International Journal of Contemporary Pediatrics
Ibrahim MFM et al. Int J Contemp Pediatr. 2020 Apr;7(4):739-746
http://www.ijpediatrics.com
pISSN 2349-3283 | eISSN 2349-3291

DOI: http://dx.doi.org/10.18203/2349-3291.ijcp20201063

Original Research Article

Device associated infections among neonates in neonatal intensive care units: a single unit survey study in Cairo, Egypt

Mohamed Farouk M. Ibrahim[1]*, Hanem Abdullah Mohamed[2], May Abdelfattah[3], Sara S. ElTatawy[1]

[1]Department of Pediatrics and Neonatal Medicine, Faculty of Medicine, Cairo University, Cairo, Egypt
[2]Pediatric Nursing Department, Faculty of Nursing, Cairo University, Cairo, Egypt
[3]Department of Clinical Pathology, Faculty of Medicine, Cairo University, Cairo, Egypt

Received: 11 February 2020
Accepted: 06 March 2020

***Correspondence:**
Dr. Mohamed Farouk M. Ibrahim,
E-mail: m.frouk76@gmail.com

ABSTRACT

Background: Device Associated Infection (DAI) namely Ventilator Associated Pneumonia (VAP) and Central Line Associated Blood Stream Infection (CLABSI) is one of the challenges for both neonatal nurses and doctors. Aims of the study were 1) Assess the rate of DAI occurrence among neonates, 2) explore the relationship between DAI rates and certain risk factors such as nurse patient ratio, hand hygiene practice, gestational age (GA), weight, and length of hospital stay among neonates.
Methods: Descriptive correlational survey research design. Sample: All neonates admitted in twelve months-duration were included (total number 1090 neonates). Nurses and doctors were observed for compliance to adequate hand hygiene technique. Tools: 1) Center for Disease Control (CDC) criteria to calculate DAI rates, 2) Hand hygiene five points checklist 3) Review of neonates charts to collect data as weight, GA 4) Ballard score and 5) nurse/patient ratio.
Results: 24 neonates developed DAI, high significant negative correlations between DAI and infants' weight, GA, nurse/patient ratio and overall compliance to hand hygiene techniques were reported (p-value ≤0.05). Length of hospital stay, inadequate hand hygiene technique had strong positive correlations with DAI rate (p-value ≤0.05).
Conclusions: Factors that could affect DAI were infant's weight, GA, length of hospital stay, inadequate hand hygiene technique and nurse/patient ratio. Recommendations: implementation of infection control programs to raise nurses as well as physicians' compliance to adequate hand hygiene technique and increase number of nurses in the Neonatal Intensive Care Unit (NICU) per shift.

Keywords: Adequate hand hygiene, Device associated infection, Neonatal Nursing, Nurse patient ratio

INTRODUCTION

Neonates hospitalized in NICUs and subjected to invasive procedures; namely assisted ventilation devices (ventilators) and venous/central catheters are more prone to DAI.[1] VAP is defined as new and persistent radiographic infiltrates and worsening gas exchange in infants who are ventilated for at least 48 hours, and who exhibit at least 3 of the following criteria: temperature instability with no other recognized cause, leukopenia, change in the characteristic of respiratory secretions, respiratory distress and bradycardia or tachycardia.[2]

VAP is a serious complication in neonates on mechanical ventilation and accounts for 6.8-32.2% of healthcare associated infections among neonates. It has a large impact on neonatal morbidity, survival, hospital costs, and duration of NICU stay.[3] In a study done by Talaat et al, VAP constituted 92% of the overall hospital-acquired pneumonia, hence, all participating hospital Infection

Prevention and Control (IPC) teams formed prevention collaborative to reduce the rate of VAP in all ICUs.[4] CLABSI is a primary blood stream infection that has no association with infection at other sites in patients who have had a central line within 48 hours of symptom onset.[5-7]

Neonatal nurses are responsible for the care of the first period of an infant's life, usually the initial 28 days, although this can be extended in some cases. They care for all infants, including those who are healthy, those who have some complications, and those who are critically ill and require intensive care. These first few weeks of an infant's life carry significant changes, transitions, and challenges for the infant. A neonatal nurse may perform several tasks as implement treatment, monitor vital signs, administer medications, assist with diagnostic testing, and operate medical equipment as ventilators, incubators, and phototherapy. To prevent neonatal infection nurses are the key element in the process.[8]

