

## A STUDY OF WOUND INFECTIONS AND MICROBIAL WOUND ISOLATES AT PRINCE SAUD BIN JALAWI HOSPITAL, SAUDI ARABIA

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Article Received on  
27 Dec. 2017,

Revised on 16 Jan. 2018,  
Accepted on 06 Feb. 2018,

DOI: 10.20959/wjpr20184-11145

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### ABSTRACT

**Introduction:** The wound is a breach in the integrity of skin that leads to subcutaneous tissue exposure. Wound infection is one of the principal cause of patient morbidity and mortality. They are also considered one of the most common nosocomial infection. The aim of this study was to analyze the surveillance dataset in order to describe the epidemiology of wound infection in Prince Saud Bin Jalawi Hospital, Saudi Arabia. **Materials and Methods:** The surveillance system data of the two-year period (2016 and 2017) in Prince Saud Bin Jalawi Hospital were analyzed. **Results:** Three hundred ninety-nine patients admitted to Prince Saud Bin Jalawi hospital during the period from January 2016 to December 2017 were notified to have wound

infection. 93.7% of patient were of Saudi nationality and 6.3% of non Saudi. More than half of patients (60.7%) were female and 39.3% were male. Age ranged from 2 to 96 years (mean  $52 \pm 23$  SD). 27.3% of patients had surgical wound infection and 27.6% had diabetes mellitus foot wound. Gram-negative bacilli were the most prevalent bacteria isolated from the wound (71.2%). The most frequent type of isolated organisms was Escherichia-Coli of sensitive type (17.3%), Staphylococcus aureus (16.8%), and Pseudomonas aeruginosa (11.8%). The bacterial isolates in the present study exhibited a high antibiotics resistance, with most isolates having resistance levels ranging between 20% and 100%. Acinetobacter baumannii showed high resistance to antibiotics ranging from 77 to 100%. **Conclusion:** Treatment of wound infection needs laboratory guidance to preserve antimicrobial agents to multi-drug

resistant pathogens. A prospective research about wound infection is needed to study the risk factors, prior hospitalization, mortality and outcome at AlAhsa region.

**KEYWORDS:** Wound infection. Microbial wound. Isolates. Prince Saud bin Jalawi Hospital. Saudi Arabia.

## INTRODUCTION

The wound is a breach in the integrity of skin that leads to subcutaneous tissue exposure.<sup>[1,2]</sup> Wounds can be classified as pathological, post-operative or accidental.<sup>[2]</sup> Wound infection is one of the principal cause of patient morbidity and mortality.<sup>[3-5]</sup> Wound infections are also considered one of the most common nosocomial infection<sup>[6]</sup>, for example, surgical site infection in United State accounted for about 31% of healthcare-associated infections (HAIs).<sup>[7]</sup>

Wound infections cause healing delays, high costs of treatment, prolonged stay in the hospital and increased care.<sup>[8]</sup> Studies in bacteriology have been shown the universal of wound infections and the types of infected bacteria have geographical variation.<sup>[5,9]</sup> In addition, the severity of wound infections complications varies with the infection site and the infecting pathogen.<sup>[1]</sup>

Wound infection control is more challenging due to the high incidence of multi-drug resistant organisms such as methicillin-resistant organisms (MRSA) and fungi.<sup>[5]</sup> However, the infection control measures in healthcare institute will be helpful by the knowledge of the pathogen that causes wound infection.<sup>[6]</sup>

Wound infection researchers have concentrated on surgical site infections.<sup>[10,11]</sup> This focused was due to the other types of wound infection are not causing a problem in developed countries.<sup>[2]</sup> On the other hand in developing countries, the other types of wound infection are still the significant causes of morbidity and mortality.<sup>[12,13]</sup>

There is a gap in the literature in relation to wound infection in Saudi Arabia. None of the studies about wound infection have been conducted in the Prince Saud Bin Jalawi Hospital. The purpose of the current study is to analyze the surveillance data to provide evidence which can be used to develop strategies for control and prevention of wound infection and to highlight the risk factors for the same in this healthcare institute. The aim of the present study was to:

- Investigate the epidemiological characteristics of wound infections at Prince Saud Bin Jalawi Hospital.
- Identify existing gaps in wound infection prevention and control in Prince Saud Bin Jalawi Hospital.
- Identify the characteristics of wound infections susceptibilities to antimicrobial drugs.

