Medical Science

pISSN 2321–7359; eISSN 2321–7367

# Healthcare associated infection in maternity and pediatric hospital, Arar, Saudi Arabia

**Nawal S Gouda[1], Basem Salama[2]**

**To Cite:**
Gouda NS, Salama B. Healthcare associated infection in maternity and pediatric hospital, Arar, Saudi Arabia. Medical Science, 2022, 26, ms329e2194.
doi: https://doi.org/10.54905/disssi/v26i126/ms329e2194

**Authors' Affiliation:**
[1]Department of Microbiology, Faculty of Medicine, Northern Border University, Arar, KSA and Faculty of Medicine, Mansoura University, Egypt
[2]Department of Family Medicine & Community, Faculty of Medicine, Northern Border University, Arar, KSA; Faculty of Medicine, Al-Azhar University, Egypt; Email: Lecuterst@yahoo.com

**Peer-Review History**
Received: 29 March 2022
Reviewed & Revised: 02/April/2022 to 29/July/2022
Accepted: 30 July 2022
Published: 06 August 2022

**Peer-review Method**
External peer-review was done through double-blind method.

**URL**: https://www.discoveryjournals.org/medicalscience



## ABSTRACT

*Introduction:* Healthcare-associated infections (HAIs) are avoidable complications from health care of health care, result in significant patient morbidity and mortality) and prolong the duration of hospital stay and economic cost. It used as an accurate indicator of the quality of health care system. The aim of the current study was to analyze the HAIs rates, to define how many and what kind of HAIs were occurred, the causative organism, type of drugs used in treatment of infection and to identify the risk factors associated with HAIs. *Method:* A nested case-control study included women hospitalized for more than 48 hours at obstetrics and gynaecology wards in the maternity and pediatrics hospital. *Results:* Overall incidence rate of HAIs was (7.8%). *Staphylococcus aureus* was the most frequent isolated pathogen (26.3%) followed by, *E. coli* (21.6%). Urinary tract infection was the most common type (49.3%). Women hospitalization more than 7 days, exposed to indwelling urinary catheter and peripheral IV catheter, aged 35 years or above, underwent to surgical operation and diabetic were at high risk of HAIs(OR >1.5). *Conclusion:* A Healthcare-associated infection requires intensified monitor and implementation of various effective prevention policies to reduce the occurrence of HAIs.

**Keywords:** Healthcare, associated, infections, risk factors, sensitivity.

## 1. INTRODUCTION

Healthcare-associated infections are infection that acquired from hospitals after the second day of admission (Datta et al., 2014; Ahmed et al., 2021). It is an issue of public health affecting hospitalized patients and lead to distribution of multi-drug resistant microorganisms prolong the duration of hospital stay, the cost of health care and increased morbidity and mortality rates that is affecting the quality level of health care services (Abubakar, 2020; Leoncio et al., 2019). The prevalence of HAI affected by the level of the health system's development and construction; its prevalence in developed countries is low compared to developing countries (Talaat et al., 2016). In developed countries, it account from 5% to 10% among patients admitted to acute care hospitals (Khan et al., 2017). In developing countries, about 16 percent of hospitalized patients are diagnosed with HAI. The high prevalence of HAI is

attributed to insufficient infection control procedures due to the lack of policy and guidelines on infection control and the shortage of health professionals in infection control, resources scarcity, and inconsistent surveillance (Bardossy et al., 2017).

Hospitalized patient exposed to intravenous catheters, urinary catheters, respirators, hemodialysis, complicated procedures, corticosteroid therapy and other factors which, affects defense mechanisms and render patients more vulnerable to infections (WHO, 2016). Central line-associated bloodstream infections (CLABSIs) are serious HAIs with a mortality rate of 12%-25%. Catheters are inserted in the center line for the provision of fluids and medications. Its prolonged use can lead to serious bloodstream infections resulting in compromised health and an increase in health care costs. It is estimated that approximately 30,100 CLABSI in ICU and acute settings in the US each year (WHO, 2016; CDC, 2016).