Although DAI is one of the primary causes of neonatal morbidity and mortality in NICUs, they are essentially preventable. Even though it is preventable simply by application of infection control measures by personnel especially nurses VAP and CLABSI are still a challenge for neonates.[4,9] The care and maintenance of these devices is primarily the bedside nurse's responsibility, whose knowledge, beliefs, and practices influence the health and outcome of NICU patients. Critical care nurses play an important role in identification of risk factors and prevention of VAP and CLABSI. Knowledge built on evidence-based practices should give the necessary confidence to pediatric ICU nurses to make appropriate decisions and prevent poor outcomes in the recovery of patients.[10]

DAI (VAP and CLABSI) are associated with high morbidity and significant mortality among neonates in NICUs. In Egypt, the need to shed light on the factors associated with DAI is of high priority. However, in the literature there are not many extended period studies highlighting the occurrence of DAIs in NICUs and correlating them with these factors. In the present study, we aimed to assess the rate of DAI occurrence among neonates admitted to NICU and to explore the relationship between DAI rates and certain risk factors (nurse patient ratio, hand hygiene practice, GA, weight, and length of hospital stay) among neonates over a period of one year.

METHODS

Research design

A descriptive correlational survey design was adopted. A non-experimental design is one type of effective research design that is very helpful to the true experimental design except there is one lost criteria, which is randomization.[11]

Sample and sampling technique

A total number of 1090 of neonates admitted to NICU of Cairo University Specialized Pediatric Hospital (CUSPH) were included in the study during a 12 month-period (from April 2018 to March 2019). All nurses and doctors were included for the adequate hand hygiene technique without telling them. Neonates who developed DAI (VAP or CLABSI) according to the CDC criteria were included; however, neonates with infections other than DAI were excluded from the study.

Tools of data collection

The following tools were used to collect the study data

Neonates' information data sheet (15 items) developed by the researcher after extensive literature review to include the factors that might affect rate of DAI. The sheet included items as GA, sex, weight, admission age, length of hospital stay etc.

GA was assessed based on a) Ballard score if subjects were admitted at birth or within 48 hours after birth, b) patient records if admitted after 48 hours of life.[12]

A five-points checklist of adequate hand hygiene technique adopted and used by the infection control unit in Kasr Al-Aini Cairo University Hospitals was used to asses nurses and doctor's compliance to it on each contact with each neonate during the twelve months.

VAP and CLABSI were prospectively surveyed and diagnosed as per the CDC criteria of diagnosing and reporting and subsequently DAI rates per 1000 device days were calculated and recorded according to the following equation:[2,13]

Device associated infection rate

DAI rate is to be calculated according to the equation:[14]

$$\frac{\text{Number of DAI for an infection site during certain duration x 1000}}{\text{Number of Device days during the same duration}}$$

Device days

A count of the number of patients with a specific device in the patient care location. To calculate device days, for each day of the month, at the same time each day, the number of patients who have the specific device was recorded (e.g., central line or ventilator).[15]

Nurse/patient ratio: every shift the number of nurses was divided by the number of patients to calculate the nurse patient ratio; more over the ratio was established daily by getting the mean of the three shifts ratio for each day during the twelve months of data collection.

Operational definitions

for the purpose of study, the following terms are defined as follow:

- DAI rate is limited to VAP infection and CLABSI as being calculated by the CDC criteria mentioned above.
- Nurse/patient ratio= nurse number divided by patients' number

Setting

The data was collected from the NICU present in the CUSPH.

Tool validity and reliability

Neonatal data sheet was submitted to five experts (three from neonatal medicine and two from pediatric nursing field) to test the content validity. Modifications of the tool were done according to the experts' judgment on clarity and appropriateness of content. Tool reliability was tested by the reliability coefficients' alpha test and found to be (73%).

Ethical considerations

The tools and the research were submitted for approval from Ethical Committee of CUSPH and were approved. An informed consent was obtained from the guardian (father or mother) of the neonate to be included in the study after brief clear description of the study aim and assuring them that: a) the information pertaining to the neonate is confidential and not to be disclosed unless they approve to, b) refusal of being included is not affect the medical as well as nursing care needed to the neonate, c) they have the right to withdraw at any point from the study without the neonate medical or nursing care is affected.

