Original Article

The Risk of Neonatal Healthcare-Associated Infections at Three Teaching Hospitals in Rwanda

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Abstract

Background
Healthcare-acquired infections (HCAIs) are a substantial source of neonatal morbidity and mortality that also carry a financial burden on families and healthcare systems worldwide. However, little is known about common and factors related to HCAIs among neonates hospitalized in Rwanda. The study's objective was to assess the risk of neonatal HCAIs in three selected teaching hospitals in Rwanda.

Methods
A retrospective cross-sectional study was conducted and stratified simple random sampling was used. Files of 273 neonates were recruited from 15th July to 30th October 2021. The data abstraction sheet was used in data collection. The data was analysed using logistic regression analysis, and the results were presented in tables.

Results
The most common neonatal HCAI agent was Klebsiella pneumoniae affecting 142/273(52%). Neonates weighting ≥3.6kg (OR=0.09; 95% CI= 0.02—0.54), 2.6–3.5kg (OR=0.07, 95% CI = 0.01–0.42); 1.5–2.5kg (OR= 0.03 (95% CI= 0.01–0.22) were significantly less likely to have an HCAIs than neonates weighting <1.5kg. Maternal blood groups, especially AB and O, had significantly higher odds for HCAI, OR=2.37 (95% CI=1.1–5.1) and OR=3.1 (95%CI=1.32–7.26) respectively.

Conclusion
Low birth weight and maternal blood type were associated with HCAIs at the three study sites and the most common HCAI was Klebsiella pneumoniae.
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Keywords: Neonates, HCAI, Neonatal Intensive Care Units, Referral teaching hospitals, Rwanda

Background

Healthcare-associated infection (HCAI) formerly known as nosocomial infections (NI) is defined as "An infection developed in a patient while hospitalized in any health care setting and which was not present or incubating on admission".[1] The term HCAI is being used interchangeably with the term NI.[2] HCAIs, worldwide, are the most frequent adverse events in healthcare delivery.[3,4] Globally, hundreds of millions of patients are affected by HCAIs each year, by increasing length of hospital stay, mortality and financial losses for patients' families and the health systems.[3,5]

The HCAIs, which are on the increase, substantially contribute to raised neonatal mortality rate (NMR), which remains higher than that for the other under-five children, despite comprehensive infection control initiatives.[6,7] According to the World Health Organization (WHO), patients with HCAIs have a higher prevalence rate, placing a far greater burden on low and middle income countries (LMICs) than on high-income countries (HICs).[8] Bloodstream infections are the most prevalent HCAIs in NICU and they can occur alone or in conjunction with organ dysfunction.[9]

Some factors were found to be associated with HCAI, including prematurity, low birth weight (LBW), patient being on ventilation machines, venepuncture, hypoxia and feeding intolerance which pose a significantly higher risk of getting HCAIs compared to neonates in different conditions,[10] HCAIs threaten neonatal health,[11] Whereby neonates, especially preterm are mostly affected because they are frequently subjected to invasive treatments and rely on central catheters for nourishment and ventilators for breathing assistance.[12,13] Furthermore, weakened immune system, function barriers of the skin and gastrointestinal tract, aggressive diagnostic and therapeutic procedures catheter-associated infections, cross transmission of multi-resistant bacteria (e.g. Klebsiella), LBW and prematurity have been associated with HCAIs.[14]

In HICs, such as the European countries like Iceland, Norway, and Croatia, the prevalence rate of HCAIs in Neonatal Intensive Care Unit (NICU) was the highest with (10·7%) followed by neonatology wards (3·5%),[15] Some factors were reported to be significantly associated with HCAIs, such as, the length of hospital stay and having one or more invasive medical devices.[16]

