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# Prevalence of Nosocomial Infections in Hebron-Palestine Hospitals

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***Authors' contributions***

*This work was carried out in collaboration between all authors. Authors MS and FAR designed the study, performed the statistical analysis, wrote the protocol, managed the literature searches, supervised the experimental work, and wrote the first draft of the manuscript. All other authors carried out the experimental work. All authors read and approved the final manuscript.*

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## ABSTRACT

**Background:** Nosocomial infections, especially urinary tract infections, form a serious problem in hospitals, and are associated with increased mortality, morbidity, and prolonged hospital stay. In addition, the most infection rates occur at neonatal intensive care units (NICUs).
**Aims:** To investigate the prevalence of urinary tract infections in different clinical departments and to screen for the main pathogens that colonize and cause infection in infants in the NICU in order to provide a scientific basis for effective prevention and control systems for nosocomial infections.
**Methods:** This cross sectional study was conducted in three hospitals in Hebron. 81 urine samples were collected from the different clinical departments at the hospitals, and 79 swab samples from the throat, umbilical cord, nose, and eye were collected from neonates who were admitted to the

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NICU section in the three studied hospitals. All samples were cultured on Mac Conkey and human blood agar, and positive cultures were identified according to their morphology, gram stain, motility, and biochemical tests. Antibiotic susceptibility testing was performed using Kirby-Bauer's disk diffusion method and interpreted according to Clinical & Laboratory Standards Institute guidelines 2016.

**Results:** Results from collected urine samples showed that 20% of patients carried infectious bacteria. *Enterobacteriaceae* pathogens were the most common in addition to *Staphylococcus aureus*, with 22% of *Enterobacteriaceae* isolates being Extended Spectrum β-lactamase (ESBL). Screening in NICU departments showed that infections were reported in 77.2% of samples, of which coagulase negative *Staphylococcus* formed 50%, *Enterobacteriaceae* formed 42%, and *S. aureus* formed about 8% of the isolated pathogens. Almost 58% of the *Enterobacteriaceae* were ESBL producing, and all *S. aureus* isolates were methicillin resistant *S. aureus* (MRSA).

**Conclusions:** The data collected point to a high threat of healthcare associated infections in the hospitals studied and to the urgent need to establish effective infection control systems in Palestine based on standardized surveillance.

*Keywords: Nosocomial infections; neonatal intensive care unit; urinary tract infections; healthcare associated infections, Palestine hospitals.*

## 1. INTRODUCTION

Nosocomial infections, or healthcare associated infections (HCAI), are infections that were not present initially and without evidence of incubation at the time of admission to a healthcare setting, where the patient is usually admitted to the hospital for reasons other than infection. These infections occur up to 48 hours after hospital admission, up to three days after discharge, or up to 30 days after an operation. Infections occur in one in 10 patients admitted to hospitals, resulting in large number of deaths each year [1]. A recent report by the US Center for Disease Control and Prevention (CDC) showed that HCAI now affects one in 25 patients. The recent HCAI progress report published by the CDC in 2016 described a significant reduction at the national level in America in 2014 for nearly all infections when compared to the baseline data (CDC 2016). Urinary Tract Infections (UTIs) are the most common type of HCAI, of which approximately 75% are associated with a urinary catheter [2], which is aggravated by increasing the usage period.

Most infections occur at the Intensive Care Unit (ICU) [3-5] due to the invasive procedures carried out and the frequent use of medical devices such as mechanical ventilators, in addition to the immunocompromised status of the admitted patient [6-7]. Cases of infection are concentrated in the Neonatal Intensive Care Unit (NICU); newborns who are admitted to this unit are at high risk for infection due to their immature immune system and deficient barrier functions of the skin and gastrointestinal tract, in addition to the invasive diagnostic and therapeutic procedures they usually undergo [8-9].