Data collection procedures

Before conducting the study an official permission was obtained from the directors of CUSPH, and permission from the head of NICU also was obtained after explaining the nature of the study. The researchers introduced self to the mothers or fathers of the neonates, clear and simple explanations about the aim and nature of the study were discussed by the researchers with them.

CDC criteria were used to calculate the DAI rate as described earlier. All medical staff and nursing staff who were in contact with these neonates during the inclusion period of 12 months were also included for assessment of hand hygiene performance as a part of routine of hand-wash checklist done in the unit. Hand hygiene compliance was surveyed for doctors and nurses during each contact with patients using the five-points checklist of the hand hygiene procedures adopted and used by the infection control unit in Kasr Al-Aini Cairo University Hospitals. When NICU staff complied with the WHO five moments of hand washing, we marked that as 'Overall compliance". However, we also surveyed the step by step process of hand washing. Those who fulfilled the hand hygiene procedure and did not miss any of the 5 steps hygiene checklist including appropriate contact-time, were marked as "Adequate"; while those who missed any point of the checklist including contact-time were marked as "Inadequate".[16] Nurse/patient ratio was calculated through nursing records of CUSPH, NICU.

Statistical analysis

Data were statistically described in terms of mean±SD, median and range, or frequencies and percentages where appropriate. Comparing categorical data, Correlation between various variables was done using Pearson moment correlation equation for linear relation in normally distributed variables and Spearman rank correlation equation for non-normal distributed variables. Probability (p) values of less than 0.05 were considered statistically significant. All statistical calculations were done using a computer program SPSS (Statistical Package for the Social Science; SPSS Inc., Chicago, IL, USA) version 15 for Microsoft Windows

RESULTS

The study included 1090 neonates (56% male and 44% female) who were admitted to the NICU over a 12-month period from April 2018 to March 2019. Their demographics are shown in (Table 1). Weight ranged from 1.03 kg to 5.27 kg (mean 3.15±2.12 kg). Length of hospital stay ranged from 1 to 147 days (mean 10.08±3.6), DAI incidence was 2.2% and total mortality rate was 10.27%.

Table 1: Descriptive statistics of all neonates (n=1090).

Item		
Sex*	Male	56%
	Female	44%
Ga of full term in weeks (n=927)		37.81±0.95
Ga of preterm in weeks (n=163)		30.85±1.9
Weight in kilograms**		(1.03-5.27) 3.15±2.12
Length of stay in days**		(1-147) 10.08±3.6
Dai, (n=24)*		2.2%
Total mortality outcome (n=112)*		10.28%

GA Gestational age, DAI Device associated infection *Values reflected as percent distribution,** Value expressed as range and mean±SD, all other values are expressed as Mean±SD

Out of 24 neonates with DAI, 13 were females (54.2%) and 11 were males (45.8%). The mean weight 1.150 kg±1.5, mean GA 32.75±3.7 weeks, mean admission age 14.12±4.3days, and mean length of hospital stay 42.5±4.5 days (Table 2).

Table 2: Sex, weight (kg), gestational age, admission age, and length of stay among neonates who developed DAI (N=24).

Sex				Weight (kg)	GA (weeks)	Admission age (days)	Length of stay (days)
Male		Female		Mean±sd	Mean±sd	Mean±sd	Mean±sd
N	%	N	%	1.150±1.5	32.75±3.7	14.12±4.3	42.5±4.5
11	45.8	13	54.2				

Table 3: Device associated infections rates per month.

	VAP*	Ventilator device days	VAP* rate/1000 DD**	CLABSI***	Central line device days	CLABSI*** rate/1000 DD**
April 2018	3	133	14.5	2	37	90.9
May 2018	0	62	0	0	26	0
June 2018	0	84	0	4	48	83.3
July 2018	1	117	8.5	0	23	0
August 2018	0	148	0	2	38	52.6
September 2018	0	100	0	2	51	39
October 2018	1	157	6.3	1	30	33
November 2018	0	171	0	0	39	0
December 2018	1	183	5.5	1	69	14.5
January 2019	3	225	13.3	2	100	20
February 2019	1	164	6.1	0	59	0
March 2019	0	193	0	0	89	0
Total	10	1737	5.7	14	609	22.9

*VAP: Ventilator Associated Pneumonia, ** DD: Device days, *** CLABSI: Central Line Associated Blood Stream Infections

Table 4: Descriptive statistics of overall compliance for hand hygiene, inadequate hand hygiene technique for nurses and doctors, nurse/patient ratio, VAP and CLABSI rate among neonates with DAI per month.