## **MATERIALS AND METHODS**

The surveillance system of healthcare-associated infections at Prince Saud Bin Jalawi Hospital is operated by the infection control department. This system conducts both active (through the infection control team), and passive surveillance (through routine microbiological data collection).

All surveillance data with wound infection were analyzed including nosocomial wound infection, with multi-drug resistant organisms (MDROs) and non-MDROs. The dataset was covered of the patients isolate.

### **Sample population**

Three hundred and ninety-nine patients were included in the study. All types of wound infections such as abscess, boils, trauma, diabetic and ulcers were included in the study.

### **Collection of samples**

All the wounds were considered infected by the presence of the pussy material. An exudate from the wound site was carefully collected using sterile cotton-tipped applicators and transferred to the microbiology laboratory for processing. A well freshly prepared blood agar plates were used for aerobically incubation. Gram stain for bacterial colonies on blood agar used, characterization of bacterial isolation based on standard microbiological methods.

### **Data analysis**

Statistical Package for the Social Sciences (SPSS) software, version 21 (2011) was used for surveillance system data collection and analysis over the two years' period (2016-2017). All patients notified with wound infection were eligible for inclusion in the analysis. The univariate analysis included: demographic data such as (patient age, sex, nationality), patient treatment specialty and risk factors. The bivariate analysis included categorical variables between patient groups. P-value <0.05 were considered significant and Chi-square test used to investigate the correlation between nominal data.

### Ethical consideration

The de-identified surveillance system data was analyzed by the researcher.

### RESULTS

Three hundred ninety-nine patients admitted to Prince Saud Bin Jalawi hospital during the period from January 2016 to December 2017 were notified to have wound infection. 58.9% were admitted during the 2017 year, while 41.1% were in 2016.

93.7% of patient were of Saudi nationality and 6.3% of non-Saudi. More than half of patients (60.7%) were female and 39.3% were male (Table 1), but there was no significant association between the type of organism isolated and the sex of the patient ( $\chi^2 = 47.7, p > 0.05$ ). Age ranged from 2 to 96 years (mean  $52 \pm 23$  SD). A significant group (32.8%) was between the age of 45 and 64 years, however, there was a significant association between age and the incidence of wound infection ( $\chi^2 = 23.99, p = 0.00001$ ) (Table 2).

There was a high proportion (13.5%) of wound infection during June of both years (2016 and 2017). Although wound infection was detected throughout the period of study, there was a low proportion (1.5%) of cases during March of both years.

**Table 1: Demographic characteristics of patients and medical intervention.**

		Count	Proportion (%)
<b>Age group</b>	< 25 years	55	13.9
	25 - 44 years	97	24.4
	45 - 64 years	131	33
	65 - 79 years	48	12.1
	80 + years	66	16.6
<b>Sex</b>	Male	157	39.3
	Female	242	60.7
<b>Nationality</b>	Saudi	374	93.7
	Non-Saudi	25	6.3
<b>Specialty</b>	Medical	125	31.3
	Surgical	258	64.7
	Orthopedics	9	2.3
	Urology	1	0.3
	Dermatology	6	1.5
<b>Location of patient</b>	Female ward	206	51.6
	Male ward	127	31.8
	ICU	2	0.5
	OPD	64	16
<b>Type of wound</b>	Surgical wound	109	27.3
	DM wound	110	27.6
	Bedsore	101	25.3
	Other wound	79	19.8

### Patient admission

A significant proportion of patients (51.6%) were admitted to female wards (medical and surgical), and 31.8% were in male wards. A small proportion of cases (0.5%) were in intensive care unit (Table 1).

