Preventive Strategies for Nurses regarding Klebsiella Infection in Neonatal Intensive Care Unit

Rania Ismail Fahim[1], Amal Abdel-Aziz Abdel-Slam[2] and Rasha Rady El Said[3]

(1) B.Sc. of Nursing, (2) Assistant Professor of Pediatric Nursing - Faculty of Nursing - Benha University- Egypt and (3) Lecturer of Pediatric Nursing Faculty of Nursing - Benha University- Egypt

Abstract

Background: Preventive strategies are more effective in preventing klebsiella infection which stands out as the main microorganism resulting in infection between neonates in neonatal intensive care unit. **Aim of the study:** Was to evaluate the effect of preventive strategies for nurses regarding klebsiella infection in neonatal intensive care unit. **Design:** A quasi-experimental research design was used to carry out the study. **Setting:** This study was carried out in Neonatal intensive care unit at Benha University Hospital. **Sample:** A convenience sample of (90) nurses & a purposive sample of (90) neonates. **Tools of data collection:** Tool (I): A structured interviewing questionnaire sheet. Tool (II): Nursing observational checklist which was adopted from. Tool (III): Nurses' attitude rating scale regarding preventive strategies of klebsiella infection, and Tool (IV): Blood culture and C - reactive protein (CRP). **Results:** The majority of the studied nurses had good knowledge, competent practice and positive attitude about preventive strategies regarding klebsiella infection post-preventive strategies implementation compared with pre-preventive strategies implementation. Also, there was statistical significant difference among the studied neonates regarding klebsiella infection pre & post-preventive strategies implementation. **Conclusion:** Improved nurses' knowledge, practice and attitude regarding preventive strategies of klebsiella infection positively affected klebsiella infection rate among neonates. **Recommendations:** Emphasis on the importance of the preventive strategies regarding klebsiella infection for neonates of the study setting.

Keywords: Klebsiella infection, Nurses, Neonatal intensive care unit, Preventive strategies.

Introduction

Neonate is an infant who is only hours, days or up to one month old. The neonate is undergoing many adaptations to extra uterine life and its physiological systems such as the immune system are far from fully developed. Potential diseases of concern during the neonatal period include neonatal sepsis, neonate respiratory distress syndrome, neonatal meningitis and neonatal hepatitis. Neonatal klebsiella sepsis forms the common cause of mortality in the first month of life. Klebsiella species are the most commonly implicated pathogen in neonatal sepsis and klebsiella has resulted in high morbidity and mortality **(Charpak et al., 2021).**

The neonates are at highest risk for infection that may be categorized as early onset of infection (day of life 0-3) or late onset of infection (day of life 4 or later). Early onset is acquisition of pathogen from mother. Late onset is acquisition of pathogen from health care team or equipment or incubator in the Neonatal Intensive Care Unit (NICU). The common types of infection in the NICU are blood stream infections as central venous catheter, peripheral venous catheter and umbilical catheter-associated blood stream

infections & ventilator-associated pneumonia **(Brunse et al., 2021).**

Klebsiella is medically the most important organism responsible for a significant proportion of hospital acquired infections in NICU including septicemias, pneumonia, urinary tract infection and soft tissue infection especially in the immunocompromised hosts as neonate **(Ziółkowski et al., 2021).**

Klebsiella are normal inhabitants of the intestine. They are saprophytes in soil and water, cause disease in neonates which are mainly Nosocomial Infection (NI) due to multi-drug resistance strains. Klebsiella organisms are short non motile gram negative, capsulated rod. Five species of Klebsiella are known to produce diseases in neonates. They can be differentiated by their capsular antigens; Klebsiella pneumoniae causes neonatal meningitis, lobar pneumonia, urinary tract infection and neonatal septicemia **(Jiménez et al., 2020).**

Implement preventive strategies regarding klebsiella infection transmission in neonatal intensive care unit can reduce klebsiella infection rate and monitoring adherence to these strategies as outlined in core infection prevention and control practices for prevent transmission of klebsiella. These strategies are hand hygiene, standard precautions, environmental cleaning and disinfection, contact precaution and cleaning & disinfection for incubator. Effective hand hygiene has been known to reduce the incidence of klebsiella infections in neonatal intensive care unit **(Gall et al., 2020).**