Month/ Year	Overall compliance for doctors	Inadequate technique for doctors	Overall compliance for nurses	Inadequate technique for nurses	Nurse/ patient ratio	Vap* rate/1000 dd***	Clabsi** rate/1000 dd***
April 18	100%	33%	83%	40%	1/3	14.5	90.9
May 18	100%	100%	100%	33%	1/2	0	0
June 18	100%	67%	83%	60%	1/3	0	83.3
July 18	100%	100%	86%	71%	1/3	8.5	0
August 18	100%	100%	100%	43%	1/3	0	52.6
Sep 18	100%	100%	83%	80%	1/2	0	39
Oct 18	100%	50%	100%	57%	1/2	6.3	33
Nov 18	100%	0%	75%	43%	1/4	0	0
Dec 18	33%	0%	83%	20%	1/4	5.5	14.5
Jan 19	100%	100%	86%	83%	1/3	13.3	20
Feb 19	50%	100%	71%	40%	1/3	6.1	0
March 19	100%	50%	86%	67%	1/2	0	0

*VAP: Ventilator Associated Pneumonia, ** CLABSI: Central Line Associated Blood Stream Infections, ***DD: Device day

In this study, 89% of VAP cases were diagnosed clinically and radiologically, while only 11% were diagnosed clinically, radiologically and microbiologically due to difficult microbiological sampling. That is why microbiological data regarding VAP causative agents could not be provided. Whereas 100% of CLABSI cases met the CDC (b, 2019) criteria for laboratory confirmed blood stream infections. (Table 3) shows monthly distribution of DAI; the highest VAP rate was in April 2018 (14.5/1000 DD) while the highest rates of CLBSI were in April, June, and August (2018) (90, 83.3, and 52.6/1000 DD respectively).

The overall compliance to hand hygiene ranged between (33-100%) for doctors and (71-100%) for nurses. The inadequate technique of hand hygiene among doctors ranged between (0-100%) while in nurses it ranged between (20-83%) which reflected better overall

compliance to, as well as performance of adequate hand hygiene of nurses more than doctors. The nurse/patient ratio ranged between one nurse to two neonates to one nurse to four neonates (Table 4). DAI diagnosis was subcategorized into VAP and CLABSI based on the causative device. CLABSI was more prevalent in unit. The most common organism cultured in neonates with CLABSI was Staphylococcus aureus (MRSA), followed by Coagulase negative staphylococci (CONS), and *Klebsiella spp.* As for outcome, most of neonates with DAI recovered and were discharged (75%) with a DAI mortality rate of 25% (Table 5). VAP and CLABSI rates as well as patient outcome had a highly significant positive correlation with both GA (p-value 0.0005, 0.001, and 0.000, respectively) and weight (p-values 0.000, 0.001 and 0.000, respectively) among neonates with DAI. Lower gestational ages and weights were associated with a higher incidence of DAI (Table 6).

Table 5: Prognosis and causative agent among neonates Who developed DAI (N=24).

Prognosis				DAI				Causative agent of CLABSI							
Improved		**Died**		**VAP**		**CLABSI**		***S. aureus* (MRSA)**		***Klebsiella***		***Cons***		***Acinetobacter***	
N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
18	75	6	25	10	41.7	14	58.3	5	35	4	29	4	29	1	7

Table 6: Correlation of VAP, CLABSI and outcome with gestational age and weight among neonates who developed DAI (n=24).

Item	GA (mean± sd)		Weight (mean± sd)	
	R. test	**p value**	**R. test**	**p value**
VAP rate	0.438	0.0005*	0.731	0.000*
CLABSI rate	0.097	0.001*	0.278	0.001*
Outcome (mortality)	0.129	0.000*	0.329	0.000*

*p-value less than 0.05 is significant

Table 7: Correlation between DAI and length of stay (days) in NICU per month.

Dai/month/year	Length of stay in days	
	R	**p**
April, 2018	0.84	0.01*
May, 2018	0.32	0.01*
June, 2018	0.34	0.001*
July, 2018	0.66	0.4
August, 2018	0.15	0.001*
September, 2018	0.34	0.2
October, 2018	0.59	0.005*
November, 2018	0.97	0.4
December, 2018	0.88	0.05*
Jane, 2019	0.5	0.4
February, 2019	0.53	0.005*
March, 2019	0.27	0.2

p-value less than 0.05 is significant

Regarding the relationship between DAI rate per month and the length of stay in the NICU, there was highly significant positive correlation in all months with p-values <0.05 except for July, September, and November (2018) and January and March (2019) (Table 7). Highlights the strong negative correlation we found between nurse/patient ratio and patient outcome.