In LMIC, HCAIs account for up to 56% of all causes of neonatal mortality, and the majority (75%) occur in Southeast Asia and Sub-Saharan Africa (SSA).[15–19] HCAI related deaths are linked to length of hospital stay, age (prematurity), chemotherapy, and practices of an individual caregiver.[17–20] Despite the gap existing between HIC and LIMC, the results showed the prevalence ranging from 8 to 15% or higher in LMICs.[4] Furthermore, in LMICs, the occurrence of HCAIs is aggravated by some countries with ineffective infection, prevention and control (IPC) measures exacerbated by poor laboratory support, ineffective use of antibiotic policies, and limited resources,[4] In Sub Saharan Africa, existing data demonstrate that numerous factors promote the high incidence rates of HCAIs in neonates which include; prematurity, and birth weight of less than 1500g (VLBW).[13] The spread of HCAIs pathogens can be through person to person, environmental or contaminated water, food and infected individuals including; contaminated health care personnel's skin , surface or contact via shared item.[21]

In Rwanda, a study conducted in Rwanda's Centre Hospitaliere Universitaire de Butare(CHUB) from June 1 to November 30, 2015, revealed that the prevalence of HCAIs was quite high (12.1%) and that the incidence of HCAIs in NICUs is roughly 30%.[22] Moreover, among all cases of HCAIs, 55% were lower respiratory tract infections (LRI) which were the most predominant, 36.2% were blood stream infections (BSI) and 17.24 % were urinary tract infections (UTI).[15, 23] Furthermore, the prevalence of HCAIs was 23.1% in NICU as reported in a survey conducted in CHUK, Rwanda.[23,24]

These results showed a need of additional knowledge on different aspects regarding neonatal HCAIs in order to decrease its burden which appears to weigh more on resource-limited countries like Rwanda.[25] Thus, this study assessed the risk of neonatal HCAIs at three selected teaching hospitals in Rwanda as it was with great importance as the previously conducted studies were focused in one hospital and the updated data on neonatal HCAIs was needed for healthcare decision makers and academicians.

Methods

Design

A retrospective cross-sectional design was used to assess the factors related to common neonatal HCAIs in three selected teaching hospitals in Rwanda. Data were gathered from the Rwanda Military Hospital (RMH), Centre Hospitaliere Universitaire de Kigali (CHUK), and King Faysal Hospital (KFH). Bloodstream infections are the most prevalent HCAIs in NICU and they can occur alone or in conjunction with organ dysfunction.[9] These hospitals were selected as they are legends in the management of critically ill neonates with well-equipped NICU, and specialised staff. The study was conducted between 15th July and 30th October 2021.

Recruitment of study participants

Files of neonates from birth to age 28 days, hospitalized in the NICU at CHUK, KFH and RMH, in the last six months prior to the data collection period (15th July to 30th October 2021) were included. A neonate who was hospitalized in the NICU but whose discharge was dated more than six months prior to the commencement of data collection, or had died respectively before seven days of hospitalization or final medical diagnosis were excluded from the study.

Sample size

The sample size was calculated based on the estimation of the neonatal population admitted to each study site per month, according to the neonatal admission registries of respective hospitals.

The total sample size of 273 neonatal files was calculated based on the previous prevalence of 23.1% from a study conducted at CHUK, Rwanda.[20] The targeted sample size of the study was calculated using the Cochran formula with a desired 95% confidence interval and 5% level of precision.[24]

$$n_0 = \frac{Z^2\,pq}{e^2} = \frac{(1.96)^2 \text{ x } 0.231 \text{ x}(1-0.231)}{(0.05)^2} = 273$$

where, p is the estimated prevalence in our study expressed as a proportion (i.e. p = 0.231) of neonates who had previously had an HCAI.[23] The q is 1-p; n_0 stands for the sample size of this study; e is the desired level of precision (5%); Z is the standard normal deviation (i.e. 1.96) at 95% confidence level. Hence, the sample size calculated was 273 neonate files.