The 5 moments of hand hygiene is the most effective hand hygiene strategies. Nurse must assess the need to perform hand hygiene based on contamination. Compliance to hand hygiene practices is part of the nurse's conscious decision making. Predisposes nurse to be noncompliant with hand hygiene, suggesting special attention may be needed when educating nurses. When hand hygiene compliance less than 50% among nurses should be maintaining motivation for compliance. Main reasons for noncompliance reported by nurses are: too busy, skin irritation, glove use and another major obstacle for hand hygiene compliance is time constraint **(Chang et al., 2020).**

Significance of the study:

Infection is estimated to affect more than 30 million pediatrics patients every year worldwide potentially leading to 6 million deaths every year. Moreover, sepsis kills up to 500,000 neonates every year **(WHO, 2018).**

There are three main causes of neonatal death in Egypt: prematurity, complications during childbirth and neonatal infections which caused mostly by klesiella in NICU. Furthermore, nine percent of leading causes of neonatal deaths in Egypt (2017) is related to sepsis **(Estimates General by the WHO and Maternal and Child Epidemiology Estimation Group (MCEE) 2018)**.

In the neonatal intensive care unit of Benha University Hospital, study was performed to identify medical errors and to determine the risk factors and consequences of these errors. Errors were detected by follow-up of neonates and review of reports including nursing follow-up sheets, resident progression notes and investigation reports. There were 3819 errors are detected that affected 97% of neonates. Types of errors included 448 infection control errors (11.73%) and 120 nosocomial infection errors (3.14%) **(El-Shazly et al., 2017).**

Aim of the study:

This study aimed to evaluate the effect of preventive strategies for nurses regarding klebsiella infection in neonatal intensive care unit.

Research hypothesis

Preventive strategies improve nurses' knowledge, practice and attitude regarding prevention the infection by klebsiella and reduced klebsiella infection among neonates in NICU.

Subjects and Method

Research design:

A quasi experimental research design was used in the current study.

Setting:

This study was carried out in neonatal intensive care unit, Benha University Hospital.

Sample:

A convenient sample of 90 nurses, who were available during the period of data collection in the previously mentioned setting. A purposive sample of (90) neonates (pre-preventive strategies (n=45) & post-preventive strategies (n=45) during period of the study.

Tools of data collection:

Tool (1): A structured interviewing questionnaire: It was developed by the researcher after reviewing related literature. It was written in an Arabic language and composed of four parts as follows:

Part (I): Personal characteristics of the studied nurses as age, sex, level of education, marital status, job, previous training on preventive strategies regarding klebsiella infection and years of experiences.

Part (II): Personal characteristics of the studied neonates as gestational age, sex, age by days, date of admission and diagnosis.

Part (III): Medical history of the neonates as presence of diseases during pregnancy, genetic diseases and problems during childbirth and laboratory investigation (complete blood count, C-reactive protein test and blood culture).

Part (IV): It was concerned with nurses' knowledge about preventive strategies regarding klebsiella infection. It was included; 22 closed ended questions as definition of hand hygiene, standard precautions, indications of alcohol-based hand rub monitored, five moments of hand hygiene and environmental disinfection.

Scoring system for knowledge:

The studied nurses' answers were compared with the model key answer, where for each knowledge item, the correct answers were scored (1) and the incorrect answers were scored (zero). The total score of questions related to knowledge of nurses were 22 marks which represents 100%.

The total level of nurses' knowledge regarding preventive strategies of klebsiella infection was categorized as the following:

- Unsatisfactory if the obtained score is less than 80% .

- Satisfactory if the obtained score is more than 80%.

Tool (II): Nursing observation checklist: It was adopted from **(WHO, 2009)** to assess nurses' practices with neonates about preventive strategies regarding klebsiella infection (pre & post-intervention phases). It involved five practices which were: routine hand washing (9 items), antiseptic hand washing (9 items), surgical scrub (9 items), 5 moment (5 items) and cleaning and disinfection of incubator (5 items) total items were (37 items).

Scoring system:

The studied nurses' practice were compared with the observational check list sheet where the score of each item of nurses' practice was classified into correctly done (2),

incorrectly done (1) and not done (0). The total scores of the studied nurses' practices were 74 grades (100%), which categorized as the following:

- Incompetent practice if the obtained score is less than 85%.
- Competent practices if the obtained score is more than 85%.

