Article Title: Healthcare Associated Infection in Maternity Hospital, Arar, Saudi Arabia

Authors: Nawal S. Gouda[1,2], Basem Salama[3,4],Baraah Tomah Abu Alsel [5], Kinda Mohamed Zuhri Hbous [6]

Affiliation:

1:Associate Professor of Microbiology, Faculty of Medicine, Northern Border University, Arar, KSA

2: Associate Professor of Medical Microbiology and Immunology, Faculty of Medicine, Mansoura University, Egypt

3:Associate Professor of Family Medicine & Community, Faculty of Medicine, Northern Border University, Arar, KSA

4: Associate Professor of Community, Faculty of Medicine, Al-Azher University, Egypt

5: Demonstrator of PathologyDepartment, Faculty of Medicine, Northern Border University, Arar, KSA

6:Demonstrator of Clinical Pathology Department, Faculty of Medicine, Northern Border University, Arar, KSA

Sponsors of The Study: Deanship of Scientific Research, Northern Border University, Arar, KSA

Corresponding Author's: Nawal S. Gouda

Address: Saudi Arabia, Arar, Northern Border University

Postal code: 73311

Phone numbers: 00966502933179

Email address:nawalsalama@gmail.com

ORCID ID: https://orcid.org/0000-0001-7178-7646

Healthcare Associated Infection in Maternity Hospital, Arar, Saudi Arabia

Abstract

Introduction: Healthcare-associated infections (HAIs) are used as an accurate indicator of the quality of health care. It increases the morbidity and mortality rates, prolongs the duration of hospital stay, increases economic burden, and should be prevented where possible.

Aim of the study: to identify the Healthcare-associated infections (HAIs) rates, define how many and what kind of HAIs, the causative organism, 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 gynecology wards in the maternity and pediatrics hospital.

Results: Overall prevalence rate of HAIs was (7.8%) and the overall incidence rate of HAI was 12.5 per 1000 patient days. S. *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%) followed by wound and soft tissue infections (30.4%). Women who were stayed in hospital more than 7 days(OR = 2.9), exposed toindwelling urinary catheter (OR = 2.2) and peripheral

IV catheter (OR = 1.9), aged 35 years or above (OR =1.9), underwent to surgical operation (OR =1.6), or diabetic (OR =1.9) wereat high risk of HAIs.

Conclusion: Healthcare-associated infections are a frequent complication in women hospitalized in maternity hospital. 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.

Keywords: Healthcare Associated Infections, Maternity, Risk factors, Sensitivity.

Introduction:

Healthcare-associated infections are infections acquired in hospitals after the second day of admission(1). It is an issue of public health affecting hospitalized patients and leads to emerge of multi-drug resistant microorganisms, prolongs the duration of hospital stay and increases morbidity and mortality rates that is affecting the qualitylevel of health care services(2,3).

The prevalence of HAI is affected by the level of the health system's development and construction; its prevalence in developed countries is low compared to developing countries(4).In developed countries, it accountsfrom 5% to 10% among patients admitted to acute care hospitals(5).Whilein developing countries, about 16 % 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, the shortage of health professionals in infection control, resources scarcity, and inconsistent surveillance(6).

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(7).

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(8,9).

Antimicrobial 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(10).

Microbiological studies are useful for confirming the definitive indication of antibiotics and for their rational use (11).Local data about antibiotic intake and resistance profile are useful to formulate antibiotic usage policies and guidelines at both local and regional levels(12).

Because of limitations in the implementation of infection control procedures, the staff orientation and preparation in many maternity hospitals; a significant number ofobstetric and gynecologic patients developof HAIs after hospital dischargeeven witha short hospital stay (13).

The aim of the current study was to identify the HAIs rates, the causative organism, type of drugs used in treatment of infection and to identify the risk factors associated with HAIs.

MATERIALS AND METHODS

Settings and data collection:

A nested case -control study included patient hospitalized for more than 48 hours was conductedfrom August 2017 to August2018 at obstetrics and gynecology wards in the maternity and pediatrics hospital in Arar city, Northern Border Area, KSA. The following data were collected; age of the women, parity, duration of hospital stay, presence of diabetes, surgical operation (caesarian section, hysterectomy, etc.),clinical course, fever, and exposure to invasive devices insertion.Biological specimens were collected for Gram staining, culture, biochemical tests, and antibacterial sensitivity test .

Criteria for diagnosis:

Infection was determined by combination of clinical findings, results of laboratory, other imaging tests and other investigations as biopsies or endoscopic procedures.