Nosocomial infections usually result in an increased length of hospital stay and an increased risk of mortality. This puts pressure on health systems to establish surveillance mechanisms to quantify and evaluate the magnitude of the problem in order to assist in justifying resource mobilization and improving infection control systems in hospitals. HCAI is a major problem in developing countries, being that hospital infection control practices are still very elementary and sometimes inefficient due to limited resources.

In Palestine, fragmented studies have been conducted on HCAI in several hospitals, but limited data are available about the infection rates, device utility rates, and antimicrobial resistance, particularly in Hebron, the largest city in Palestine. Early studies conducted in 2005 showed the prevalence of methicillin resistance among *Staphylococcus aureus* isolates in West Bank hospitals to be about 8.7% [10], while recently reported cases are much higher (personal communication). Other recent studies showed that Extended Spectrum β-lactamase (ESBL) producing pathogens are gradually increasing in Palestine particularly with co-resistance to other antibiotics [11]. Moreover, (unpublished) study from Al-Makased hospital in Jerusalem showed that a high number of Carbapenem-resistant *Enterobacteriaceae* (CRE) were detected by screening at the first day of admission coming from other hospitals, which

indicates that CRE is widely spread in Palestine (personal communication). Here we investigated the prevalence of several common types of nosocomial infections in Hebron hospitals and attempted to determine the most frequent pathogens causing these infections and their antimicrobial resistance patterns.

## 2. MATERIALS AND METHODS

### 2.1 Study Design

The study was conducted in three major Hebron hospitals in two separated parts. The first part investigated the prevalence of UTI in patients who were admitted to different clinical sections in the studied hospitals for more than 48 hours. The second part of the study aimed to screen the frequency of pathogens appearing in the NICU section.

### 2.2 Urinary Tract Infection

81 urine samples were collected from patients who were admitted to the different clinical departments in the three studied hospitals for more than 48 hours. The collected samples were then cultured on 5% human blood agar and MacConkey agar for 24 hours at 37°C. Positive cultures were identified according to their morphology, gram stain, motility, and biochemical tests (catalase test, triple sugar iron (TSI), and citrate utilization test).

### 2.3 Screening for Pathogens in NICU

Over one month, 79 swabs from the throat, umbilical cord, nose, and eye were collected from neonates who were admitted to the NICU section in the three studied hospitals. Additionally, birth weight, prematurity status, duration of hospital stay, instrumentation/invasive procedures, and other risk factors were evaluated for all neonates included in the study. Infection control practices among the health personnel were also observed. Samples were cultured on 5% human blood agar and MacConkey agar for 24 hours at 37°C. Positive cultures were identified according to their morphology, gram stain, motility, and biochemical tests (catalase test, TSI, citrate utilizing).

### 2.4 Antibiotic Susceptibility Testing

Antibiotic susceptibility testing was performed for all *Enterobacteriaceae* and *S. aureus* isolates using Kirby- Bauer's disk diffusion method and interpreted according to Clinical & Laboratory Standards Institute (CLSI) guidelines 2016. *Enterobacteriaceae* isolates were tested for their sensitivity to the antibiotics ampicillin (AMP) (10 µg), cefotaxime (CTX) (30 µg), chloramphenicol (C) (30 µg), trimethoprim-sulfamethoxazole (SXT), ciprofloxacin (CIP) (5 µg), cephalothin (KF), and meropenem (MEM) (10 µg), (Bioanalyse Ltd, Turkey) , while *S. aureus* isolates were tested for ciprofloxacin, chloramphenicol, trimethoprim-sulfamethoxazole, cephalothin, and cefoxitin (FOX) (30 µg) (Bioanalyse Ltd, Turkey). ESBL production was detected using Extended-Spectrum ß-Lactamase (ESBL) phenotypically confirmation test using double disk synergy method for the two combinations ceftazidime (CAZ) (30 µg)-amoxicillin/clavulanic acid (AMC) (20 µg/10 µg) and ceftriaxone (CRO) (30 µg)-amoxicillin/clavulanic acid (AMC) (20 µg/10 µg).