Tool (III): Nurses' attitude rating scale regarding preventive strategies of klebsiella infection:

It was adopted from **(Jzimakoff, 2009)** to assess the nurses' attitude toward preventive strategies of klebsialla infection. It was included 19 statements.

Scoring system of the studied nurses' attitude:

For each attitudes items, agree was scored (2), neutral was scored (1) and disagree was scored (0). The total attitude score of 19 statements were 38 scores.

The total scores of nurses' attitude were categorized as the following:

-Negative attitudes less than (75%) of total attitude scores.
- Positive attitudes more than (75%) of total attitude scores.

Tools validity and reliability

The data collection tools were revised by a panel of three experts in the field of pediatric nursing to test face and content validity. Modifications of the study tools were done according to the panel judgment on clarity of sentences, appropriateness of content and sequence of items. Regarding reliability, internal consistency reliability of all items of the tools was assessed using coefficient alpha.

Field work:

A permission from dean faculty of nursing presented to Benha University for administrator of Benha University Hospital in order to take their approval for conducting the study.

- The actual field work was carried out over a period of six months (from 1 June to 30 November 2020). The researchers were available one day/week from 9am-3pm. The total number of the studied nurses included in the study were (90) nurses and (90) neonates (pre-preventive strategies (n=45) & post-preventive strategies (n=45). The pilot study were carried out on 10% of nurses and neonates (n=9 & 9 neonates). The nurses who fulfilled the criteria were invited to participate after providing them with a simple and full explanation of the aim and process of the study to obtain their verbal informed consent. The nurses who participate were interviewed using the questionnaire sheet. The researchers filled nurses' assessment sheet through their personal characteristic. The data related to the neonates were gathered throughout two phases of assessment using previously mentioned tools.

Theoretical part: consists of 3 sessions, every session contain (9) nurses. Each session started by setting objectives and preparation of the content which covers the following items; the reason behind the application of the sessions, definition of neonates, risk factor, definition of klebsiella, preventive strategies of klebsiella infection.

Practical part: Was carried out in 5 session to be (9) nurses in each session. Each session started by setting objectives and preparation of the content which covers the following items; routine hand washing, antiseptic hand washing, surgical scrub, disinfection of incubator, disinfection of environmental service.

The preventive strategies implementation:

-First Phase:

A pretest was carried out by using the previously mentioned tools to assess knowledge, practice and attitude of nurses and assess klebsiella infection rate between neonates before implementation of preventive strategies of klebsiella infection

-Second Phase:

This phase included analysis of the pre-test findings and identification of the actual needs of the nurses' knowledge, practice and attitude regarding preventive strategies of klebsiella infection. Accordingly, the preventive strategies were designed by the researchers using simple Arabic language and different illustrated pictures in order to facilitate subjects understanding.

-Third Phase (Planning &Implementation):

General and specific objectives of preventive strategies program were stated and implemented to satisfy the actual needs of the study subjects; evaluation was carried out immediately after the implementation of the preventive strategies by using the same pretest format as a post test.

- Fourth Phase:

Each nurse was individually interviewed after applying preventive strategies for doing post- test in order to evaluate her knowledge, practices and attitude.

Comparison between nurses' pretest and post-test finding was done to determine the effect of preventive strategies on increasing nurses' knowledge, practice and attitude regarding klebsiella infection and assessment done after conducting the preventive strategies program to evaluate its effect on rate of klebsiella infection among neonates.

Ethical considerations:

The researchers explained the aim of the study to the nurses and they were informed that the study is harmless. The researchers secured that all the gathered data are confidential and are used for the research purpose only. The nurses were informed that they are optionally allowed either to participate or not in the study and they have the right to withdraw at any time. An oral consent was taken from the mothers.

Pilot study:

A pilot study was carried out on 10 % of the total sample size (9 nurses & 9 neonates) over a period of two weeks to test the validity and applicability of the study tools and to estimate the time needed to fill the study tools. No radical modifications were carried out on the study tools so the pilot study subjects were included in the study sample.