Table 8: Correlation of patient outcome with CLABSI, VAP, and nurse/patient ratio in neonates with DAI (n=24).

Item	Patient outcome (mean± sd)	
	R. test	**p value**
Nurse patient ratio	-0.102	0.000*
CLABSI rate	0.32	0.162
VAP rate	0.418	0.612

*p-value less than 0.05 is significant

Table 9: Correlation between DAI and nurse/patient ratio (n=24) per month.

Month/year	Dai/nurse patient ratio	
	R	**p. Value**
April, 2018	0.438	0.58
May, 2018	0.080	0.94
June, 2018	0.129	0.22
July, 2018	0.438	1.0
August, 2018	0.097	0.91
September, 2018	0.129	1.1
October, 2018	0.438	0.54
November, 2018	0.701	0.000
December, 2018	0.459	0.000
Jane, 2019	0.438	0.09
February, 2019	0.097	0.63
March, 2019	0.162	0.63

p-value less than 0.05 is significant

Decreased nurse/patient ratio reflected a significant increase in mortality outcome (p-value=0.000). However, authors showed no significant correlation between CLABSI and VAP rates with patient outcome (Table 8).

Highlights that nurse/patient ratio and showed strong significant correlation with development of DAI in the months that had the lowest nurse/patient ratio

(November, December 2018) with p-value ≤0.000 in both months. This result means that the less nurses' number to neonates the more the incidence of DAI (Table 9).

Table 10: Correlation between DAI and hand hygiene for doctors and nurses (overall compliance, adequate and in adequate technique) among neonates with DAI (n=24).

Dai monthly	Overall compliance for doctors		Inadequate hand hygiene for doctors		Overall compliance for nurses		Inadequate hand hygiene for nurses	
	R	p		p	R	p	R	p
April, 18	-0.24	0.01*	0.331	0.7	-0.143	0.01	0.31	0.5
May, 18	-0.72	0.03*	0.61	0.0000*	-0.82	0.4	0.34	0.6
June, 18	-0.91	0.01*	0.58	0.0000*	-0.27	0.01*	0.58	0.0000*
July, 18	-0.31	0.91	0.61	0.0005*	0.55	0.9	0.66	0.0005*
August, 18	-0.35	0.07	0.24	0.0000*	-.035	0.7	0.24	0.5
September, 18	-0.48	0.09	0.62	0.0000*	-0.48	0.09	0.62	0.0000*
October, 18	-0.19	0.35	0.67	0.6	-0.49	0.2	0.67	0.000*
November,18	-0.87	0.01*	0.35	0.2	-.07	0.0001*	0.35	0.2
December,18	-0.79	0.0001*	0.45	0.6	-0.79	0.5	0.45	0.6
January, 19	-0.142	0.35	0.41	0.0000*	-0.612	0.5	0.91	0.0000*
February, 19	-0.22	0.0001*	0.81	0.0000*	-0.2	0.0001*	0.27	0.9
March,19	-0.19	0.34	0.34	0.61	-0.109	0.7	0.64	0.0000*

p-value less than 0.05 is significant

There were negative correlations with high significances between overall compliance to hand hygiene of doctors and nurses in six and four months of the whole 12 months of the data collection (p-value ≤0.05), respectively. In the same table it was clear that there were strong positive correlations between the inadequate hand hygiene in both doctors and nurses in seven months for doctors and six months for nurses (p-value ≤0.05), respectively (Table 10).