Treatment specialties were 64.7% surgical, 31.3% medical, 2.3% of patients were treated under orthopedics, and a small proportion (1.5%) were treated with dermatology (Table 1).

### Patient and existing conditions

All patients had at least one pre-existing condition. The most frequently reported pre-existing condition (35.1%) was diabetes mellitus, followed by the major operation (22.3%) and bed-ridden (18.5%). 15.8% of patients had a gangrenous disease.

### Type of wound infection

27.3% of patients had surgical wound infection and 27.6% had diabetes mellitus foot wound. In the other hand, 25.3% had bedsore wound and 19.8% were from other wounds (Table 1). There was a significant association between the type of wound and the sex of the patient (Table 2).

**Table 2. Association between risk factors and infected wound.**

Potential risk factor		No of infected wound				$(x^2, p)$
		Male		Female		
		Count	Proportion (%)	Count	Proportion (%)	
Age group	< 25 years	20	36.4	35	63.6	$(x^2 = 23.99, p < 0.00001)$
	25 - 44 years	51	52.6	46	47.4	
	45 - 64 years	59	45	72	55	
	65 - 79 years	9	18.8	39	81.2	
	80 + years	16	24.2	50	75.8	
Type of wound	Surgical wound	53	48.6	56	51.4	$(x^2 = 35.6, p < 0.00001)$
	Diabetic wound	58	52.7	52	47.3	
	Bedsore	16	15.8	85	84.2	
	Other wound	30	38	49	62	
Microorganism	Acinetobacter sensitive	1	20	4	80	
	Acinetobacter MDR*	1	10	9	90	
	MRSA(methicillin resistant staph aureus)	4	28.6	10	71.4	
	Pseudomonas	11	23.4	36	76.6	
	Enterococcus	3	17.6	14	82.4	
	E- Coli sensitive	22	31.9	47	68.1	
	E-Coli ESBL**	25	56.8	19	43.2	

Streptococcus	10	71.4	4	28.6	
Vancomycin Resistant Enterococci	0	0	0	0	
Klebsiella sensitive	15	42.9	20	57.1	
Klebsiella ESBL	4	80	1	20	
Providencia sensitive	1	33.3	2	66.7	
Providencia ESBL	0	0	0	0	( $x^2 = 47.7, p > 0.05$ )
Proteus sensitive	7	53.8	6	46.2	
Proteus ESBL	2	100	0	0	
Morganilla sensitive	0	0	7	100	
Morganilla ESBL	0	0	1	100	
Enterobacter cloacae	3	50	3	50	
Citrobacter	9	64.3	5	35.7	
Serratia	3	60	2	40	
Flavimonas	0	0	0	0	
Stentrophomonas	0	0	0	0	
Staph aureus	25	37.3	42	62.7	
Pseudomonas MDR	0	0	4	10	
Staphylococcus Epidermidis	1	33.3	2	66.7	

\* MDR: Multi-Drug Resistant \*\* ESBL: Extended-Spectrum Beta-Hactamases

### Micro-organisms isolated

Gram-negative bacilli were the most prevalent bacteria isolated from the wound (71.2%). The most frequent type of isolated organisms was Escherichia-coli of sensitive type (17.3%), Staphylococcus aureus (16.8%), and Pseudomonas aeruginosa (11.8%). Extended-spectrum beta-lactamases (ESBL) producing Escherichia-coli (11%) and Klebsiella pneumonia (8.8%), Methicillin-resistant Staphylococcus aureus (MRSA) (3.5%), Morganilla producing ESBL was rarely isolated during the study period. No organism was peculiar to any of the wound types (Table 3).