Statistical analysis:

The collected data were organized, tabulated and analyzed using electronic computer and statistical package for social sciences (SPSS) version 20. Descriptive statistics were calculated for the data in the form of: Means and standard deviation for quantitative data, and frequency and distribution for qualitative data. Also in analytical statistics, inter-group comparison of categorical data was performed by using chi square test (X^2-value). Also, Pearson correlation coefficient test was used. P value <0.05 was considered statistically significant (*) while >0.05 considered statistically insignificant and P value <0.001 considered highly significant (**) in all analyses.

Results

Table (1): Regarding characteristics of studied nurses, the current study revealed that, more than half of the studied nurses' age

(57.8%) was >25 years, the majority of them (96.7%) were females. More than half of them (57.8%) were graduated from technical institute of nursing; more than one third of them (58.9%) had less than five years of experience.

Table (2): Regarding characteristics of the studied neonates, the current study illustrated that, more than three quarters (78.9%) of the studied neonates had respiratory distress syndrome. Regarding gestational age of the studied neonates, more than half (56.7%) of studied neonates had gestational age >37 weeks with X±SD gestational age 34.79±3.29 weeks. Regarding the gender of the studied neonates, more than half 52.2% of them were females. Moreover, majority of studied neonates (100%) didn't have genetic diseases.

Table (3): Reflected that, more than one third of the studied neonates (40%) had positive (klebsiella) blood culture in assessment phase strategies implementation. While, less than quarter of studied neonates (17.7%) had positive (klebsiella) blood culture in post-preventive strategies implementation. Also there were statistically significant difference between complete blood count, c-reactive protein test and blood culture pre & post preventive strategies implementation ($P<0.05$).

Table (4): Regarding total knowledge, practice and attitude scores of the studied nurses, the current study shows that, there was highly statistically significant difference in nurses' total knowledge, practice and attitude scores regarding prevention of klebsiella infection in post-preventive strategies implementation compared with pre-preventive strategies implementation results ($P \leq 0.001$). Where less than half of nurses (40%) had satisfactory knowledge in pre-preventive strategies implementation improved and reached (77.8%) with mean 16.96±2.594 in post-preventive strategies implementation

Also less than half of nurses (44.4%) had competent practice in pre-preventive strategies implementation improved and reached (85.6%) with mean 65.77±2.065 in post-preventive strategies implementation. While less than half (48.9%) of the studied nurses had positive attitude in pre-preventive strategies implementation improved and reached more than three quarter (77.8%) with mean 43.73±3.597 had highly positive attitude toward prevention of klebsiella infection in post-preventive strategies implementation.

Figure 1: reveals that, there was a highly statistically significant improvement in nurses total knowledge regarding prevention of klebsiella infection in post-preventive strategies implementation compared with pre-preventive strategies implementation where less than half of studied nurses (40%) had satisfactory level of knowledge in pre-preventive strategies implementation while more than three quarter of studied nurses (77.8%) had satisfactory level of knowledge in post-preventive strategies implementation compared with pre-preventive strategies implementation.

Figure 2: Illustrates that, there was highly statistically significant improvement in nurses' total practices regarding prevention of klebsiella infection in post-preventive strategies implementation compared with pre-preventive strategies implementation where less than half of the studied nurses (44.4%) had competent practices in pre-preventive strategies implementation while majority of the studied nurses (85.6%) had competent practices in post-preventive strategies implementation.

Figure 3: Reflects that, less than half (48.9%) of the studied nurses had positive attitude in pre-preventive strategies

implementation while more than three quarter (77.8%) of the studied nurses had highly positive attitude toward prevention of klebsiella infection in post-preventive strategies implementation. Also reveals that, there was statistically significant improvement in nurses' level of attitude regarding prevention of klebsiella infection in post-preventive strategies implementation compared with pre- preventive strategies implementation.