DISCUSSION

The current study found a VAP rate of 5.7/1000 ventilator days in NICU, which is concomitant with neonatal VAP rate in the United States (4-6.5/1000 DD) and in other countries like Rio de Janiro and lower than the neonatal VAP rate in the International Health care-associated Infection Control Consortium (INICC) report which was 8.95/1000 DD and much lower than another Egyptian study which showed 34.2 episodes/1000 ventilator days.[17-19] This low rate observed in this study could be attributed to the routine strict implementation of VAP prevention bundle in CUSPH, NICU unit.[20]

This study found that DAI mortality rate was 25%, this finding goes in harmony with Kasim et al, who studied nosocomial infections in NICUs, the authors found that mortality was significantly higher among infected neonates with VAP and CLABSI.[21] As neonates are exposed to various therapeutic interventions such as intubation and central venous catheters that provide a portal of entry for pathogens, these render neonates more susceptible to infections.[22]

CLABSI is the most common DAI, owing to the fact that it is the most common cause of healthcare associated infections (HAIs) in NICU.[23] CLABSI rate in this study was 22.9/1000 central line days that was consistent with the range of CLABSI rate in limited resource countries like Egypt from 2.6 to 60 per 1000 central line days.[24] Nevertheless, lower rates are present in Europe ranging from 10.6 to 12.3 and United States ranging from 1.8 to 5.2.[24,25]

Regarding the causative organisms in this study, gram positive bacteria represented more than half of the causative agents; MRSA 35% and CONS 29% were the most prevalent organisms, this compares to other studies which found CONS 51% and *S. aureus* 23%.[25]

An important fact to note was that DAI rates in the study did not affect patient outcome in terms of mortality; we showed no correlation between patient outcome and CLABSI and VAP rates. The reason for that may be attributed to early diagnosis and strict adherence to medical protocol of treatment and care of nosocomial infection that may have averted an unfavorable outcome. Also, the setting (CUSPH, NICU) has recently adopted an oral care technique developed by Ragab et al, using maternal breast milk, this might have reflected a reduction of DAI as well as its squeal.[9] Breast milk contains secretory IgA, lysozymes, white blood cells, and lactoferrin and has been shown to encourage the growth of healthy lactobacilli and reduce the growth pathogenic bacteria which may have led to more favorable outcomes.[26]

The correlation found to be significant with DAI rates in the study with GA and neonatal weight. Prematurity is known to be a risk factor for increased morbidity and mortality. Current study reflected this theory by showing a significant increase in VAP and CLABSI rates with lower gestational ages and neonatal weights. As the second leading cause of death in children under five years old, prematurity remains a global health problem.[27] Patient outcome also correlated positively with neonatal gestational age and weight showing increased mortality in neonates who had lower gestational ages and weights. Infant mortality increases sharply with decreasing GA, from 175.94 per 1,000 live births at <32 weeks to 2.39 per 1,000 live births at 37-41 weeks.[28] Another study done by Sengupta et al, on catheter duration and risk of CLABSI in neonates with Peripherally inserted central catheters (PICCs) reported neither relationship between the development of CLABSI and weight nor gestational age.[29]

The results showed a strong negative correlative relationship between nurse/patient ratio, and patient prognosis. As it is deeply rooted in the literature, nursing is the heart and back bone of neonatal care; the effects of a one-to-one nurse-to-patient ratio on the mortality rate in neonatal intensive care was studied by Watson et al, and researchers found a strong reduction of mortality rates in NICUS when the nurse patient ratio was decreased.[30] In addition to results showing a correlation between outcome and nurse/patient ratio, it also shows a correlation between DAI and nurse/patient ratio evidenced by the fact that the two months (November, December 2018) that had the lowest nurse/patient ratio are the same two months that showed a significant positive correlation with DAI rates.

Nevertheless, in a systematic review conducted by Sherenia net al, to study nurse-to-patient ratios and neonatal outcomes, seven out of seven analyzed studies reported higher mortality due to decreased nurse-to-patient ratios.[31] These findings build on the crucial role that is played by the neonatal nurses in the prevention of health associated infections as well as the care of the neonates whom developed it.[31] Jung Cho, and Cho also studied CLABSI in neonates and concluded that it should also be ensured that appropriate patient-to-nurse ratios are maintained within the NICU, as decreased nurse/patient ratios are associated with increased CLABSI incidence.[23]

The at hand study results displayed a highly strong positive correlation between performing hand hygiene inadequately and the development of DAI during all but 2 months of this study period with a p-value that ranged between ≤0.005 and 0.000. These finding sheds light on the importance of adapting the meticulous WHO steps and contact time of hand wash in healthcare settings and that monitoring "adequate" rather than mere comlienceto hand hygiene is more essential. In a study conducted by Yalaz et al, to evaluate device-associated infections in neonatal intensive care units the researchers concluded that clinicians should aim to decrease the incidence of DAI and its complications by adhering to strict hand hygiene protocols.[1] Pessoa-Silva et al, demonstrated the success of this plan; after training personnel on adequate hand hygiene technique in a study of a total of 5325 neonates, improved compliance was independently associated with infection risk reduction among very low birth weight neonates; bacteremia markedly decreased after implementation of hygiene protocols.[32]

CONCLUSION

The current study found that DAI is a condition that affects neonates in NICU of CUSPH; factors that seem to strongly affect the prevalence of DAI in our NICU are: weight, GA, length of hospital stay, inadequate hand hygiene technique of nurses and doctors and nurse patient ratio.