Sampling strategy

The stratified simple random sampling was used to determine the number of files to be selected proportionately from each of the three hospitals, based on the monthly admission of neonates in each hospital. Accordingly, CHUK had 71 (26.0%) files, KFH 61 (22.3%), and RMH had the majority of 141 (51.6%) files; total, 273 files of neonates. At each hospital, files were chosen by simple random sampling.[27]

Validity and reliability of the tool

The instrument was developed based on an exhaustive review of the related literature, on common factors associated with HCAIs which includes; prematurity, LBW, ventilation machine, and venepuncture,[10,13] With deep analysis by investigators. Inclusion of items from this adopted tool had logical connection with the objective since the study questions were about risk factors of HCAI and were described in regard to the context of neonatal admission file and the continuity of the newborn progress sheet. All of these used tools (neonatal admission file and continuity of newborn progress sheet) justify the face validity of the used tool in this study. A pretesting was conducted on 10 files to test the instrument for validity, reliability as well as feasibility purposes and the results showed a Cronbach's alpha of 0.68.

To validate the content of data collection instrument, the number of items used were enough and appropriate; and adequately represented in each section to measure the common types of neonatal HCAIs from the risk factors to the specific types of neonatal HCAIs as well as the outcome of the neonates at the above-mentioned teaching hospitals. The instrument validity was based on the constructs of the conceptual framework and reflection of relevant current research on the topic of HCAIs. Identifying the types and factors associated with common neonatal nosocomial infections were added to criterion validity on the topic in Rwanda.

Data collection tool

Section A: Demographic characteristics of the mother: maternal age, obstetric history, mother's blood group, religion, parity, gravida, residence, current pregnancy history. In section B: Neonatal profile before admission: age (in weeks), neonate's weight and sex, types of delivery, feeding, place of birth, Apgar, neonatal blood group, neonatal diagnosis on admission. Finally in section C was neonatal profile after admission: admission diagnosis of the newborn in NICU and procedure done on or after admission, admission and discharge dates, procedure and treatment, neonate's medical/surgical/treatment history, current medications, admission physical examination, investigations, common neonatal nosocomial infections, a summary of illness, management/plan, reasons for neonatal demise.

Data collection procedures

Data were collected using the data abstraction sheet and neonatal files. The investigator was responsible for data collection and took the time to talk with local healthcare professionals, especially unit managers of the respective neonatal intensive care units, about the research purpose and how it will proceed and requested their cooperation for the study to be successful. The unit managers worked together with the researcher, who was given all the materials needed to start data collection, including neonate files and neonatal admission registry. The researcher consulted each file for variables under investigation and ticked on the data sheet, the corresponding variable. Each data abstraction sheet was given a code; and the researcher had established a list composed of neonates' identities to avoid using the same file twice. After completing the data abstraction sheets, the data were entered in IBM SPSS Statistics for Windows version 21.0 (IBM Corp, Armonk, NY, USA) for cleaning and analysis.

Outcome Variables

The study had two outcome variables namely common HCAIs) and factors related to neonatal HCAIs. To identify the most common HCAIs at the three hospitals pathogens were listed and their presence was highlighted among neonates by displaying the number and proportion of each pathogen according to the blood culture results from the neonate files. Factors independently associated with neonatal HCAIs were obtained by multiple logistic regression analyses. The researcher plotted each variable with common neonatal HCAIs in bivariate logistic regression analysis and finally those significantly associated with HCAIs were finally combined and plotted together against common neonatal HCAIS in multivariate logistic regression analysis.

Data analysis

Descriptive statistics were used to interpret and summarise variables in frequency and percentages. Binary logistic regression analysis was used to test associations between variables and neonatal HCAIs. A P value < 0.05 was considered to have statistical significance. Bivariate and multivariable logistic regression analyses were performed to determine if there was any or independent association of sociodemographic characteristics and other variables with HCAI.

Ethical considerations

Ethical approval was granted by the University of Rwanda Institutional Review Board (IRB) under Ref: CMHS/IRB/198/2021.Then, the permission to collect data was obtained from the research committees of each study hospitals. The researcher guaranteed the integrity and quality of the research by ensuring that the data which came from the neonatal files will be used only for the research purpose. As a retrospective study consent from participants was not necessary, however, confidentiality and anonymity of the NICU registration book and file contents were ensured by using codes instead of namesand protecting the dataset by personal password, only accessed by the researcher.