## 3. RESULTS

### 3.1 Urinary Tract Infection

Among the 81 patients, almost 65% had an indwelling catheter, 26% were without, while 9% had one removed. 17 (20%) of patients had significant bacteria, of which 9% had in place an indwelling catheter [Fig. 1].

The most commonly isolated microorganisms were *Escherichia coli*, *Klebsiella pneumonia*, *Pseudomonas*, *Enterobacter*, *Enterococcus*, *S. aureus*, Coagulase negative (*CoN) Staphylococcus*, and other *Enterobacteriaceae* species [Table 1]. *Streptococcus* cultures were considered as negative. Antibiograms for the isolated species show the different antibiotic resistance trends between the isolates. 56% were resistant to trimethoprim-sulfamethoxazole, ampicillin, and cephalothin [Table 2]. 22% of the *Enterobacteriaceae* were ESBL producing.

**Table 1. Distribution of isolated pathogens from urine samples**

| Pathogen | Isolates | Percentages |
|---|---|---|
| *CoN S* | 1 | 6% |
| *S. aureus* | 1 | 6% |
| *Enterobacter* | 1 | 6% |
| *E. coli* | 1 | 6% |
| *Klebsiella* | 2 | 13% |
| *Enterococcus* | 2 | 13% |
| *Pseudomonas* | 3 | 19% |
| Other *Enterobacteriaceae* | 5 | 31% |

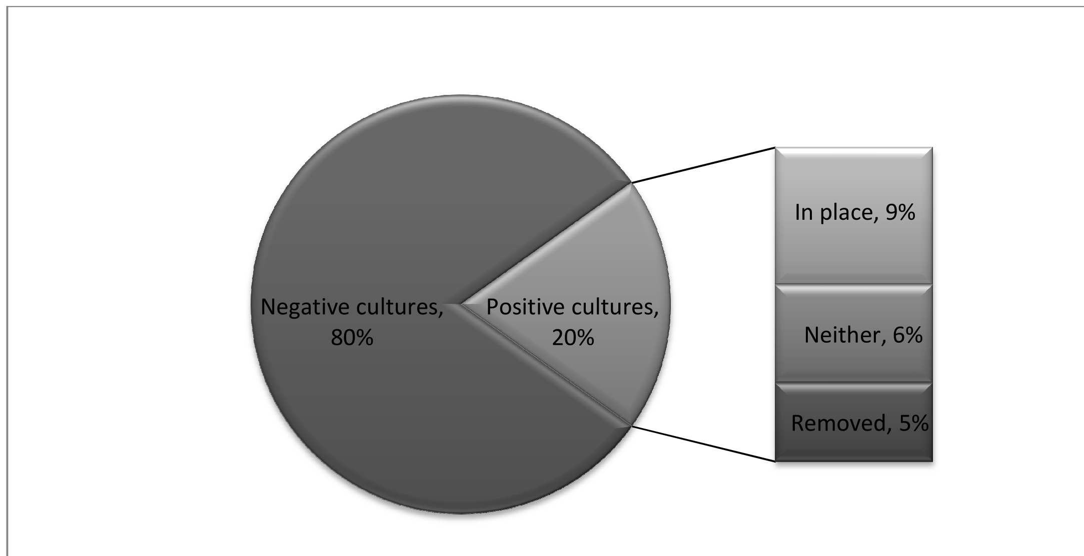


**Fig. 1. The results for the overall urine samples and the distribution of indwelling catheter use among infected patients. Data show that 20% of the patients had significant infection, of which 9% were with indwelling catheter, 5% had removed one, while 6% never used an indwelling catheter**

**Table 2. Antibiogram for the isolated bacterial strains from urine samples. The highest resistance rates were for trimethoprim-sulfamethoxazole (85%), ampicillin (77%), and Cephalothin (69%)**

| Antibiotic | Percentage of resistance (100%) |
|---|---|
| Cefotaxime | 54% |
| Meropenem | 8% |
| Trimethoprim-sulfamethoxazole | 85% |
| Chloramphenicol | 0% |
| Cephalothin | 69% |
| Ciprofloxacin | 15% |
| Ampicillin | 77% |

