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Original article

Nosocomial Bacterial Infection in Misurata Central Hospital, Libya

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Abstract
Nosocomial infection is a major global safety concern for both patients and health-care professionals. During hospitalization, the patient is exposed to pathogens through different sources, such as the environment, healthcare staff, and other infected patients. The human and financial costs of treating surgical site infections are increased. Additionally, the number of surgical procedures performed continues to rise, and surgical patients are initially seen with increasingly complex comorbidities. This study aims to investigate the sterility state of the surgical sites before and after an operation in both surgical categories (clean surgery and clean-contaminated surgery), to isolate and identify the bacterial species from the collected samples, and to evaluate the nosocomial infection in Misurata central hospital if it is under control or not. This study was performed during the period between Mar/2018 and September 2018 on the patients who were admitted to the surgical departments (MSW, FSW, HDU) and the ICU. 61 samples have been taken from each surgical type (post-operation). As for control, the same number of samples, from the same patients, were taken from the suggested surgical wound site before starting the sterilization for an operation (pre-operation). Two swabs have been collected from each patient before the operation from the site of incision and after the operation from the wound before the patient is discharged. However, in this study, out of 134 samples with bacterial growth, including pre and post-operation, 111 samples were gram-positive bacteria (82.8%), and only 23 samples were gram-negative bacteria (17.2%) with a p-value of 0.000. The infection rate (14.8%) in clean surgery, the infection rate (23%) in clean-contaminated surgery, and the overall infection rate is 23 out of 122, the total infection rate=18.9% with a p-value of 0.928. In conclusion, the nosocomial infection in Misurata Central Hospital is caused by the gram-positive bacteria (82.8%), which is associated with non-significant morbidity and mortality. The infection rates are 14.8% and 23% in clean and clean-contaminated surgery, respectively, which are non-significant. Finally, the nosocomial infection in Misurata Central Hospital is still under control. Therefore, infection control programmes should be put in place to decrease the nosocomial infection rate in addition to public educational programs, which is the responsibility of all healthcare professionals.
Keywords. *Nosocomial Bacterial Infection, Post-operative Wounds, Misurata Central Hospital.*

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Introduction

Nosocomial infection is a major global safety concern for both patients and healthcare professionals [1]. Indeed, nosocomial infections are used interchangeably with the terms healthcare-associated infections (HAIs) and hospital-acquired infections (HAIs). HAIs are responsible for significantly higher mortality rates, length of stay, and hospital costs, being an increasing cause for concern in healthcare worldwide [2]. During hospitalization, the patient is exposed to pathogens through different sources, such as the environment, healthcare staff, and other infected patients [3]. However, HAIs are the major cause of morbidity and mortality and a public health problem that is associated with a significant economic and human impact [4]. Moreover, the pathogens that cause HAI infections can come either from endogenous or exogenous sources [5]. In fact, HAIs might be caused by viral infection, fungal infection [3.6], parasitic infection [7.8], or bacterial infection [9.10.11]. On the other hand, A wound is defined as a disruption of the integrity and function of tissues in the body [12]. Distinctly, the surgical-site infection (SSI) is a common cause of healthcare-associated infection. SSI complicates up to 5% of clean procedures and 30% of clean-contaminated procedures, and is the most common nosocomial infection among surgical patients. SSI leads to a significant increase in hospital stay, Intensive Care Unit (ICU) admission, long-term surgical-site complications, patient suffering, readmission, cost, and death. It is estimated that 40–60% of SSIs are preventable [13]. However, the human and financial costs of treating surgical site infections are increased. Additionally, the number of surgical procedures performed continues to rise, and surgical patients are initially seen with increasingly complex comorbidities.

Nowadays, it is estimated that approximately half of surgical site infections are deemed preventable using evidence-based strategies [14]. Therefore, this study aims to: investigate the sterility state of the surgical sites before and after an

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operation in both surgical categories (clean surgery and clean-contaminated surgery), to isolate and identify the bacterial species from the collected samples, and to evaluate the nosocomial infection in Misurata central hospital if it is under control or not.