Results

Demographic characteristics of neonates

The demographic characteristics of neonates are presented in Table1. The majority of neonates, 203 (74.4%) were preterm, 101 (37.0%) weighed less than 1.5kg, and 162 (59.3%) were boys, 179 (65.6%) had a dystocic delivery. Most, 169 (61.9%), had an APGAR score of 8-10; and 205 (75.1%) received breastmilk after birth. The most frequent NICU admission diagnoses (200, 73.3%) were prematurity, LBW, or respiratory distress syndrome. The majority of neonates, 126 (46.2%) were born at RMH, and 108 (39.6%) were hospitalized for 24 to 31 days (Table1).

Table 1. Neonatal socio-demographic characteristics (n = 273)

Variables	n (%)
Infection	
Escherichia/enterococci	11 (4.0)
Pseudomonas aeruginosa	1 (0.4)
Klebsiella pneumonia	142 (52.0)
Staphylococcus aureus	68 (24.9)
Candida albicans/Enterobacter species	10(3.7)
None	41(15.0)
Outcome at discharge	
Totally recovered	141 (51.7)
Disabilities	50 (18.3)
Death	80 (29.3)
Other/transferred	2 (0.7)
Demise	
Yes	80 (29.3)
No	193 (70.7)
Reason for death	
Respiratory distress syndrome	1 (0.4)
Prematurity	5 (1.8)
Neonatal infection	62 (22.7)
HIE	7 (2.6)
Other	5 (1.8)
Alive	193 (70.7)

Common types of HCAIs among hospitalized neonates

Table 2 shows the most commonly acquired healthcare pathogens at the hospitals. About a half of the neonates, 142 (52.0%), had Klebsiella pneumonia, and close to quarter 68 (24.9%) had Staphylococcus aureus. The majority, 193 (70.3%), survived. Of those that survived, 141 (51.7%), totally recovered, 50 (18.3%) survived with disabilities, and 2(0.7%) were counter-transferred to another health facility. About one third 80 (29.3%) of neonates died, and HCAIs were the major cause 62 (22.7%).

Table 2. Common types of healthcare-associated infection affecting neonates (n = 273)

Variable	n (%)
Diagnosis at admission	
Prematurity/LBW/R for I/RDS	200 (73.3)
HIE/N Sepsis	44 (16.1)
Others(congenital anomalies)	29 (10.6)
Any treatment/procedure	
Yes	272 (99.6)
No	1 (0.4)
Treatment/Procedure given	
Mechanical ventilation/central line/drain	71 (26)
IV line/Oxygen therapy	160 (58.6)
Blood transfusion	32 (11.7)
Surfactant	5 (1.8)
Others(surgical procedure)	5 (1.8)
Medication given	
Antibiotics	260 (95.2)
Non antibiotics	13 (4.8)
Physical exam performed	
Yes	273 (100)
No	0 (0)

Diagnosis and management of healthcare associated Infections

Table 3 shows the frequency and proportion of neonates with a diagnosis and management of a HCAI. The majority of neonates, 200 (73.3%) were diagnosed with Prematurity/LBW/R for I/RDS, and all 273 (100%) received a physical examination. Almost all neonates, 272 (99.6%) were given a treatment or procedure; the majority, 160 (58.6%) received an IV line and/or oxygen therapy, and 260 (95.2%) were given antibiotics.