The most common form of nosocomial infection in the world is catheter-associated urinary tract infections (CAUTIs), accounting for more than 12 percent of confirmed HAI in acute health care facilities. It caused by the endogenous microflora of the patients. The catheters inserted inside serve as a conduit for the entrance of pathogens, whereas the incomplete drainage from the catheter holds some volume of urine in the bladder, which gives the bacterial residence stability year (WHO, 2016; CDC, 2016). Surgical site infections (SSIs) are the second most prevalent type of HAIs predominantly caused by *Staphylococcus aureus*, leading to prolonged hospitalization and increase the risk of death. It caused by the endogenous microflora of the patient. The incidence based on the surgical procedure and surveillance standards used (Talaat et al., 2016).

Ventilator associated pneumonia (VAP) is HAI pneumonia observed in patients receiving mechanically assisted ventilator. It generally occurs 2 days or more after airway intubation and manifested by fever, leucopenia and leucopenia (Salama et al., 2016). Increased patient age, diabetes mellitus, renal diseases, immunosuppression, surgical operation, antibiotic exposure, invasive devices exposure (urinary or central venous catheter), nasogastric tubes, intubation, admission to the intensive care unit (ICU), hospital stay duration, and mechanical ventilation were the risk factors independently associated with HAI in hospitalized persons (Despotovic et al., 2020; Rodríguez-Acelas et al., 2017).

Antibiotic resistance is a major health concern in resource-limited countries where the burden of infectious diseases is high, with often higher resistance rates than in developed countries (Kołpa et al., 2018). In order to develop antibiotic resistance, bacteria use various mechanisms. It has been divided into four main biochemical mechanisms: a) antimicrobial molecule modifications, b) prevention of antibiotics to reach target, c) change or bypass of target sites, and d) resistance due to global cell adaptive processes (Munita, 2016). Microbiological studies are useful for confirming the definitive indication of antibiotics and for their rational use (Levy-Hara et al., 2016). Data about antibiotic intake and resistance profile data are useful to help formulate antibiotic usage policies and guidelines at both local and regional levels (Le Doare et al., 2016).

There are limitations in the implementation of infection control procedures and the orientation of staff and preparation in many maternity hospitals. Patients in gynaecology and obstetrics word have a short hospital stay and a large number of HAIs are found after hospital discharge (Ali et al., 2018). The aim of the current study was to analyze the HAIs rates, to define how many and what kind of HAIs were occurred, what are the causative microbes, what kind of drugs can be used in treatment of infection and to identify the risk factors associated with HAI.

## 2. METHODS

**Settings and data collection**

We conducted a nested case -control study included patient hospitalized for more than 48 hours in a period from May 2020 to May, 2021 at obstetrics and gynaecology wards in the maternity and paediatrics hospital in Arar city, Northern Border Area, KSA. During the study period, 2412 patients were hospitalized for more than 48 hours and 217 patients developed HAIs. Whereas 525 patients were randomly selected for statistical analysis to identify the risk factors associated with HAI (175 cases and 350 controls with ratio of 1:2 cases to control). Cases were selected from patients who have HAI while controls were selected from patients without HAI.

**Sociodemographic Data and Specimen Collection**

The following data were collected; age of the women, parity, duration of hospital stay, presence of diabetes, surgical operation (caeserian section, hysterectomy etc) clinical course, fever and exposure to invasive devices insertion such as, peripheral intravenous catheter, urinary catheter or intubation.

**Criteria for diagnosis**

Infection is determined by combination of clinical findings, results of laboratory, other imaging tests (x-ray, ultrasound, computed tomography scans, magnetic resonance imaging) and other investigations as biopsies or endoscopic procedures.

