antibiotics [no, %]	32 cases, 12.9%
• Oral & IV antibiotics [no, %]	81 cases, 32.7%
• Debridement & antibiotics [no, %]	119 cases, 48.0%
• Antibiotics & debridement & Removal of implant [no, %]	16 cases, 6.4% (8.7% of cases with implants)

SSI, surgical site infection; LOS, length of stay
[@] Categories for this variable are mutually exclusive.

Table 3
Logistic regression analysis of the predictors of postoperative SSI following spine surgeries.

	B	SE	p value	OR	95% CI	
					Lower	Upper
DM (yes# vs. no)	.753	.158	<.001*	2.12	1.556	2.896
IHD (yes# vs. no)	–.056	.208	.788	.95	.628	1.422
Smokers# vs. nonsmokers	.505	.165	.002*	1.66	1.199	2.291
Spine location			.934			
Cervical	–.046	.245	.850	.96	.591	1.543
Thoracic	.062	.237	.794	1.06	.668	1.694
Primary vs. revision#	.786	.219	<.001*	2.20	1.428	3.375
Instrumentation (yes# vs. no)	–.005	.194	.981	.99	.681	1.456
Levels	.123	.078	.116	1.13	.970	1.318
Approach			.482			
Approach posterior	–.682	.572	.233	.51	.165	1.550
Approach-lateral	–18.994	0.246	.998	.00	.000	.
Approach-thoracic	–.969	.628	.123	.38	.111	1.299
Pathology (degenerative# vs. traumatic)	–.147	.202	.467	.86	.581	1.283
Open# vs. MISS	1.005	.282	<.001*	2.73	1.570	4.748
Blood transfusion (yes# vs. no)	.374	.175	.033*	1.45	1.031	2.050
ASA1			.004*			
ASA class II	.038	.174	.828	1.04	.739	1.460
ASA class III	.731	.238	.002*	2.08	1.302	3.316
Operative_time_≥3 hours#	–.047	.193	.806	.95	.653	1.392
LOS_ ≥4 days#	.535	.157	.001*	1.71	1.255	2.322
Constant	–5.081	.696	.000	.01		

SSI, surgical site infection; #, reference category; *, statistical significance; LOS, length of stay; ASA, American Society of Anesthesiologists; MISS, minimal invasive spine surgery; IHD, ischemic heart disease; DM, diabetes mellitus.

A cut-off of 4 days was the optimum LOS above which the postoperative infection is more likely to occur. At this cut-off, sensitivity is 0.70, specificity is 0.47, and the area under the curve is 0.61 (Fig. 1 and Table 4).

Discussion

This is a multicenter cohort study in 5 countries of the MENA region, which is the first in the region, to estimate the incidence of postoperative wound infection following spine surgery. The overall incidence of postoperative infection was 4.2% (95% CI: 3.72–4.77%), with the lowest incidence in Iraq (2.1%, 95% CI: 1.05–4.15) and the highest one in Qatar (4.9%, 95% CI: 3.66–6.44), with no statistically significant difference between countries. These figures were similar to those reported by other spine surgery cohorts with 0.2% to 4.2% [20–24]. Surgical site infection rates were identified in 161 studies from North America, Europe, and Asia, and pooled average SSI rates for spine surgery were 1.9% (median, 3.3%; range, 0.1%–22.6%) [25]. In our study, postoperative wound infections were in the form of deep (46.4%), superficial (43.1%), organ space (1.2%) infections, and dehiscence (9.3%).

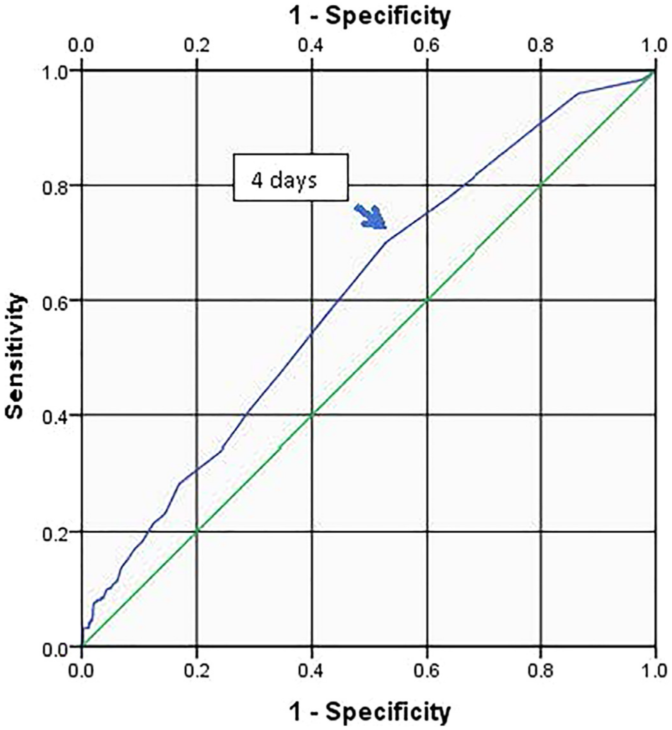

Fig. 1. Receiver operating characteristic curve of the cut-off length of stay for postoperative infection after spine surgery.

Table 4
Cross tabulation of length of stay and postoperative SSI.