Table 3. Diagnosis and management of healthcare-associated infection (n=273)

Variable	n (%)
Diagnosis at admission	
Prematurity/LBW/R for I/ RDS	200 (73.3)
HIE/N Sepsis	44 (16.1)
Others(congenital anomalies)	29 (10.6)
Any treatment/procedure	
Yes	272 (99.6)
No	1 (0.4)
Treatment/Procedure given	
Mechanical ventilation/ central line/drain	71 (26)
IV line/Oxygen therapy	160 (58.6)
Blood transfusion	32 (11.7)
Surfactant	**5 (1.8)**
Others(surgical procedure)	5 (1.8)
Medication given	
Antibiotics	260 (95.2)
Non antibiotics	13 (4.8)
Physical exam performed	
Yes	273 (100)
No	0(0)

Abbreviations: LBW, Birth Weight; R for I, Risk for Infection; HIE/N sepsis, Neonatal sepsis; RDS, Respiratory Distress Syndrome; HIE, Hypoxic Ischemic Encephalopathy.

Factors related to HCAIs among neonates

A bivariate logistic regression analysis was used to assess the association between common HCAIs and other study variables. Maternal blood group O was associated with HCAIs twice as much (OR = 2.235; 95%CI = 1.062–4.705, P = 0.034) as blood group A. Neonatal LBW of less than 1.5 kg was associated with HCAI, while higher weights were protective. The male sex was more highly associated with HCAIs (OR =1.689; 95% CI = 1.030–2.772, P = 0.038) than the female sex. Discharge was significantly associated with neonatal HCAI (OR = 0.629; 95% CI = 0.475–0.831, P = 0.001). The hospital II was significantly associated with HCAI with (OR = 1.2; 95% CI = 0.54–2.65, P = 0.009). And finally, neonatal demise reduced the likelihood of acquiring HCAI (OR = 0.218; 95% CI = 0.12-0.41, P = 0.001) (Table 4).

Table 4. Bivariate and multivariable logistic regression analysis for relationship with healthcare-associated infections

Variables	Bivariate analysis				Multivariable analysis			
	COR	95% CI		P Value	Adjusted OR	95%CI		P Value
		Lower	Upper			Lower	Upper	
Maternal Blood group								
A	Ref				Ref.			
B	0.888	0.47	1.67	0.711	1.13	0.55	2.31	0.742
AB	1.976	1.02	3.82	**0.043**	2.37	1.1	5.1	**0.028**
O	2.235	1.06	4.71	**0.034**	3.10	1.32	7.26	**0.009**
Neonatal weight (kg)								
< 1.5	Ref				Ref.			
1.5-2.5	0.059	0.01	0.28	**<0.001**	0.03	0.01	0.22	**<0.001**
2.6-3.5	0.154	0.03	0.72	**0.017**	0.07	0.01	0.42	**0.004**
≥ 3.6	0.149	0.03	0.72	**0.018**	0.09	0.02	0.54	**0.008**
Neonatal sex								
Female	Ref							
Male	1.689	1.03	2.77	**0.038**	-	-	-	-
Place of birth								
Hospital 1	Ref							
Hospital 2	1.2	0.54	2.65	**0.009**	-	-	-	-
Hospital 3	0.843	0.4	1.79	0.656	-	-	-	-
Neonatal procedure/ treatment								
No	Ref							
Yes	1.406	0.98	2.01	0.062	-	-	-	-
Neonatal demise								
No	Ref				Ref.			
Yes	0.218	0.12	0.41	**0.001**	3.33	0.996	11.2	0.051

Multivariable logistic regression analysis of HCAIs among neonates

After conducting multivariable logistic regression analysis of the variables that were significant in bivariate analysis, three variables remained statistically significant which include; maternal blood group AB and O and neonatal weight of 1.5kg and above (Table 4). A neonate with the maternal blood group AB (OR = 2.365, 95% CI = 1.097–5.098; P = 0.028), was over two times more likely to have an HCAI than a neonate whose mother's blood group type was A. Similarly, a neonate with a mother who had blood group O (OR = 3.097, 95% CI = 1.321-7.262; P = 0.009) was three times more likely to have an HCAI than neonates with a mother of blood group A. Neonates with weight from 1.5kg to 3.6kg and above were much less likely to have an HCAI, than an infant weighting below 1.5kg. And finally, a borderline significance showed that neonatal demise was three times more likely to be associated to HCAI (OR = 3.37, 95% CI = 0.996–11.186, P = 0.051) (Table 4).