Recommendations

Implementation of infection control programs to raise nurses as well as physicians' compliance to adequate hand hygiene technique.

Increase number of nurses in the NICU per shift to be similar to the world ratio which is one to one.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee of CUSPH

REFERENCES

1. Yalaz M, Altun-Köroglu Ö, Ulusoy B, Yildiz B, Akisu M, Vardar F, et al. Evaluation of device-associated infections in a neonatal intensive care unit. Turkish J Pediatr. 2012 Mar 1;54(2):128.
2. CDC (a) 2019: Pneumonia (Ventilator-associated [VAP] and non-ventilator-associated Pneumonia [PNEU]) Event. January 2019:1-16.
3. Azab SF, Sherbiny HS, Saleh SH, Elsaeed WF, Elshafiey MM, Siam AG, et al. Reducing ventilator-associated pneumonia in neonatal intensive care unit using "VAP prevention Bundle": a cohort study. BMC Infec Dis. 2015 Dec;15(1):314.
4. Talaat M, El-Shokry M, El-Kholy J, Ismail G, Kotb S, Hafez S, et al. National surveillance of health care associated infections in Egypt: developing a sustainable program in a resource-limited country. Am J Infec Cont. 2016 Nov 1;44(11):1296-301.
5. Bell T, O'Grady NP. Prevention of central line associated bloodstream infections. Infec Dis Clin. 2017 Sep 1;31(3):551-9.
6. Centers for Disease Control and Prevention. Atlanta (GA): Centers for Disease Control and Prevention; 2017. National Healthcare Safety Network (NHSN) Patient Safety Component Manual 2017. Available at:https://www.cdc.gov/nhsn/pdfs/validation/2017/pcs manual_2017.pdf. Accessed 1 September 2018.
7. Nationales Referenzzentrum für Surveillance von nosokomialen Infektionen. Berlin (Germany):