**Laboratory Processing**

Specimens were transported to microbiology laboratory. The samples were inoculated onto different microbiological media and incubated aerobically for 18–24 hours at 37∘C. Identification of bacteria was performed based on colony morphology, Gram stain and biochemical tests (catalase, coagulase, bacitracin, novobiocin, and optochin for Gram-positive bacteria, and triple sugar iron agar, indole test, motility test, urea test, hydrogen sulfide production, citrate test, and lysine decarboxylase test for Gram-negative bacteria)

**Antibacterial Susceptibility Test**

Antibacterial susceptibility testing was done by using modified Kirby-Bauer disk diffusion method and interpreted according to Clinical and Laboratory Standard Institute guidelines. The criteria to select the antimicrobial agents were based on availability, CLSI guide line and frequent prescription of drugs for the management of infections.

**Ethical Consideration**

Ethical clearance was obtained from ethical committee for the initiation of the study. All information was kept confidential by assigning code and assessed only by principal investigator.

**Statistical analysis**

Data were statistically analyzed by SPSS version 22 software (SPSS Inc., Chicago, IL, USA). To evaluate the relations between independent and dependent variables, a Chi-square test was used. Crude odds ratios (COR) and their 95% confidence intervals (CI) were calculated. A $p$ Value < 0.05 was interpreted a statistically significant.

## 3. RESULTS

During the study period, 2,782 patients were hospitalized for more than 48 hours and 217 patients developed HAIs with overall incidence rate of HAIs was (7.8%). Among the 217 different bacterial isolates, S. *aureus* was the most frequent isolated pathogen (26.3%) followed by, *E. coli* (21.6%), *K. pneumoniae* (13.4%), *CONs* (11.1%), *Enterococci* (8.7%), *P. aeruginosa* (7.4%), *Acintobacter spp.* (6.9%), *P. mirabilis* (3.7%) and *Citrobacter* (0.9%) as presented in Table 1.

T**able 1** Isolated bacteria distribution

| Organism | No | % |
|---|---|---|
| *Staph. aureus* | 57 | 26.3 |
| *E. coli* | 47 | 21.6 |
| *Klebsiella Pneumonia* | 29 | 13.4 |
| CONS | 24 | 11.1 |
| *Enterococci* | 19 | 8.7 |
| *Pseudomonas* | 16 | 7.4 |
| *Acinetobacter* | 15 | 6.9 |
| *P. mirabilis* | 8 | 3.7 |
| *Citrobacter* | 2 | 0.9 |
| Total | 217 | 100 |

Among the common site/type of infection, urinary tract infection was the most common type (49.3%) followed by wound and soft tissue infections (30.4%), while blood stream and respiratory infections were the least ones as showed in Figure 1. Table 2 and 3 showed the antibiogram of microorganism responsible for HAI. *Staph. aureus* isolates showed high degree of sensitivity to vancomycin and linezolid (100%, 96% respectively) followed by cefoxitin 79%, nitrofurantoin 79%, tetracycline 75% and least sensitive to penicillin (30%). The second common organism reported was *E. coli*, the majority of isolates of this were sensitive to imipenem (98 %) followed by meropenem (87%), amikacin (87%), levofloxacin (85%), gentamicin (85%), and ciprofloxacin (72%) and

least sensitive to tobramycin (34%). Most of the *K. pneumoniae* strains were sensitive to imipenem (83%) followed by amikacin and meropenem (79% for each).

**Table 2** Antibacterial susceptibility pattern for Gram positive isolates

| Antibiotics | *S. aureus* (57) | | CONS (24) | | *Enterococci* (19) | | Total (100) | |
|---|---|---|---|---|---|---|---|---|
| | S | % | S | % | S | % | S | % |
| Penicillin | 17 | 30 | 8 | 33 | 5 | 26 | 30 | 30 |
| Amoxicillin- clavulanic acid | 35 | 61 | 16 | 67 | 15 | 79 | 66 | 66 |
| Cefoxitin | 45 | 79 | 21 | 88 | 10 | 53 | 76 | 76 |
| Gentamicin | 36 | 63 | 12 | 50 | 12 | 63 | 60 | 60 |
| Erythromycin | 26 | 46 | 7 | 29 | 10 | 53 | 43 | 43 |
| Clindamycin | 36 | 63 | 16 | 67 | 16 | 84 | 68 | 68 |
| Linezolid | 55 | 96 | 20 | 83 | 18 | 95 | 93 | 93 |
| Vancomycin | 57 | 100 | 24 | 100 | 17 | 89 | 98 | 98 |
| Tetracycline | 43 | 75 | 20 | 83 | 10 | 53 | 73 | 73 |
| Nitrofurantoin | 45 | 79 | 24 | 100 | 12 | 63 | 81 | 81 |
| Methicillin | 19 | 33 | 4 | 17 | 9 | 47 | 32 | 32 |