### 3.2 Screening in Neonatal Intensive Care Unit (NICU)

Of the 79 collected swaps, 33 were from the umbilical cord, 36 from the throat, 5 from the eyes, and 5 from the nose. Significant bacteria were reported in 61 samples (77.2%), of which 39 were with one pathogen, 20 with two pathogens, and two were with three pathogens. *CoN Staphylococcus* were the predominant bacteria with percentage of 50%, while *Enterobacteriaceae* formed 42% of the reported pathogens, and *S. aureus* formed about 8% [Fig. 2].

The antibiogram for *Enterobacteriaceae* isolates showed that 78% were resistant to ampicillin, 56% were resistant to trimethoprim-sulfamethoxazole, 72% were resistant to cefotaxime, which were all ESBL producing (Table 3). Additionally, all *S. aureus* isolates were resistant to trimethoprim-sulfamethoxazole and Cephalothin, and all were methicillin resistant *S. aureus* (MRSA).

**Table 3. Antibiogram for the isolated *Enterobacteriaceae* strains from neonatal swaps at the neonatal intensive care units. The highest resistance rates were for ampicillin 78%, cefotaxime 72%, and Cephalothin 61%.**

| Antibiotic | No of resistant isolates | Percentage of resistance |
|---|---|---|
| Ampicillin | 28 | 78% |
| Ciprofloxacin | 5 | 14% |
| Cephalothin | 22 | 61% |
| Chloramphenicol | 4 | 11% |
| trimethoprim-sulfamethoxazole | 20 | 56% |
| Meropenem | 4 | 11% |
| Cefotaxime | 26 | 72% |

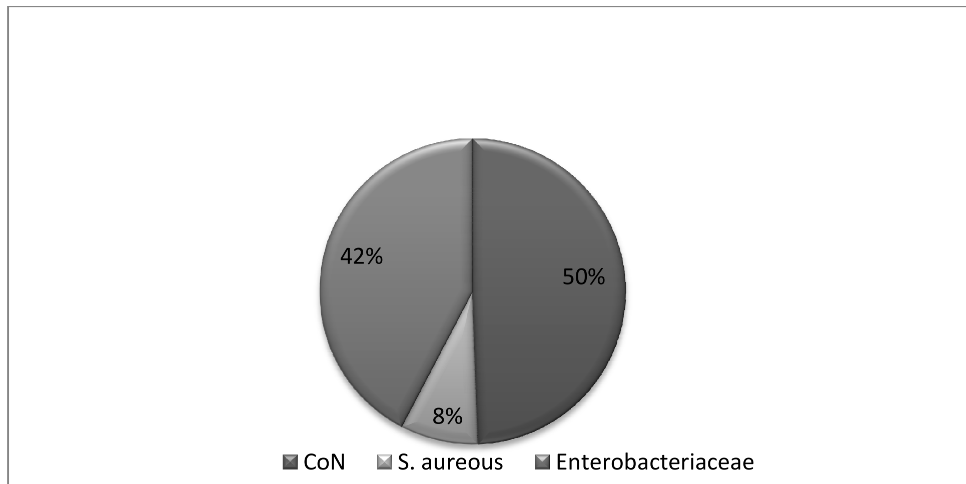


**Fig. 2. The distribution of the isolated pathogens from neonatal intensive care units. The coagulase negative (*CoN) Staphylococcus* was the predominant pathogen making up 50%. *Enterobacteriaceae* formed about 42% of the isolated pathogens, whereas *S. aureus* formed 8%**

## 4. DISCUSSION

Nosocomial infections are infections acquired by patients during their admission period in the hospital. It may be caused by bacteria, viruses, or fungi, which can be easily transmitted from person to person through contaminated objects, hands, or medical devices. The infectious disease society of America has termed antibiotic-resistant bacterial species like *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumonia*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter* spp. as "ESKAPE", to underline how they are currently the major cause of infections in US hospitals, and how they effectively “escape” the effects of antibiotics [12]. In North America and Europe, infection rates ranged between 5%–10% in hospitalized patients, while in Latin America, Sub-Saharan Africa and Asia, infection rates were more than 40% [13]. A study from Lebanon in the Middle East showed the prevalence of urinary infections to be 42% [14], whereas another study from India showed that the incidence of NI in ICU patients was 24.9% [15].