Discussion

The study aimed to identify the common types of HCAIs and their associated factors among neonates hospitalized in three selected teaching hospitals in Rwanda. In this study regarding the maternal demographic characteristics, the majority were between the age of 21-25 and were having 2 gravida; and most of the mothers had 1 parity, were catholic, and were living in urban areas furthermore they had gestational hypertension(HTN), HTN disease, blood group O and had UTI (40%) as health related risk factor. Similarly, results were reported in a study conducted in the NICU of specialised Hospital of Gondar in Northwest Ethiopia where the majority of the mothers were below 35 years of age, living in urban and the majority were married Christian, and were primipara, and delivered at a hospital.[29–31]

In this study, the neonatal demographic characteristics showed that, the majority of neonates were preterm and male. Several studies have reported the similar results like in a study conducted in China on the epidemiology and risk factors of neonatal healthcare acquired infections where an observational and prospective surveillance study on 1347 neonates, conducted in the respiratory intensive care unit of a teaching hospital, it was found that the majority of the participant were male with a proportion of 66.3%, as well as in a study conducted in Tanzania.[29–34] Inversely, a study reported that female were mostly affected than male.[32]

In this study, the majority of the participants had birth weight below 1.5kg and were born by caesarean section at 179(65.6%), similar results were found in a study conducted in Cameroon where the majority had birth weight below 2.5kg, and contrary to this most of the participant were born by normal vaginal delivery.[35,36] In addition to this, the majority of neonates were fed breast milk after delivery at the highest proportion were premature, similar results were also found in a study conducted in Tanzania where the majority were premature at 200(72%).[34] Most of the participants at around 46.1% were born at hospital III and around 42.5%, and at admission, 73.3% of the participants were diagnosed with Prematurity/LBW/R for I/RDS, while 108(39,6%) were hospitalized around 21 to 28 days, similarly, results were reported in a cross-sectional, hospital-based study in a neonatal intensive care unit at Bugando Medical Centre(BMC), Mwanza, Tanzania where the majority were diagnosed prematurity144(72.0) and 143(71.5) were hospitalized more than two days at enrolment.[34,35]

Regarding diagnosis of the participants, the majority were diagnosed with Prematurity/LBW/R for I/RDS similar results were found in a cross sectional study showed that the majority of studied neonates was preterm (58.7%) and 32.7% had birth weight less than 1500 g,38.7% had a birth weight of 1500-2500g.[36] Furthermore, 272(99.6%) among them were given medications/procedures, and the majority of 160(58.6%) were given oxygen therapy and/or IV medications among them 260(95.2%) were given antibiotics, while all the participants got physical examination, similarly results were found in cross sectional hospital based study conducted in Tanzania found that 87.5% of neonates with HCAIs were administered medications including antibiotics and 128(66.7) were on oxygen-therapy.[32]

Regarding the most common healthcare acquired infection, this study showed that Klebsiella pneumoniae were most predominant in about 142(52%) of the participants, and the majority of the participants totally recovered at the proportion of 141(51.6%) and the minority (80, 29.3%) of the participants died at similar results were found in a prospective cohort study conducted in Turkey where common HCAIs were caused by gram negative bacteria which includes Klebsiella pneumonia (38.9%) and mortality rate was at 10.8% of the total participants 352.[36,37] As well as in India where mortality rate was at 29%.[6] Inversely, several studies done by Sanjay Kumar et al. and Mahmoud Mohamed on healthcare associated infections in intensive care Unit and its correlation with environmental surveillance revealed that gram positive cocci were the most predominant(67%) than gram negative bacilli(33%),[27,37] And the reason among those participants died were neonatal HCAIs infection at 62(22.7%), similar results were found by WHO in a study conducted in developing countries where neonatal deaths related to HCAIs were ranging from 4 to 56 % of all neonatal deaths,[39,40]