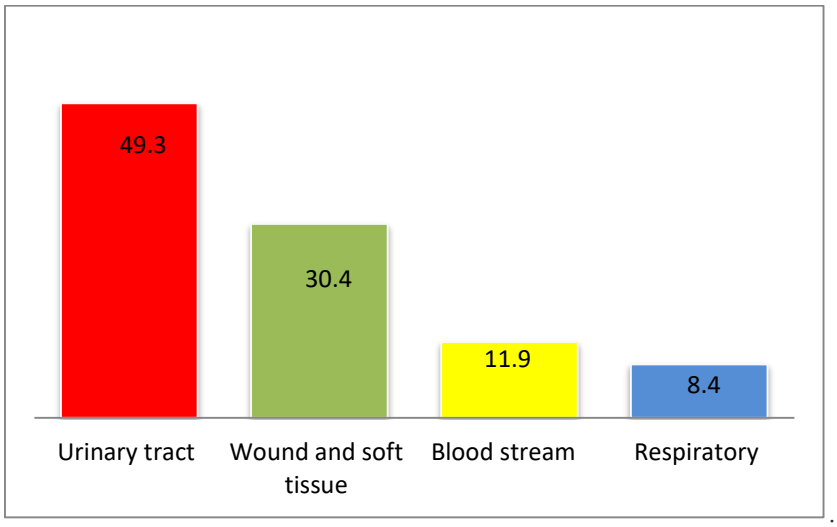


**Figure 1** Rates of health care associated infection

**Table 3** Antibacterial susceptibility pattern for Gram negative isolates

| Antibiotics | *E. coli* (47) | | *Klebsiella* (29) | | *Pseudomonas* (16) | | *Proteus* (8) | | *Acinetobacter* (15) | | *Citrobacter* (2) | | Total (117) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | S | % | S | % | S | % | S | % | S | % | S | % | S | % |
| Amikacin | 41 | 87 | 23 | 79 | 14 | 87 | 7 | 88 | 8 | 53 | 2 | 100 | 95 | 81 |
| Amoxicillin- clavulanic acid | 21 | 45 | 11 | 38 | 7 | 44 | 5 | 63 | 6 | 40 | 1 | 50 | 51 | 44 |
| Cefepime | 31 | 66 | 12 | 41 | 11 | 67 | 4 | 50 | 3 | 20 | 2 | 100 | 63 | 54 |
| Ceftazidime | 22 | 47 | 8 | 28 | 13 | 81 | 3 | 37 | 2 | 13 | 2 | 100 | 50 | 43 |
| Ciprofloxacin | 34 | 72 | 12 | 41 | 15 | 94 | 7 | 88 | 8 | 53 | 2 | 100 | 78 | 67 |
| Gentamicin | 40 | 85 | 11 | 38 | 16 | 100 | 6 | 75 | 7 | 47 | 1 | 50 | 81 | 69 |
| Imipenem | 46 | 98 | 24 | 83 | 15 | 94 | 8 | 100 | 6 | 40 | 2 | 100 | 101 | 86 |
| Meropenem | 41 | 87 | 23 | 79 | 11 | 67 | 8 | 100 | 7 | 47 | 2 | 100 | 92 | 79 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Piperazine/ tazobactam | 36 | 77 | 17 | 59 | 9 | 56 | 6 | 75 | 5 | 33 | 2 | 100 | 75 | 64 |
| Nitrofurantoin | 36 | 77 | 9 | 31 | 8 | 50 | 2 | 25 | 4 | 27 | 1 | 50 | 60 | 51 |
| Trimethoprim-sulphamethoxazole | 27 | 57 | 9 | 31 | 4 | 25 | 6 | 75 | 6 | 40 | 2 | 100 | 54 | 46 |
| Tobramycin | 16 | 34 | 10 | 34 | 5 | 31 | 8 | 100 | 15 | 100 | 2 | 100 | 56 | 48 |
| Colistin | 40 | 85 | 25 | 86 | 15 | 93 | 8 | 100 | 15 | 100 | 2 | 100 | 105 | 90 |
| Levofloxacin | 40 | 85 | 19 | 66 | 11 | 67 | 6 | 75 | 12 | 80 | 2 | 100 | 90 | 77 |