In this study, we investigated the prevalence of several common nosocomial infections in Hebron hospitals over a period of one month. The study included pathogen identification and determination of antibiotic susceptibility patterns for pathogens isolated from patients who were admitted for more than 48 hours to the three studied hospitals. The urinary tract infection rate was 20% among the patients from the different clinical department in the three studied hospitals. 18.3% of patients who had in place or removed indwelling catheter had significant infections, which indicates a high threat of infection especially in patients who require mechanical devices. The highest rates of infection were in intensive care units surgical, and obstetrics sections, which may be related to the invasive procedures and the frequent use of medical devices in addition to the immunocompromised status of the admitted patients and overcrowding in these units.

Most infectious cases were reported in the NICU wards from the three hospitals, so for further investigation we carried out screening for the bacterial species that may be colonized in this section. Throat, umbilical, nose, and eye swab cultures revealed 77.2% positive results. 42% of them were identified as *Enterobacteriaceae* species, 8% as *S. aureus*, while *CoN Staphylococcus* was the dominant species appearing in this section (49%) [Table 2]. These results are in agreement with previous studies that showed *CoN Staphylococcus* was the most commonly isolated pathogen in the NICU [16]. Although this pathogen is typically of low virulence, it is still associated with morbidities in premature infants, and in some cases causes sepsis particularly in neonates with very low birth weight, which leads to prolonged hospital stay and increased hospital costs [16-17]. The highest infection rates were associated with premature

babies who required mechanical ventilation and feeding. Additionally, the medical staff in the studied hospitals had reported other types of infections such as sepsis and ventilator associated pneumonia mostly from *Acinetobacter*, *K. pneumonia*, and *E. coli*, which needed to be admitted to a special quarantined section. One of the infants was with orogastric tube, ventilator, and vascular catheter, and had to be isolated after identification with *E. coli* sepsis and subsequent treatment with meropenem and cefixime, but later the infant had died.

The antibiotic resistance patterns for both gram negative and gram positive pathogens indicate a potentially high threat of widely spread resistant species, particularly of multidrug resistant pathogens, as 56% of the *Enterobacteriaceae* isolated from NICU were resistant to trimethoprim-sulfamethoxazole and 78% were resistant to ampicillin. Additionally 69% of the *Enterobacteriaceae* isolated from NICU and 22% of *Enterobacteriaceae* isolated from UTI patients were ESBL producers. Furthermore, 100% of *S. aureus* were MRSA, and the most alarming finding was that four samples isolated from the NICU were CRE. This is probably due to the misuse of meropenem as a treatment for neonates in this unit. Previous knowledge of the antibiotic susceptibility of the pathogens isolated in this unit may help to formulate an antibiotics usage policy to avoid unnecessary use of broad spectrum antibiotics and therefore prevent the emergence of new antibiotic resistant strains.

The high rates of HCAI in the local hospitals are due to overcrowded wards, insufficient supplies, low nurse to patient ratios, and most importantly the lack of implemented authoritative infection control programs. This can be eliminated by applying effective infection control systems depending on standard surveillance and long-period retrospective studies.

## 5. CONCLUSION

This study showed a significant prevalence of antibiotic resistance in nosocomial infections, and the data can be considered a representative sample for local hospitals. There is still a need to establish standard surveillance systems to monitor infection trends and to control antibiotic treatment according to the emerging strains.

HCAI present a high threat to patient's health, and therefore there is a need for improvement in clinical services by applying effective infection control interventions to eliminate the spread of infections as much as possible.

## CONSENT

It is not applicable.

## ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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