**Table 3: Frequency of micro-organism isolated.**

Microorganism	Count	Proportion (%)
Acinetobacter sensitive	5	1.3
Acinetobacter multidrug resistant (MDR)	10	2.6
MRSA	14	3.6
Pseudomonas	47	12.2
Enterococcus	17	4.4
E- Coli sensitive	69	17.9
E-Coli ESBL	44	11.4
Streptococcus	14	3.6
Klebsiella sensitive	35	9.1
Klebsiella ESBL	5	1.3
Providencia sensitive	3	0.8

Proteus sensitive	13	3.4
Proteus ESBL	2	0.5
Morganilla sensitive	7	1.8
Morganilla ESBL	1	0.3
Enterobacter cloacae	6	1.6
Citrobacter	14	3.6
Serratia	5	1.3
Staph aureus	67	17.4
Pseudomonas MDR	4	1.0
Staphy. Epid	3	0.8

### Antibiotic resistance

The bacterial isolates in the present study exhibited a high antibiotics resistance, with most isolates having resistance levels ranging between 20% and 100%. *Acinetobacter baumannii* showed high resistance to antibiotics ranging from 77 to 100%. In the other hand *pseudomonas aeruginosa* exhibited moderate to high resistance to tested antibiotics ranging from 4.9% to cefepime and 100% to gentamycin. *E-coli* ESBL producing showed 100% resistance to nor-floxacin (Table 4).

Table 4. Degree of susceptibility of micro-organisms isolated to antibiotics expressed in percentage of resistance

Micro-organism	Ceftazidime	Cefepime	Augmentin	Gentamycin	Norfloxacin	Ciprofloxacin	Imipenem	Tazocin
	R (%)	R (%)	R (%)	R (%)	R (%)	R (%)	R (%)	R (%)
Acinetobacter sensitive	0	0	80	0	0	80	80	80
Acinetobacter MDR	90	90	100	0	0	90	77.8	85.7
MRSA	100	0	0	20	0	100	0	0
Pseudomonas	13.3	4.9	46.7	0	0	23.3	15.4	25.7
Enterococcus	0	0	73.3	80	0	0	53.3	0
E- Coli sensitive	23.9	9	19	26.9	0	14.9	3.1	3.6
E-Coli ESBL	63.4	16.3	25.6	18.2	100	47.6	0	22.5
Streptococcus	0	0	100	0	0	0	0	0
Klebsiella sensitive	28.6	17.1	17.1	28.6	0	24.2	11.4	24.2
Klebsiella ESBL	60	0	20	20	0	40	0	20
Providencia sensitive	33.3	0	0	100	0	0	0	0
Proteus sensitive	9.1	0	0	11.1	100	9.1	0	0
Proteus ESBL	100	100	0	100	0	100	0	0
Morganilla sensitive	28.6	28.6	71.4	28.6	0	28.6	0	0
Enterobacter cloacae	0	0	100	0	0	0	0	0
Citrobacter	7.1	0	57.1	0	0	0	0	7.1
Serratia	33.3	0	100	0	0	0	0	0
Staph aureus	0	0	44.4	3.9	0	0	46.7	0
Pseudomonas MDR	0	0	0	100	0	0	0	0



## DISCUSSION

Wound infection is a serious problem in hospitalized patients that can contaminate surgical sites and associated with a high morbidity and mortality.<sup>[2-6]</sup> There is geographical variation in the microbiological pathogens that cause wound infections.<sup>[5]</sup> Therefore, empirical wound management will be having a beneficial effect from the regular assessment of the causative agents and susceptibility.

Ideally, wound infection has a strong association with patients age where people at extremes of life prone to wound infection as reported by Christopher et al.<sup>[6]</sup> Consistent with the previous study, the present study demonstrated a significant association between wound infection and age of the patient. This finding was also in agreement with the results of a study reported by Egbe and his colleagues<sup>[14]</sup>, and another study in Ethiopia<sup>[15]</sup> and Torpy et al.<sup>[16]</sup> The result which reported in this study contradict what was reported by Ezebialu et al.<sup>[17]</sup>

As reported in previous studies, the current study showed a significant association between prevalence of wound infections and patients gender.<sup>[5,6,18]</sup>

Gram-negative bacteria were the most commonly isolated pathogens in the present study as what was reported in previous researches.<sup>[2,19,20]</sup>

Although there was no association between the wound pathogen isolated and the type of wound similar to the previous study, Bondei et al.<sup>[21]</sup> On the other hand, some previous studies reported an association between specific microorganisms and particular wound types.<sup>[21,22]</sup> Additional studies required to clarify this association.