Table (1): Distribution of the studied nurses regarding their personal characteristics (n=90)

Items	Studied nurses (n=90)	
	No.	%
Age in years		
<25	52	**57.8**
25<35	19	21.1
35<45	19	21.1
X ±SD	26.53±10.21	
Gender		
Male	3	3.3
Female	87	**96.7**
Educational level		
Secondary school of nursing	27	30.0
Technical institute of nursing	52	**57.8**
Bachelor degree of nursing	11	12.2
Job		
Nursing technician	68	75.6
Nursing supervisor	22	24.4
Years of experience		
1<5	53	**58.9**
5<10	18	20.0
>10	19	21.1
X ±SD	8.73±5.31	
Training course about preventive strategies of klebsiella		
Yes	0	00
No	90	**100**

Table (2): Distribution of the studied neonates regarding their personal characteristics (n=90)

Items	Studied neonates (n=90)	
	No.	%
Diagnosis		
Jaundice	5	5.5
Anemia	1	1.1
Pneumonia	13	14.4
Respiratory disorder syndrome	71	**78.9**
Gestational age\weeks		
<37	39	43.3
>37	51	**56.7**
X ±SD	**34.79±3.29**	
Age/day		
<5	27	30.0
5<10	40	**44.4**
10<15	15	16.7
15-28	8	8.9
Gender		
Male	43	47.8
Female	47	**52.2**
Presence of genetic diseases		
No	90	**100**
Yes	00	00
Presence of diseases during pregnancy		
No	50	**55.6**
Yes	40	44.4
Presence of problems during childbirth		
No	40	44.4
Yes	50	**55.6**

Table (3): Distribution of the studied neonates regarding laboratory investigation (n=90)

Items	Studied neonates (n=90)					
	Pre-preventive strategies (n=45)		Post- preventive strategies (n=45)		X^2	p-value
	No.	%	No.	%		
Complete blood count						
Normal	16	35.6	27	**60**	5.38	0.02*
Abnormal (indication for infection)	29	64.4	18	40		
C-reactive protein test						
Normal (less than 10 mg\l)	16	35.6	27	**60**	5.38	0.02*
Abnormal (more than 10 mg\l)	29	64.4	18	40		
Blood culture						
Sterile (no indication for infection)	16	35.6	28	62.3	7.31	0.02*
Positive (klebsiella)	18	40	8	**17.7**		
Positive (other microbe)	11	24.4	9	20		

Table (4): Total knowledge, practice and attitude scores of the studied nurses pre & post-educational program (n=90)

Items	Studied nurses (n=90)					
	Pre- preventive strategies		Post- preventive strategies		X2	p-value
	No.	%	No.	%		
Total knowledge score						
Unsatisfactory	54	60.0	20	22.2	26.52	.000**
Satisfactory	36	40.0	70	**77.8**		
X ±SD	12.82±3.217		**16.96±2.594**			
Total practice score						
Incomplete	50	55.6	13	14.4	33.43	.000**
Compete	40	44.4	77	**85.6**		
X ±SD	51.68±3.479		**65.77±2.065**			
Total attitude score						
Negative	46	51.1	20	22.2	16.17	.000**
Positive	44	48.9	70	**77.8**		
X ±SD	25.75±5.671		**43.73±3.597**			

Figure (1): Distribution of the studied nurse' knowledge regarding preventive strategies of klebsiella pre & post-preventive strategies (n=90)

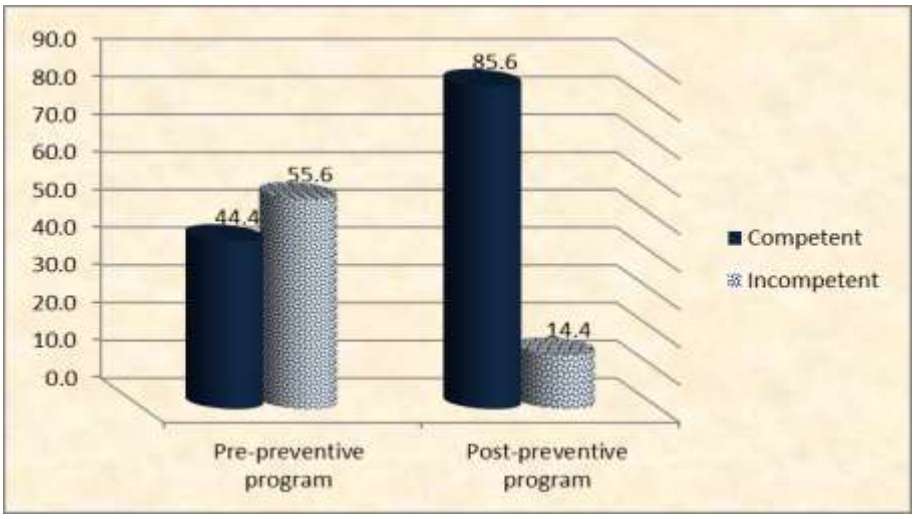

Figure (2): Distribution of the studied nurses' practice regarding preventive strategies of klebsiella infection pre & post-preventive strategies (n=90)