Nationales Referenzzentrum für Surveillance von nosokomialen Infektionen; 2010. NEO-KISS Protocol, Nosocomial infection surveillance for preterm infants with birth weight<1500g. Available at: http://www.nrzhygiene.de/fileadmin/nrz/module/neo/NEO KISSProtocol_english_240210.pdf. Accessed 16 August 2018.
8. Chhugani M, Kaushik A. Neonatal Nursing-Yesterday, Today and Tomorrow. J Neonatal Boil. 2014;3:144.
9. NemaRagab, Dabash SE, Rashad HM, Iskander I. Effect of oropharyngeal care using breast milk on the incidence of neonatal ventilator-associated pneumonia. Biosci Res. 2018 Oct 1;15(4):4148-52.
10. Goel V, Gupta S, Goel T. Ventilator-associated pneumonia: A review of the clinically relevant challenges in diagnosis and prevention. Bri J Med Practition. 2016 Jun 1;9(2):910.
11. Polit D, Beck C. Essentials of nursing research: Appraising evidence for nursing practice. 7th Ed. Lippincott and Williams London; 2017.
12. Ballard JL, Khoury JC, Wedig KL, Wang L, Eilers-Walsman BL, Lipp R. New Ballard Score, expanded to include extremely premature infants. J Pediatr. 1991 Sep 1;119(3):417-23.
13. CDC, b (2019): Bloodstream Infection Event (Central Line-Associated Bloodstream Infection and Non-central Line Associated Bloodstream Infection) 1-45. Available at: https://www.cdc.gov/nhsn/pdfs/pscmanual/4psc_clabscurrent.pdf. Accessed January 2019.
14. Edwards JR, Peterson KD, Andrus ML, Dudeck MA, Pollock DA, Horan TC. National Healthcare Safety Network (NHSN) report, data summary for 2006 through 2007, issued November 2008. Am J Infec Control. 2008 Nov 1;36(9):609.
15. Guide to the Eliminations of Catheter-Related Blood stream Infections. An APIC guide 2009.
16. WHO: The WHO Multimodal Hand Hygiene Improvement Strategy? WHO Guidelines on Hand Hygiene in Health Care First Global Patient Safety Challenge Clean Care is Safer Care. 2009;99-123.
17. Goerens A, Lehnick D, Büttcher M, Daetwyler K, Fontana M, Genet P, et al. Neonatal ventilator associated pneumonia: a quality improvement initiative focusing on antimicrobial stewardship. Fron Pediatr. 2018 Sep 24;6:262.
18. Silva AR, Silva TC, Bom GJ, Vasconcelos RM, Simões Junior R. Ventilator-associated pneumonia agents in Brazilian Neonatal Intensive Care Units-a systematic review. Brazilian J Infec Dis. 2018 Aug;22(4):338-44.
19. Leblebicioglu H, Erben N, Arman D. International Nosocomial Infection Control Consortium (INICC) national report on device-associated infection rates in 19 cities of Turkey, data summary for 2003-2012. Ann Clin Microbiol Antimicro. 2014;13:51.
20. Obeid A, Naous A, Naja Z, Naja AS. Pediatric Intensive Care Unit Using a Modified Ventilator Associated. Res J Med Sci. 2014;8(1):13-9.
21. Kasim K, El Sadak AA, Zayed K, Abdel-Wahed A, Mosaad M. Nosocomial infections in a neonatal intensive care unit. Middle East J Sci Res. 2014;19:1-7.
22. Nagata E, Brito AS, Matsuo T. Nosocomial infections in a neonatal intensive care unit: incidence and risk factors. Am J Infec Control. 2002 Feb 1;30(1):26-31.
23. Cho HJ, Cho HK. Central line-associated bloodstream infections in neonates. Korean J Pediatr. 2019 Mar;62(3):79.
24. Paula AP, Oliveira PR, Miranda EP, Felix CS, Lorigados CB, Giovani AM, et al. The long-term impact of a program to prevent central line-associated bloodstream infections in a surgical intensive care unit. Clinics. 2012 Aug;67(8):969-70.
25. Dubbink-Verheij GH, Bekker V, Pelsma I, van Zwet EW, Smits-Wintjens VE, Steggerda SJ, et al. Bloodstream infection incidence of different central venous catheters in neonates: a descriptive cohort study. Front Pediatr. 2017 Jun 20;5:142.
26. Edmond K, Zaidi A. New approaches to preventing, diagnosing, and treating neonatal sepsis. PLoS Med. 2010 Mar;7(3): e1000213.
27. Saigal S, Doyle LW. An overview of mortality and sequelae of preterm birth from infancy to adulthood. Lancet. 2008 Jan 19;371(9608):261-9.
28. Mathews TJ, MacDorman MF. Infant mortality statistics from the 2003 period linked birth/infant death data set. Nation Vital Statist Rep. 2006;54(16):1-29.
29. Sengupta A, Lehmann C, Diener-West M, Perl TM, Milstone AM. Catheter duration and risk of CLA-BSI in neonates with PICCs. Pediatrics. 2010 Apr 1;125(4):648-53.
30. Watson SI, Arulampalam W, Petrou S, Marlow N, Morgan AS, Draper ES, et al. The effects of a one-to-one nurse-to-patient ratio on the mortality rate in neonatal intensive care: a retrospective, longitudinal, population-based study. Archiv Dis Childhood-Fetal Neon Ed. 2016 May 1;101(3):F195-200.
31. Sherenian M, Profit J, Schmidt B, Suh S, Xiao R, Zupancic JA, et al. Nurse-to-patient ratios and neonatal outcomes: a brief systematic review. Neonatology. 2013;104(3):179-83.
32. Pessoa-Silva C, Hugonnet S, Pfister R, Touveneau S, Dharan S, Posfay-Barbe K, Pittet K. Reduction of Health Care–Associated Infection Risk in Neonates by Successful Hand Hygiene Promotion. Pediatrics. 2007 Aug;120(2):e382-90.

Cite this article as: Ibrahim MFM, Mohamed HA, Abdelfattah M, ElTatawy SS. Device associated infections among neonates in neonatal intensive care units: a single unit survey study in Cairo, Egypt. Int J Contemp Pediatr 2020;7:739-46.