The Maternal blood group especially Group O with OR:2.235 P:0.034 was significantly associated with HCAIs. Inversely, the study done al. Maternal blood group was not considered when considering factors associated with HCAIs.[29] Neonatal weight at 1.5-2.5 kg OR: 0.059, P<0.001 has no particular difference in acquiring HCAIs compared to other weight groups; Place of Birth was significantly associated with neonatal HCAIs OR:0.65, P:0.004.Similarly, results were found in an observational study done in a NICU of a tertiary care teaching hospital in India, where that the birth weight (<1500g), gestational age (≤ 37 weeks) were significantly associated with HCAIs. Birth weight (less <1500g) showed the highest association (OR 4.16; 95% CI; P:0.0001) and gestational age (≤ 37 weeks) OR 1.73, P: 0.0009.[36,37,41] In this study admission and discharge and neonatal Treatment process was significantly associated with neonatal HCAIs O.R:0.629 P:0.001, O.R:1.406 P:0.062 respectively, and finally Neonatal Outcome(total recovered) was significant OR:0.493 P:0.000; place of birth OR: 1.200, P:0.009 and finally neonatal death OR:4.578 P:0.000 was significantly associated with HCAIs, similar results was reported in Egypt by Mahmoud Mohammed where most of the procedures provided for the neonates were significantly associated with HCAIs and umbilical catheter (P:0.011), mechanical ventilator (P: 0.027), and peripheral IV line (P:0.045). As regard to the neonatal outcome of the infected new-borns by HCAIs in the NICU, where 48% recovered and 52% died.[36,42]

The maternal blood groups especially AB and O were statistically significant OR: 2.365, P: 0.028 and O.R:3.097,0.009 respectively. However in a cross sectional study conducted in University of Gondar comprehensive specialised hospital neonatal intensive care unit Northwest Ethiopia, maternal blood group were not considered in the social demographic characteristics of the mothers,[29] and in this study neonatal weight and gestational age were statistically significantly associated with HCAIs and similar results was found in a cross sectional study in Egypt and found a significant association between the occurrence of LBW and gestational age less than 37 weeks. Birth weight of less than 1.5kg with OR:1.0 and P:0.003.[2,36]

Limitations

Since the researcher collected the data using only the clients' files, some factors related to healthcare providers that may affect neonatal HCAIs and its related mortality rate were not gathered. This study was conducted by using retrospective cross sectional design therefore prospective study is recommended to emphasize the factors related to HCAIs in neonatology and was conducted in three selected teaching hospitals, and therefore the study findings may not be generalized to the whole country. Further studies with representative sample size are needed with diverse study settings which include private hospitals for data to be generalized.

Conclusion

This study has shown that, LBW, neonatal death, and maternal blood type were associated with HCAIs at the three study sites and the most predominant HCAI was klebsiella pneumonia. Hence, understanding the risk factors associated with HCAIs is crucial to help reduce neonatal morbidity and mortality related cost of care, and potential increase in antibiotic resistance in clinical settings.

Recommendations

The academicians should teach medical/ nursing students about the impact of HCAIs to the economic status of the patient and that of the nation as whole without forgetting their impact on public health of the community for them to be aware hence contribute effectively in their prevention and management. The MOH should participate actively in prevention and management of HCAIs by organizing training and conducting evaluation sessions for ensuring that HCAIs are decreasing as they are main life-threatening conditions for neonatal health especially those with low immunity. Additional to this more implementation studies need to be conducted in this area to help in the reduction and prevention of HCAIs.

Conflict of interest

The author declares no conflict of interest regarding this study work.

Authors' contribution

AU, PM contributed in conception, design, data analysis and interpretation and writing of manuscript. VB, conception, design, data analysis and interpretation. IM, data analysis, interpretation and writing manuscript. PU, data analysis and interpretation. UA, data collection, data entry and data analysis. AV, data collection, data analysis and interpretation. ME, data collection, data analysis and interpretation. NN, data collection, data entry and data analysis.

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