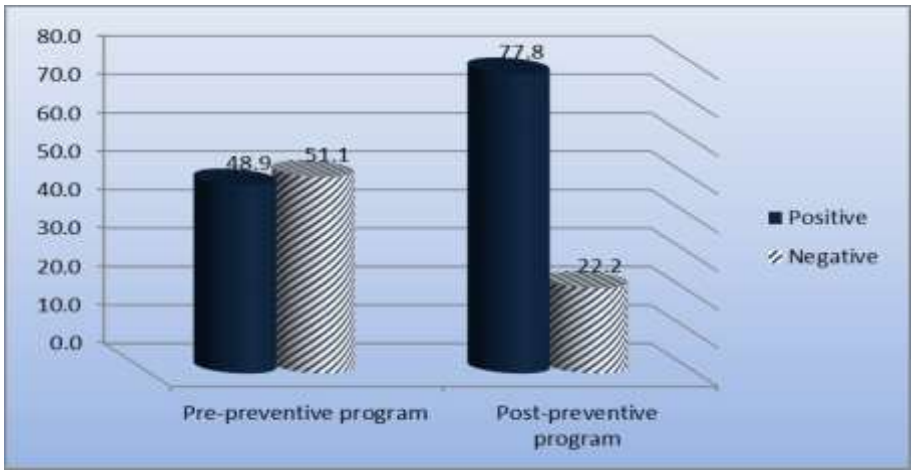

Figure (3): Distribution of the studied nurses' attitude regarding preventive strategies of klebsiella infection pre & post-preventive strategies (n=90)

Discussion

Klebsiella is an opportunistic pathogen, which mostly affects those with weakened immune systems as neonates and tends to cause infections. Klebsiella infection is a major cause of neonatal mortality. There are preventive strategies regarding klebsiella infections to reduce neonatal mortality rate. It is important for nurses to update their knowledge about preventive strategies regarding klebsiella and its implications for resource-limited setting **(Zhao et al., 2020)**.

Nurses should be informed about diseases that caused by klebsiella sepsis and should be able to diagnose the presenting problem and prevent it. Moreover, the nurse needs to improve their practice and their level of attitude toward preventive strategies regarding klebsiella infection **(García & Gómez, 2020)**.

The present study was a quasi-experimental study aimed to evaluate the effect of preventive strategies for nurses regarding klebsiella infection in neonatal intensive care unit.

Regarding personal characteristics of the studied nurses, the results of the present study revealed that, 57.8% nurses were in the age group <25 years with mean age 26.53±10.21 years old. The researcher point of views this may be related to the fact of the hospital occupied critical and intensive care unite with young nurses. These findings were supported by **AbduAllah et al., (2019),** in a study entitled "Effect of educational program for nurses on central venous catheter maintenance bundle for critically ill pediatric patients" and stated that, more than half of studied nurses' age between 25<30 years old with mean age 29.36±4.32 years. In contrast with **Mohammed et al., (2018),** in a study about "Effect of preterm neonates developmental supportive care program on nurses performance regarding nurses age" they found that, less than half of the studied nurses were between (30 – 40) years old, and 4% of them were 50 years old.

Concerning gender of studied nurses, the current study revealed that, majority of the studied nurses were females. The researcher point views this may be attributed to the increase of numbers of females who studied nursing than males. This finding came in line with **Abdel-Mohsen et al., (2019),** in a study entitled "Assessment of nurses' performance toward care of children undergoing chest tube" and reported that more than three quarters of studied nurse were females. Moreover, these findings agreed with **De Almedia et al., (2018),** the study entitled "Nursing intervention: post-operative care with chest tube in adult" who stated that, the majority of the participants (90%) were female.