Regarding the risk factors associated with HAIs, (table 4) showed, the mean age of women with HAIs was 36.2 ± 11.2SD compared the mean age of the participants without HAIs was 27.4 ± 9.5SD with significant difference between two groups (t = 9.4 P = 0.001). Women older than 35 years of age were more likely to have HAI than those between 25 and 35 year of age (OR 1.9; vs. 1.8); as compared to women younger than 25 years of age. Diabetes mellitus carried higher risk factors for HAIs (OR = 1.5 P = 0.03). In comparison to patients who did not have the surgical treatment, women who had it were 1.6 times more likely to develop HAI (P = 0.01). Diabetic women were1.5 more likely to develop HAIs compared to non-diabetic women (P = 0.03).

The average length of stay for HAI patients was 12.4 days (SD ± 7.2) while the average length of stay for non-HAI patients was 7.9 days (SD ± 4.9) (t = 8.4 P = 0.001). There is a significant difference between women with and without HAIs [P = 0.001) and hospitalization more than 7 days was tripled the risk of HAIs (OR = 2.9, P = 0.001). Regarding invasive device, indwelling urinary catheter and peripheral IV catheter were doubled the risk of HAIs (OR 2.2, P = 0.001and OR 1.9, P = 0.001 respectively). There was no significantly association between HAI as regards to parity, educational level and tracheal intubation (P > 0.05).

**Table 4** Analysis of risk factors of health care associated infection

| Risk factors | Cases | Controls | OR | CI (95%) | P-value |
|---|---|---|---|---|---|
| | N=175 (%) | N=350(%) | | | |
| Age (years) | | | | | |
| <25 | 22(13) | 73 (21) | - | - | |
| 25-35 | 82(47) | 154 (44) | 1.8 | 1.1-3.1 | 0.04 |
| >35 | 71(40) | 123(35) | 1.9 | 1.1-3.4 | 0.02 |
| Education | | | | | |
| Secondary and above | 97(55) | 187(53) | - | - | |
| Below secondary | 41(23) | 109(31) | 1.3 | 0.8-2.1 | 0.26 |
| Non educated | 37(22) | 54(18) | 0.7 | 0.46-1.0 | 0.15 |
| Parity | | | | | |
| 1-2 | 32(18) | 61(18) | - | | |
| 3-4 | 84(48) | 159(45) | 1.0 | 0.6-1.7 | 0.98 |
| 5 + | 59(34) | 130(37) | 0.87 | 0.5-1.5 | 0.59 |
| Diabetes mellitus | 68(39) | 103(29) | 1.5 | 1.1-2.3 | 0.03 |
| Surgery (yes) | 103(59) | 165(47) | 1.6 | 1.1-2.4 | 0.01 |
| Peripheral Iv catheter | 143(82) | 247(71) | 1.9 | 1.2-3.0 | 0.006 |
| Urinary catheter | 99(57) | 133(38) | 2.2 | 1.5-3.1 | 0.001 |
| Intubation | 84(48) | 164(47) | 1.0 | 0.73-1.5 | 0.8 |
| Hospital stay>7 days | 113(65) | 134(38) | 2.9 | 2.0-4.3 | 0.001 |

## 4. DISCUSSION

Maternal infections as well as nosocomial infection are vital factors for morbidity and mortality especially in postnatal period. It is widely prevalent in both developing as well as developed countries (Cai et al., 2017). This study was carried out to find out the most prevalent HA infection, various risk factors which are commonly associated with HA infections, common organisms isolated and pattern of drug sensitivity in them. Our study showed the overall incidence rate of HAI was 7.8% which was very low compared to that reported in Ethiopia19.4%, Singafore 11.9%, Iran9.4 %, and USA 4.0 % (Ali et al., 2018; Cai et al., 2017; Askaria et

al., 2012; Magill et al., 2014). This could be due to the low patient load, uncrowded, good infrastructure facilities and hospital layout design.