Laboratory Processing:

The samples were inoculated onto different microbiological media and incubated aerobically for 18–24 hours at 37º C. Identification of the isolates were carried out 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 sensitivity testing:

Using the modified Kirby-Bauer disk diffusion process, antibacterial susceptibility testing was performed and interpreted according to the guidelines of the Clinical and Laboratory Standard Institute(14).The standards for the selection of antimicrobial agents were based on availability, the CLSI guideline and the frequent prescription of infection control drugs.

Statistical analysis:

Data were entered and statistically analyzed by SPSS version 22.0 software (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to analyze frequency, mean, range, and standard deviation. 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 statistically significant.

Results:

During the study period, 2,782 patients were hospitalized for more than 48 hours, of them 217 patients developed HAIs with overall prevalence rate of HAIs was 7.8%and the overall incidence rate of HAI was 12.5 per 1000 patient days.

Among the 217 different bacterial isolates, S. *aureus* was the most frequent isolated pathogen (26.3%) followed by, *E. coli* (21.6%)as shown in Table1.

Table (1): Type of isolated bacteria

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%) (Table 2).

Table (2): Rate of health care associated infection

Site	**No**	**%**
Urinary tract	107	49.3
Wound and soft tissue	66	30.4
Blood stream	26	11.9
Respiratory	18	8.4
Total	**207**	**100**

Based on antibiotic susceptibility, Staph. *aureus* isolates showed high degree of sensitivity to vancomycin and linezolid (100%, 96% respectively), while *E. coli* isolates were sensitive to imipenem (98 %)(Table 3 & 4).

Table (3): 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

Table (4): 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;525 patients were randomly selected to identify the risk factors associated with HAI (175 HAI cases and 350 controls without HAIsin a ratio of 1:2).

On comparing HAI cases with other cases,the mean age showed significant difference between the two groups (t = 9.4 P = 0.001). Women older than 35 years were more likely to have HAI than those between 25 and 35 years of age (OR 1.9; vs. 1.8).Patient who had surgical procedure and diabetes were more likely to develop HAIs (1.6 & 1.5 times respectively).

There was 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).Indwelling urinary catheter and peripheral IV catheter weredoubled the risk of HAIs (OR 2.2, P = 0.001and OR 1.9, P = 0.001 respectively). There was not significantly association between HAI as regards to parity, educational level, and tracheal intubation (P > 0.05) (Table 5).

Table (5): Analysis of risk factors of health care associated infection

Risk factors	**Cases** N=175 (%)	**Controls** N=350(%)	**OR**	**CI (95%)**	**P-value**
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

Discussion

Maternal infection as well as nosocomial infection are vital factors for morbidity and mortality specially in postnatal period. It is widely prevalent in both developing as well as developed countries (10).

Our study showed the overall incidence rate of HAI was 12.5 per 1000 patient days. The prevalence rate of HAI was 19.41% compared to 19.4%reported in in Ethiopia, 11.9% in Singapore, 9.4 % in Iran, and 4.0 % inUSA (15-18).This could be explained by the low patient load, uncrowded, good infrastructure, and design of the hospital layout.

In the current study, urinary tract infection was the most common type of infection (49.3%) followed by SSI (30.4%). In line with our results,Melaku et al(19)found that UTI and SSI were the most prevalent infections (48%, 45.6% respectively).In other studies, SSI was the most prevalent site for infection in rates of 89.1% and 47% respectively(21,22).

In the present work, Gram negative isolates were predominated than Gram positive isolates (53.9% versus 46.1%). This agreed with Melaku et al(19), who reported 52.6% Gram negative infection while Gram positive infection represented 47.4%. Gedebou et al(21)reported higher prevalence of Gram-negative infection (80%).

It was observed that *S. aureus* was the most common causative agent (26.3%).This is in correlation with studies by others (19-21)who showed the same finding.Most of the *S. aureus* isolates were sensitive to vancomycin (100%) followed by linezolid (96%). This is in accordance with Latika et la(20) Contrary, it has been shown in many studies that *S. aureus* was resistant to almost all commonly used antibiotics(22).

In our study, women age was significantly associated with HAIs that is in line with another study (23). Also,diabetic women were at more risk of HAI compared to non-diabetic. Rodríguez-Acelas et al(9)reported that, diabetes mellitus was independently associated with HAIs. 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 HAI was associated with prolonged hospital stay(15)·Hospital stay increases the exposure to infectious agent that is prevalent in hospital environment.