Materials and methods

This study was performed on patients admitted to surgical departments (MSW, FSW, HDU, and ICU) at Misurata central hospital.

Study population and sample size

Samples were collected from patients undergoing clean or clean-contaminated surgery. Sixty-one samples were taken for each surgical type post-operation, with an equal number of pre-operation control samples.

Bacterial media and identification

Media used included Blood agar, Chocolate agar, Macconkey agar, Mueller-Hinton agar, and Mannitol salt agar. Identification was based on Gram stain [15], and biochemical tests like API 20 E system, Catalase, and Coagulase tests.

Statistical analysis

The obtained data was subjected to and statistically analyzed by the Minitab 16 program by using the Chi-square test, two-proportion test, Fisher's test, Mann-Whitney test, Wilcoxon signed-rank test, Fisher's test method for grouping information, and Pearson's correlation test to determine the degree of correlation, which measures the degree of linear correlation between two variables and the direction of this link. A probability p-value of ≤ 0.05 was considered significant whenever appropriate by determining the confidence interval =95% and error interval =5%.

Ethical approval

Ethical approval was obtained from authorities at Misurata Central Hospital, and verbal approval was obtained from the patient.

Result and Discussion

Results: Results of clean surgery: The pre-operation samples: Fifteen samples (24.6%) out of 61 showed no bacterial growth. 46 (75.4%) with bacterial growth, with a p-value of 0.000, as shown in (Table 1). The most common identified bacteria were *S. aureus*, which presented in 36 samples (59%) with a p-value of 0.000. *Staphylococcus epidermidis* existed in 6 samples (9.83%) and *Bacillus spp* in 4 samples (6.55%).

Table 1. Results of bacterial growth in the samples of clean surgery.

Samples	Result	Number	%	p-value
Pre-operation samples	No bacterial growth	15	24.6	0.000
	Bacterial growth	46	75.4	
Post-operative samples	bacterial growth	21	34.4	0.001
	No Bacterial growth	40	65.6	

The post-operative samples: Out of 61 cultured samples, 21 (34.4%) showed bacterial growth, whereas 40 samples (65.6%) showed no bacterial growth, p-value=0.001, as shown in (Table 1). The existing bacteria were 10 *S. aureus* (16.39%), 5 *Klebsiella pneumonia* (8.19 %), 2 *Staphylococcus epidermidis* (3.27%), and one sample (1.63%) for each of *Serratia odorifera, Serratia marcescens, E. coli, and Proteus mirabilis*, as shown in (Table 2). Out of the existing bacteria, 9 samples showed pathogenic bacteria (p-Value = 0.003), which are *Serratia odorifera, Serratia marcescens, E. coli, Proteus mirabilis*, and *Klebsiella pneumonia*. The post-operation samples in clean surgery showed a decrease in the number of bacterial growths from 46 sample (75.4%) pre-operation to 40 sample post-operation (65.6%) with p-value 0. 231. Pathogenic and (Commensal flora) non-pathogenic bacteria, which obtained from the clean surgery, are illustrated in (Table 3).

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Table 2. The existing bacteria in the samples of the clean surgery category.

Samples	Bacterial spp	No. of Samples
Pre- operation samples	*S. aureus*	36
	Staphylococcus epidermidis	6
	Bacillus spp	4
Post- operation samples	*S. aureus*	10
	Staphylococcus epidermidis	2
	Klebsiella pneumonia	5
	E. Coli	1
	Serratia marcescens	1
	Serratia odorifera	1
	Proteus mirabilis	1

Table 3. Existing pathogenic & non-pathogenic bacteria in clean surgery.