In the current study, urinary tract infection was the most common type of infection which accounted for (49.3%) followed by SSI (30.4%). Our results are in accordance with study conducted by Melaku et al., (2012) who found that UTI and SSI were the most prevalent infections (48%, 45.6% respectively). In other study Latika et al., (2019), surgical site infection was the most common reported type. They concluded that SSI was the most prevalent site for infection in rate of 89.1% and 47% respectively. In the current study Gram negative isolates were predominate than Gram positive isolates (53.9% versus 46.1%). This is in agreement with Melaku et al., (2012), who reported 52.6% Gram negative infection while Gram positive infection represented 47.4%.

High prevalence of Gram negative infection of bacterial isolates were Gram negative (80%) (Gedebou et al., 1988). It was observed that *Staphylococcus aureus* was the most common causative agent (26.3%) followed by *E. coli* (21. 6%). It is in correlation with study by others (Melaku et al., 2012; Latika et al., 2019) they showed *Staphylococcus aureus* being the commonest isolated organism. Most of the *S. aureus* isolates were sensitive to Vancomycin (100%) followed by Linezolid (96%), Cefoxitin (79 %). This is in accordance with Latika et al., (2019) Contrary, to this it has been shown in many studies that *Staphylococcus aureus* was resistant to almost all commonly used antibiotics (Messele et al., 2009).

Regarding the risk factors, age of the women was significantly associated with HAIs that is in line with another study (Pathaket al., 2017). Diabetic women were at more risk of HAI compared to non –diabetic. Diabetes mellitus was independently associated with HAIs (Rodríguez-Acelas et al., 2017). It is explained by low immunity associated with diabetes mellitus and high susceptibility to infection. The duration of hospital stay carried a higher risk of HAIs that supported by a study conducted in Ethiopia which reported that hospital acquired infection was associated with prolonged hospital stay (Ali et al., 2018). Hospital stay increases the exposure to infectious agent that is prevalent in hospital environment. Women exposed to surgery were more likely to HAI compared to non-exposed women this in agreement with (Hassan et al., 2020) study. Persons exposed to surgery exposed to more than one hand exposure which the main source of infection in hospitals. Peripheral venous catheters significantly associated with more risk of HAIs. Mermel et al., (2017) reported that, Short-term peripheral venous catheters responsible for an average of 6.3% and 23% of nosocomial BSIs and nosocomial catheter-related BSIs, respectively. Indwelling urinary catheter was associated with the risk of HAIs. Urinary catheter may be not properly and incomplete evacuation, that lead to stagnation of urine. This is in agreement with Askarian et al., (2012) and Hassan et al., (2020) studies.

## 5. CONCLUSION

Healthcare-associated infections are a frequent complication in women. They are related to duration of hospital stay and invasive procedures, which requires intensified monitor and implementation of various effective prevention policies to reduce the occurrence of HAIs.

**Authors' contributions**

The authors confirm contribution to the paper as follows: study conception and design: Basem and Nawal authors; data collection: Nawal Author; analysis and interpretation of results: Basem and Nawal author; draft manuscript preparation: Basem and Nawal authors. All authors reviewed the results and approved the final version of the manuscript

**Ethical approval**

The study was approved by the local committee of research in Northern Border University, Saudi Arabia ethical approval code: 9760Med.

**Acknowledgments**

We express gratitude to the Deanship of Scientific Research, Northern Border University for supporting this project. Also we would like to express our gratitude to all of the individuals who provided samples for the study.