Length of stay	Postoperative SSI	
	Yes	No
4 or more days	173	2958
Less than 4 days	74	2644
Total	247	5602

SSI, surgical site infection; Sensitivity, 173/247=0.70; Specificity, 2,644/5,602=0.47; AUC, 0.61.

Different risk factors of postoperative infection were reported in the literature, such as BMI>35 kg/m^2, chronic steroid use, prolonged operation time, hematocrit <33%, and ASA class >2 [26], smoking [21,27,28], chronic hypertension and diabetes mellitus [27]. However, in our study, 7 independent predictors of SSI were identified; diabetes, smoking, revision surgery, open surgery, perioperative blood transfusion, ASA class III, and >4 days LOS. This discrepancy may be due to different operational definitions of these variables or changes in population characteristics over time.

Many previous studies [29–31] have suggested that personal factors such as diabetes, heart disease, steroid use, and concurrent infection may increase the risk for wound infection. In our study, both diabetes and smoking were significant predictors of infection. Surgical factors such as increased operative time, massive blood loss, transfusions, and involvement of increased operative personnel have been reported, but with no evident increased risk of postoperative spinal wound infection [30]. In our study, both blood transfusion and surgical time were significantly associated with postoperative infection. However, after adjusting for possible confounders, we were left with blood transfusion as a significant predictor, but not the surgical time.

The type of spinal surgery could affect the risk for postoperative infection. Heller's review [32] yielded an infection rate after discectomy of 0.6% to 5%, with the higher rates corresponding to the microdiscectomy procedure. In addition, instrumentation showed increased rate of infection in spinal fusion from 1.3% to 6.6% in 17 patients [30], and from 4.3% to 8.7% in 27 patients [33]. Our study revealed that instrumentation and open surgeries were significant predictors of infection. Other studies reported rates of infection ranging from 2.4% to 8.5% after instrumented fusions [29,34-36]. It has been reported that the risk of a postoperative infection increased with the number of levels fused [37]. In our study, there was a significant direct association between number of levels fused and risk of infection, yet after adjustment for possible confounding variables, this association was no longer significant, possibly because some other unknown confounders were not controlled for while investigating such association.

The association between SSI and total and postoperative hospital stays has been reported by many observational studies [38–48]. Postoperative and total hospital LOS is known to be prolonged by the occurrence of SSI. Although it is assumed that SSI occurs mainly during surgery at the surgical site, the hospital environment is a known source of bacterial contamination in many settings, and therefore being discharged earlier after surgery may decrease the risk of SSI [3]. In our study, postoperative LOS was a significant predictor of SSI, even after controlling for possible confounders. The median length of stay was 5 days (IQR, 3–10).

When the ROC curve was applied, a cut-off of 4 days was the optimum LOS above which the postoperative infection was more likely to occur. At this cut-off, sensitivity is 0.70, specificity is 0.47, and area under the curve is 0.61. This cut-off of 4 days may be of clinical importance for reducing postoperative infections following spine surgery. However, since the relationship between LOS and infection is at best a bi-directional relationship, we have to interpret this cut-off LOS of 4 days with caution. Moreover, LOS is very likely associated with other confounding factors such as; surgical complexity and medical comorbidity.

Several methods of interventions were reported in the literature including; systemic antibiotics, local intraoperative antibiotics, multimodal preoperative skin preparation, negative pressure wound therapy, more extensive incisional closure (eg, muscle flap closure), and more extensive postoperative wound care [49–52]. Many of these interventions have shown a reduction in wound complications, particularly in spine surgery [51,53]. In our study, wound infection was treated with oral antibiotics (32 cases, 12.9%), oral and intravenous antibiotics (81, 32.7%), and debridement (119 cases, 48.0%). Principal areas of concern with current surgical antibiotic prophylaxis (SAP) approaches across countries including low- and middle-income countries (LMICs) include timing of administration and prolonged use postsurgery [54–57].

Implant removal was done for 16 cases. Those constituted 8.7% of 184 cases with postoperative infection cases with implants (that constituted 6.4 % of all cases with postoperative infection). In a previous study, it was necessary to remove spinal instrumentation in 35% of patients with postoperative wound infections [34]. However, Beiner et al. [7] recommended irrigation and debridement, leaving all instrumentation in situ, and, if necessary, a second debridement followed by delayed primary closure. Further studies are recommended to investigate how surgical care and antibiotic prophylaxis differ between MENA counties, and between MENA countries and developed countries.

There are limitations to the current study. Although the findings in this study may be generally well established and universally agreed upon by spine surgeons, yet the situation in the MENA region still lacks many regional information on this topic. Another limitation of this study is related to its retrospective nature and the possibility of selection bias, especially that not every country in the region was represented. Moreover, other confounding variables not included in this study such as; antibiotics administered, drains used, and other closure methods, were not considered in the analysis. This study was limited to 30 days for wound complication and its prediction, although other studies have reported wound complications after 30 days [57]. The strength of the study lies in its large sample size, recruited from different settings in the region

Conclusions

This is the first study that highlighted the incidence of postoperative SSI in spine surgery in the MENA region. Incidence figures are comparable to figures in different areas of the world. Identifying predictors of SSI might help high-risk patients benefit from more intensive wound management. Further studies are recommended to investigate how surgical care and antibiotic prophylaxis differ between MENA counties, and between MENA countries and developed countries.

Declarations of Competing Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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