The current study reported E-coli as the most common micro-organism isolated in wound infection. The result of this study differs from other studies such as in Nigeria which reported staphylococcus aureus to be the predominant.<sup>[1,6,23]</sup> The present study showed Staphylococcus aureus as the second most isolated pathogen in the wound. Sule et al observed that Klebsiella pneumoniae as the most common pathogen in wounds in a study.<sup>[24]</sup> Egbe et al demonstrated that Staphylococcus aureus and Pseudomonas aeruginosa were the first and second most prevalent pathogen isolated, in contrast to the present study that showed Staphylococcus aureus and Pseudomonas aeruginosa as second and third micro-organisms isolated respectively. Therefore, this is an evidence of local and geographical variability and shows each health institute should determine the microorganisms and other associated factors.

Antibacterial resistance surveillance has an important role in the control and prevention of pathogens. Global and regional surveillance programs have demonstrated variable susceptibilities among pathogens. *Acinetobacter baumannii* was resistant to Cephalosporin, Penicillins and Aminoglycoside, and this result was similar to other studies.<sup>[25,26]</sup> In some researches, more than 80% of *Acinetobacter baumannii* strains are resistant to all Aminoglycosides.<sup>[27,28]</sup> Resistance to Cephalosporins, Aminoglycosides and Ciprofloxacin was widespread, however, more than 70% of isolates in this study were resistant to Carbapenems (Imipenem and Meropenem) but with no Colistin resistance. However, the resistance of *Acinetobacter baumannii* to Carbapenem in the present study was considerably higher than those found in other studies.<sup>[29,30]</sup> This could be due to a wide Carbapenem misuse. On the other hand Somily and colleagues (2012) reported a higher resistance of *Acinetobacter baumannii* to Imipenem (>90%) in Saudi Arabia.<sup>[31]</sup>

*Pseudomonas aeruginosa* was the third most commonly isolated organism in this study. There are institutional and geographical worldwide variations in the anti-pseudomonas activities between agents.<sup>[32]</sup> The results of the current study showed high resistance (100%) to gentamycin and variable resistance to Cefepime, Tazocin and imipenem - which contrasts with a study conducted in Canada by Zhanel et al (2008).<sup>[33]</sup>

Similar to previous study<sup>[19]</sup> Gentamycin was the most broadly active antibiotics against *Staphylococcus aureus* and *E-coli* with variable resistance ranging from minimal resistance in *Staphylococcus aureus* (3.9%), to moderate resistance in *E-coli* (26.9%). The current study showed 60.9% resistance to ampicillin and 44% resistance to Augmentin, where Motayo and others reported 67.7% resistant to ampicillin and 80.8% resistant to Augmentin.<sup>[19]</sup>

Therefore, before prescription of antibiotics for wound infections, a laboratory guidance is needed to preserve the effectiveness of the antibacterial agents for multi-drug resistant microorganisms.

## LIMITATIONS

The retrospective data created a selection bias and lack of required data. The short duration and attributable morbidity and mortality, cost or outcome.

## CONCLUSION

Wound infection prevalence was high and affected by age. Gram-negative was the predominant pathogens in this study, and the most common micro-organism isolated was *E. coli*, *Pseudomonas*. Treatment of wound infection needs laboratory guidance to preserve antimicrobial agents to multi-drug resistant pathogens. A prospective research about wound infection is needed to study the risk factors, prior hospitalization, attributable morbidity, mortality and outcome at AlAhsa region.

## ACKNOWLEDGEMENT

We would like to acknowledge infection control team at Prince Saud Bin Jalawi Hospital; sister Anwar and sister Rebecca for their help in data collection.

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