**Funding**

This study was funded by Deanship of Scientific Research, Northern Border University. This study has not received any external funding.

**Conflicts of interest**

The authors declare that there are no conflicts of interests.

**Data and materials availability**

All data associated with this study are present in the paper.

## REFERENCES AND NOTES


1. Abubakar U. Point-prevalence survey of hospital acquired infections in three acute care hospitals in Northern Nigeria. Antimicrob Resist Infect Control 2020; 9:1-7.
2. Ahmed NJ, Haseeb A, Khan AH. Prevalence of different types of healthcare-associated infections in a military hospital in Al Saih. Medical Science 2021; 25(116):2559-2564
3. Ali S, Birhane M, Bekele S, Kibru G, Teshager L, Yilma Y, Ahmed Y, Fentahun N, Assefa H, Gashaw M, Gudina EK. Healthcare associated infection and its risk factors among patients admitted to a tertiary hospital in Ethiopia: longitudinal study. Antimicrob Resist Infect Control 2018; 7(1):2.
4. Askarian M, Yadollahi M, Assadian O. Point prevalence and risk factors of hospital acquired infections in a cluster of university-affiliated hospitals in Shiraz, Iran. J Infect Public Health 2012; 5(2):169–176.
5. Bardossy AC, Zervos J, Zervos M. Preventing hospital-acquired infections in low-income and middle-income countries: impact, gaps, and opportunities. Infect Dis Clin 2016; 30(3):805–18.
6. Cai Y, Venkatachalam I, Tee NW, Tan TY, Kurup A, Wong SY, Low CY, Wang Y, Lee W, Liew YX, Ang B. Prevalence of Healthcare-Associated Infections and Antimicrobial Use Among Adult Inpatients in Singapore Acute-Care Hospitals: Results From the First National Point Prevalence Survey. Clin Infect Dis 2017; 64(Suppl 2):S61–S67.
7. CDC. Bloodstream infection event (central line-associated bloodstream infection and non-central line-associated bloodstream infection). Atlanta, Georgia: CDC; 2015. [Online] Available from: http://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf [Accessed on 10th August, 2016]
8. CDC. Urinary tract infection (catheter-associated urinary tract infection [CAUTI] and non-catheter associated urinary tract infection [UTI]) and other urinary system infection [USI]) events. Atlanta, Georgia: CDC; 2016. [Online] Available from: http:// www.cdc.gov/nhsn/pdfs/pscmanual/7psccauticurrent.pdf [Accessed on 10th August, 2016]
9. Datta P, Rani H, Chauhan R, Gombar S, Chander J. Health-care-associated infections: Risk factors and epidemiology from an intensive care unit in Northern India. Indian J Anaesth 2014; 58(1):30.
10. Despotovic A, Milosevic B, Milosevic I, Mitrovic N, Cirkovic A, Jovanovic S, Stevanovic G. Hospital-acquired infections in the adult intensive care unit—Epidemiology, antimicrobial resistance patterns, and risk factors for acquisition and mortality. Am J Infect Control 2020; 48(10):1211-1215
11. Gedebou M, Habte-Gabr E, Kronvall G, Yoseph S. Hospital-acquired infections among obstetric and gynaecological patients at TikurAnbessa Hospital, Addis Ababa. J Hosp Infect 1988; 11(1):50-9.
12. Hassan R, El-Gilany AH, El-Mashad N, Azim DA. An overview of healthcare-associated infections in a tertiary care hospital in Egypt. Infect PrevPract 2020; 19:100059.
13. Khan HA, Baig FK, Mehboob R. Nosocomial infections: Epidemiology, prevention, control and surveillance. Asian Pac J Trop Biomed 2017; 7(5):478-82.
14. Kołpa M, Wałaszek M, Gniadek A, Wolak Z, Dobroś W. Incidence, microbiological profile and risk factors of healthcare-associated infections in intensive care units: a 10 year observation in a provincial hospital in Southern Poland. Int J Environ Res Public Health 2018; 15(1):112.
15. Latika, Smiti Nanda, Pushpa Dahiya, Sushila Chaudhary. Study of pattern of nosocomial infections among post-operative patients following obstetrical and gynaecological surgeries in a tertiary care institute of northern India. Int J Reprod Contracept Obstet Gynecol 2019; 8(4):1421-1425.
16. Le Doare K, Jarju S, Darboe S, Warburton F, Gorringe A, Heath PT, Kampmann B. Risk factors for Group B Streptococcus colonisation and disease in Gambian women and their infants. J Infect 2016; 72(3):283-94.
17. Leoncio JM, Almeida VF, Ferrari RA, Capobiango JD, Kerbauy G, Tacla MT. Impact of healthcare-associated infections on the hospitalization costs of children. Rev Esc Enferm USP. 2019; 53:e03486-.
18. Levy-Hara G, Amábile-Cuevas CF, Gould I, Hutchinson J, Abbo L, Saxynger L, Vlieghe E, Lopes Cardoso F, Methar S, Kanj S, Ohmagari N. "Ten commandments" for the appropriate use of antibiotics by the practicing physician in an outpatient setting. Front Microbiol 2011; 2:230.
19. Magill SS, Edwards JR, Bamberg, W, Beldavs ZG, Dumyati G, Kainer MA, Lynfield R, MaloneyM, McAllister-Hollod L, NadleJ and Ray SM. Emerging Infections Program Healthcare-Associated Infections and Antimicrobial Use Prevalence Survey Team Multistate point-prevalence survey