In relation to the educational level of the studied nurses, the present study showed that, more than half of the studied nurses had technical nursing institute. The researcher point views this may be related to the fact of technical nursing institute provides the community with large number of graduated nurses than other agencies such as faculties of nursing. This finding goes in the same line with the results of a study conducted by **Mohammed et al., (2019),** in a study entitled "Intervention program for nurses about care of preterm neonates undergoing continuous positive airway pressure" in the NICU at Benha Special Pediatric Hospital, Egypt, and found that, more than half of studied nurses had technical institute of nursing.

This finding disagreed with the result of the study done by **Bakhshi et al., (2018),** in a study entitled "Impact of instructions on the developmental status of premature infants on the clinical practice of neonatal intensive care unit

Concerning years of experience of the studied nurses, the current study findings clarified that, 58.9% of studied nurses had less than 5 years of experiences with mean 8.73±5.31 years working at NICU. The researcher point views this may be attributed to the studied nurses age <25 years and more than half of the studied nurses studied technical nursing institute. This result is in agreement with the study of **Artelt et al., (2018),** in a study entitled "Transmission risk on a neonatal intensive care unit escherichia coli versus klebsiella pneumoniae" they founded that, about one third of studied nurses had less than 5 years of experiences working at NICU.

This result disagreed with **Idrees & Hassan (2019),** in a study entitled "Practice–based guidance for nurses about the behavioral cues exhibited from preterm infants " at Mansoura University Children Hospital they revealed that, about one third of

studied nurses had between 5 to 10 years experiences working at NICU.

Regarding personal characteristics of the studied neonates, the results of the present study revealed that, 56.7% of the studied neonates had gestational age <37 weeks with mean gestational age 34.79±3.29 weeks. This finding was in accordance with **Brooks et al., (2018),** in a study entitled "Developing premature infant GUT microbiome is major factor shaping microbiome of neonatal intensive care unit room" they illustrated that, about half of studied neonates had <37 weeks with mean gestational age 33.21±4.32 weeks. Also agreed with **Johnson et al., (2019),** in a study about "Saving neonatal lives by improving infection prevention and control in neonatal intensive care unit" they found that, more than half of the studied neonates were between (38 – 40) weeks.

Regarding the gender, the current study found that, 52.2% of the studied neonates were females respectively. This result was consist to some extent with the finding of the study done by **Abebe et al., (2019),** in a study entitled "Blood culture result profile and antimicrobial pattern reported from neonatal intensive care unit" they reported that, more than half of the studied neonates were females. This result was in contrast with **AbduAlla et al., (2019),** they reflected that, less than three quarters and more than half of the studied samples were males.

Regarding medical history of the studied neonates, the present study illustrated that, the majority of studied neonates didn't have genetic disease. This finding agreed with **Johnson et al., (2019),** they reported that, about half of the studied neonates didn't have genetic disease. This result was in disharmony with **Yuan et al., (2020),** in a study entitled "Genomic epidemiology of outbreak of klebsiella pneumoniae producing extended spectrum B-lactamases in neonatal intensive care unit" they illustrated that, more than third of the studied neonates had genetic disease.

Regarding laboratory test of the studied neonates, the present study revealed that, there was statistically significant difference between complete blood count, C-reactive protein test and blood culture pre & post-preventive strategies implementation ($P<0.05$). Where, 40% the studied neonates had positive klebsiella blood culture in pre-preventive strategies implementation. While, 17.7% of them had positive (klebsiella) blood culture in post- preventive strategies implementation.

In the same direction, these results were similar to **Yuan et al., (2020),** they found that, there was a reduction in rate of klebsiella infection from base line for neonates in NICU ($P=0.032$) in post-educational program intervention. These result in harmony with **Baek et al., (2020),** they clarified that, there was highly statistically significant difference in blood culture pre & post-educational program intervention ($P \leq 0.001$).

Regarding total score of the studied nurses' knowledge, the current study represented that, 40% of studied nurses had satisfactory total percentage score of knowledge pre-preventive strategies implementation. While, more than 77.8% of the studied nurses had satisfactory total percentage score of knowledge post-preventive strategies implementation. From the researcher point of view, this finding may be due to increase nurses knowledge regarding klebsiella infection after implementation of preventive strategies.