Women exposed to surgery were more likely developed HAI compared to non-exposed women this in agreement with Hassan et al(24]).Persons exposed to surgery are usually exposed to more than one hand which is the main source of infection in hospitals. Peripheral venous catheters significantly associated with more risk of HAIs. Mermel(25)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. The Indwelling urinary catheter was associated with the risk of HAIs. This agrees with Askarian et al(16)and Hassan et al[(24)·This may be due tounproperor incompleteevacuation, that lead to urine stagnation.

Conclusion: Healthcare-associated infections are a frequent complication in hospitalized womenin maternity hospital. 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.

Acknowledgement: We express gratitude to the Deanship of Scientific Research, Northern Border University for supporting this project.We are eternally grateful toour colleagues, Dr. Kinda Mohamed ZuhriHbous(Department of Clinical Pathology) and Dr. Braa Tomah Abu Alsel(Department of Pathology)for their help.

*Conflict of interest:*The authorsdeclared any conflict of interest with respect to the authorship and /or publication of the paper**.**

Ethical approval: Ethical clearance was considered, and the study was approved by local committee of research in Northern Border University, Saudi Arabia (H-09-A-51)

Consent to participate:An informative consent was collected from every subject in the study. In case of unconscious patients, consents were taken from their legal guardians.

*Consent for publication***:** Included patients were informed that obtained results would be subjected to scientific publishing.

*Funding:*This study was funded by the Deanship of Scientific Research, Northern Border University.

Author's contributions: Both NG and BS shared in designing the protocol to be carried out, conducting the samples processing procedures,and shared in writing the manuscript and analyzing resulting data.

References:

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):63.
2. Leoncio JM, Almeida VF, Ferrari RAP, Capobiango JD, Kerbauy G, Tacla MTGM. Impact of healthcare-associated infections on the hospitalization costs of children. Rev Esc Enferm USP. 2019;53: e03486.
3. 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):1296-1301.
4. Khan HA, Baig FK, Mehboob R. Nosocomial infections: Epidemiology, prevention, control, and surveillance. Asian Pacific Journal of Tropical Biomedicine. 2017;7(5):478-82.
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 North Am. 2016 ;30(3):805-18.
6. 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):30-5.
7. WHO. Preventing bloodstream infections from central line venous catheters. Geneva: WHO; 2016. [Online] Available from: http:// www.who.int/patientsafety/implementation/bsi/en/
8. Despotovic A, Milosevic B, Milosevic I, Mitrovic N, Cirkovic A, Jovanovic S, et al. 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.
9. 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-e156.
10. 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.
11. Levy-Hara G, Amábile-Cuevas CF, Gould I, Hutchinson J, Abbo L, SaxyngerL, et al.; International Society of Chemotherapy Antimicrobial Stewardship Working Group. "Ten Commandments" for the Appropriate use of Antibiotics by the Practicing Physician in an Outpatient Setting. Front Microbiol. 2011; 2:230.

12. Le Doare K, Jarju S, Darboe S, Warburton F, Gorringe A, Heath PT, et al. Risk factors for Group B Streptococcus colonisation and disease in Gambian women and their infants. J Infect. 2016 ;72(3):283-94.
13. 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.
14. Clinical and Laboratory Standards Institute; 2016. Performance Standards for Antimicrobial Susceptibility Testing.
15. Ali S, Birhane M, Bekele S, Kibru G, Teshager L, Yilma Y, et al. Healthcare associated infection and its risk factors among patients admitted to a tertiary hospital in Ethiopia: longitudinal study. Antimicrob Resist Infect Control. 2018; 7:2.
16. Cai Y, Venkatachalam I, Tee NW, Tan TY, Kurup A, Wong SY, et al. 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.
17. 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):169-76.
18. Magill SS, Edwards JR, Bamberg W, Beldavs ZG, Dumyati G, Kainer MA, et al. 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):1198-208.
19. 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):135-44.
20. 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.
21. 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.
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. Pathak A, Mahadik K, Swami MB, Roy PK, Sharma M, Mahadik VK, et al. 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 Jun 14;6:66.
24. Hassan R, El-Gilany AH, Abd Elaal AM, El-Mashad N, Azim DA. An overview of healthcare-associated infections in a tertiary care hospital in Egypt. Infect PrevPract. 2020 ;2(3):100059.
25. Mermel LA. Short-term Peripheral Venous Catheter-Related Bloodstream Infections: A Systematic Review. Clin Infect Dis. 2017 ;65(10):1757-1762.