of health care-associated infections. N Engl J Med 2014; 370(13):1198–1208.
20. Melaku S, Gebre-Selassie S, Damtie M, Alamrew K. Hospital acquired infections among surgical, gynaecology and obstetrics patients in Felege-Hiwot referral hospital, Bahir Dar, northwest Ethiopia. Ethiop Med J 2012; 50(2):135.
21. Mermel LA. Short-term peripheral venous catheter–related bloodstream infections: a systematic review. Clin Infect Dis 2017; 65(10):1757-62.
22. Messele G, Woldemedhin Y, Demissie M, Mamo K, Geyid A. Common causes of nosocomial infections and their susceptibility patterns in two hospitals in Addis Ababa. Ethiop J Health Biomed Sci 2009; 2(1):3-8.
23. Munita JM, Arias CA. Mechanisms of antibiotic resistance. Virulence mechanisms of bacterial pathogens. Microbiol Spectr 2016; 22:481-511.
24. Pathak A, Mahadik K, Swami MB, Roy PK, Sharma M, Mahadik VK, Lundborg CS. Incidence and risk factors for surgical site infections in obstetric and gynecological surgeries from a teaching hospital in rural India. Antimicrob Resist Infect Control 2017; 6(1):66.
25. Rodríguez-Acelas AL, de Abreu Almeida M, Engelman B, Cañon-Montañez W. Risk factors for health care–associated infection in hospitalized adults: systematic review and meta-analysis. Am J Infect Control 2017; 45(12):e149-56.
26. Salama B, Elgaml A, Alwakil I, Elsayed M, Elsheref S. Ventilator Associated Pneumonia: Incidence and Risk Factors in a University Hospital. J High Inst Public Health 2014; 44(1):8-12.
27. Sarvikivi E, Kärki T, Lyytikäinen O, Finnish NICU Prevalence Study Group. Repeated prevalence surveys of healthcare-associated infections in Finnish neonatal intensive care units. J Hosp Infect 2010; 76(2):156-60.
28. Talaat M, El-Shokry M, El-Kholy J, Ismail G, Kotb S, Hafez S, Attia E, Lessa FC. National surveillance of health care–associated infections in Egypt: developing a sustainable program in a resource-limited country. Am J Infect Control 2016; 44(11):1296-301.
29. WHO. Preventing bloodstream infections from central line venous catheters. Geneva: WHO; 2016. [Online] Available from: http://www.who.int/patientsafety/implementation/bsi/en/ [Accessed on 10th August, 2016]