Pre-operative bacteria	No	Post-operative bacteria	No	Note
S. aureus	36	*S. aureus*	10	Commensal flora (Non pathogenic)
Staphylococcus epidermidis	6	*Staphylococcus epidermidis*	2	Commensal flora (Non pathogenic)
Bacillus spp	4	-		Commensal flora (Non pathogenic)
		Klebsiella pneumonia	5	Pathogenic
		E. Coli	1	Pathogenic
		Serratia marcescens	1	Pathogenic
		Serratia odorifera	1	Pathogenic
		Proteus mirabilis	1	Pathogenic

Results of clean- contaminated surgery: The pre-operation samples: The isolated bacteria from the control samples in this category showed that 43 samples had bacterial growth (70.5%), 18 sample had no bacterial growth (29.5%) with a p-value of 0.000, out of 43 samples with bacterial growth 29 were *S. aureus* (47%) with p-value 0.000, 9 were *Staphylococcus epidermidis* (15%), and 5 were *Bacillus spp* (8%) as shown in (Table 4).The post-operative samples: Out of 61 cultured samples, 37 (60.6%) showed no bacterial growth, whereas 24 (39.3%) showed clear bacterial growth, as shown in (Table 4). A p-value of 0.029 was determined post the operation. Pathogenic bacteria have been detected in 14 samples out of 24 of total bacterial growth, with a p-value = 0.000. The existing bacterial species can be seen in (Table 5). The post-operation samples in clean-contaminated surgery showed a decrease in the number of bacterial growth from 43 samples (70.5%) pre-operation to 24 samples post-operation (39.3%) with a p-value of 0.001.

Table 4. Results of bacterial growth in the samples of clean-contaminated surgery

Samples	Result	Number	%	P-value
Pre-operation samples	No bacterial growth	18	29.5	0.000
	Bacterial growth	43	70.5	
Post-operative samples	No bacterial growth	37	60.7	0.001
	Bacterial growth	24	39.3	

Table 5. The existing bacteria in the samples of clean-contaminated surgery.

Samples	Bacterial spp	No. of Samples
Pre- operation samples	*S. aureus*	29
	Staphylococcus epidermidis	9
	Bacillus spp	5
Post-operation samples	*S. aureus*	8
	Staphylococcus epidermidis	2
	Klebsiella pneumonia	1
	Klebsiella ornithinolytica	2

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	E. Coli	3
	Acinetobacter baumannii	1
	Pseudomonas aeruginosa	7

The pathogenic and non-pathogenic bacteria(Commensal flora), which were obtained from the clean-contaminated surgery, are illustrated in (Table 6). The number of pathogenic bacteria in both surgery types is shown in (Table 7).

Table 6. Existed pathogenic & non-pathogenic bacteria in clean-contaminated surgery.

Pre-operative bacteria	No		No	Note
S. aureus	29	*S. aureus*	8	Commensal flora (Non pathogenic)
Staphylococcus epidermidis	9	*Staphylococcus epidermidis*	2	Commensal flora (Non pathogenic)
Bacillus spp	5			Commensal flora (Non pathogenic)
		Pseudomonas aeruginosa	7	Pathogenic
		E.coli	3	Pathogenic
		Klebsiella ornithinolytica	2	Pathogenic
		Klebsiella pneumonia	1	Pathogenic
		Acinetobacter baumannii	1	Pathogenic

Table 7. Surgical category in relation to No. of pathogenic bacteria

n=61 for each	Clean	Clean- contaminated	Total No.	p- value
Total No. bacterial growth	21	24	45	0.256
No. of pathogenic bacteria	9	14	23	0.061
p-value	0.001	0.010	0.020	

The infection rate will be determined by using the number of existing pathogenic bacteria in the post-operation samples. Therefore, in the clean surgery, the number of pathogenic bacteria is 9 out of 61, in contrast to 52 samples with no pathogenic bacteria (p-value=0.759). The infection rate=14.8%, which indicates no statistical significance. As for the clean-contaminated surgery, the number of pathogenic bacteria is 14 out of 61, in contrast to 47 samples with no pathogenic bacteria (p-value=0.889). The infection rate=23%, which indicates no statistical significance. Consequently, the overall infection rate is 23 out of 122, the total infection rate=18.9% with a p-value of 0.928 as presented in (Table 8). It is noteworthy that while the distribution of pathogenic bacteria showed statistical significance in relation to the surgical category (p=0.001 and p=0.010 as shown in Table 7), the actual infection rates were found to be statistically non-significant. Specifically, the infection rates of 14.8% for clean surgery and 23% for clean-contaminated surgery yielded p-values of 0.759 and 0.889, respectively, indicating no statistical meaning for these rates in the context of this study.

Table 8. Clean, clean contaminated surgery infection rate.

Surgery type	Infection rate	p-value
Clean	14.8%	0.759
Clean contaminated	23%	0.889
Overall	18.9%	0.928

Discussion

This study was performed in Misurata Central Hospital during the period between Mar /2018 to Sep 2018. Two swabs have been collected from each patient before the operation from the site of incision and after the operation from the wound before the patient is discharged. However, in this study, out of 134 samples with bacterial growth, including pre and post- operation, 111 samples were gram-positive bacteria (82.8%) Although Staphylococcus aureus is a major human pathogen, its presence in this study was interpreted within its status as commensal flora, and only 23 samples were gram-negative bacteria (17.2%) with a p-value of 0.000, which means that the presentation of the gram-negative bacteria is non-significant. Our result is in disagreement with the results obtained by Musher et al. (2004) [16], who

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found that gram-positive was 31% and 44% gram negative. In another result obtained by Huang et al. (2016) [17], who presented 66.7% and 33.3% gram positive and gram-negative, respectively.

It is worthy to remember that nosocomial bacteraemia is a major subgroup of hospital-acquired infections. Gram-negative bacteraemia is associated with significant morbidity and mortality, and it has been associated with higher case fatality rates when compared to gram-positive bacteraemia [18]. However, the skin is colonized by various types of bacteria, but up to 50% of these are Staphylococcus aureus [19]. These bacteria reappear in the wounds after the operation, and it's considered normal as they were already on the skin as normal flora [20.21]. This is understandable since these bacteria are part of the patient's skin flora. The large number of bacteria found at the end of the operation might be explained by early recolonisation of commensal skin flora. Importantly, the infection rate (14.8%) in clean surgery, as pathogenic bacterial spp existed in 9 samples out of 61 post- operation samples (p-value=0.759), which means that this infection rate is non-significant. This result is similar to that obtained by Reid et al. (2002) [22], who described 12.6% as an infection rate post-operation.

On the other hand, Ahmed et al., (2007) [23] investigated the infection rate in the clean surgical group, he found that 7.2% of the cases developed infection post-operation. As for the infection rate (23%) in clean-contaminated surgery, pathogenic bacterial spp existed in 14 samples out of 61 post-opples (p-value=0.889), which is also non- significant. Our result is higher than the results obtained by Walz et al., (2006) [24], who determined 8.7% as an infection rate in clean-contaminated surgery. As well as higher than the results obtained by Mulu et al., (2012) [25], who determined 12.8% the rate of nosocomial infections among clean-contaminated operations. Interestingly, the significant reductions in bacterial growth post-operation, in clean-contaminated surgery, indicate that the sterility status was good before the operation in this type of surgery. Bringing the results together, we can easily recognize that the nosocomial infection in Misurata Central Hospital is still under control. Therefore, the infection control programmes should be put in place to decrease the nosocomial post-operations rate in addition to public educational programs, which is the responsibility of all healthcare professionals.

Conclusion

Nosocomial infection in Misurata Central Hospital is mainly caused by Gram-positive bacteria (82.8%) largely representing commensal skin flora. While certain pathogenic bacteria were isolated, the clinical infection rates in clean (14.8%) and clean-contaminated (23%) surgery are statistically non-significant ($p>0.05$). The situation remains under control, though infection control programs are necessary to maintain this status.

Authors' Contributions

All authors contributed to the conception, design, and analysis of the data. Salem Sariti and Narjes abuoud drafted and critically reviewed the manuscript for intellectual content and approved the final version.

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Conflict of interests

The authors declare no conflicts of interest.

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