These findings similar to **Johnson et al., (2019),** in a study entitled "Saving neonatal lives by improving infection prevention in low resources units" they reported that 40% of subjects had poor knowledge score in the pre-intervention educational program and 65% of subjects had good knowledge score in the post-intervention educational program. Also, these findings were supported by the study done by **Waseem et al., (2019),** in a study entitled "Effective intervention of klebsiella infection in neonatal intensive care unit of tertiary care hospital" they showed that, 45% of subjects had poor level of total knowledge score in pre-intervention of educational program and 70% of subjects had good level of knowledge in post- intervention of educational program. Also, there was a significant difference in the knowledge of subjects before and after implementation of program (P< 0.05).

On other hands, these were contrary to **Wang et al., (2019),** in a study entitled "Epidemiologic analysis and control strategy of Klebsiella pneumoniae infection in intensive care units" in a teaching hospital of People's Republic of China, who reported that, majority of studied nurses were average knowledgeable about successful control of klebsiella pneumoniae in neonatal intensive care unit in the pre-intervention educational program.

The researcher pointed of view, poor knowledge of the studied nurses in pre-preventive strategies implementation toward prevention of klebsiella infection due to lack of opportunity for attending workshops, seminars and guideline booklet availability regarding preventive strategies about klebsiella infection in the hospital.

Regarding nurses' total level of practice about preventive strategies of klebsiella infection in NICU, the current study reflected that, 44.4% of the studied nurses had competent total percentage practice score regarding prevention of klebsiella in pre-preventive strategies implementation. However 85.6% of studied nurses had competent total percentage practice score regarding prevention of klebsiella in post-preventive strategies implementation. This indicated to improvement in nursing practice after implementation of preventive strategies which may be due to efficient application of the preventive strategies and the readiness of studied nurses to improve their level of practice.

These results were in accordance to some extent with **Waseem et al., (2019),** they found that, total practice score improved after implementation of educational program. Moreover, **Manzo et al., (2018),** they illustrated that; the majority of the studied nurses had competent practice post-educational program intervention.

The researcher pointed of view, incompetent total level of nurses' practice regarding prevention of klebsiella infection in pre-preventive strategies implementation may be attributed to decline of nurses knowledge, limited resources and training related to preventive strategies of klebsiella infection and the burden of work.

Regarding nurses' total level of attitude toward preventive strategies of klebsiella infection in NICU, the current study revealed that, there were highly statistically significant differences in nurses' level of attitude regarding prevention of klebsiella infection in post-preventive strategies implementation compared with pre-preventive strategies implementation. Also 48.9% of the studied nurses had positive attitude in pre-preventive strategies implementation while

77.8% of the studied nurses had highly positive attitude toward prevention of klebsiella infection in post-preventive strategies implementation.

These results supported by **Carter et al., (2020),** in a study entitled "Health care worker perceptions of the implementation context surrounding an infection prevention intervention in neonatal intensive care unit" in Zambia they found that, the majority of studied sample (98%) had positive attitude toward infection prevention intervention in post-intervention phase compared with pre-intervention phase results (P<0.001).

The researcher pointed of view, more than half of the studied nurses had negative attitude toward preventive strategies of klebsiella in pre-preventive strategies implementation might be due to lack of opportunity for attending workshops, seminars and guideline booklet availability regarding preventive strategies about klebsiella infection in the hospital.

Conclusion:

There was a highly statistically significant improvement in the studied nurses' knowledge, practice and attitude scores regarding preventive strategies of klebsiella post-preventive strategies implementation. Moreover, the improved nurses' knowledge, practice and attitude regarding preventive strategies of klebsiella infection positively effect on klebsiella infection rate among neonates in neonatal intensive care unit.

Recommendations:

- Implementation of preventive strategies based on the reduction of klebsiella infection rate should be included in hospital policy.
- Providing educational program which emphasized on the evidence-based practiced about infection control measure in the neonatal intensive care unit for the recently graduated nurses.
- Emphasis on the importance of the preventive strategies regarding klebsiella infection for neonates.

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الاستراتيجيات الوقائية للممرضات فيما يتعلق بعدوى الكلبسيلا في وحدة العناية المركزة لحديثي الولادة

رانيا اسماعيل فهيم - امل عبد العزيز عبد السلام - رشا راضي السيد

الاستراتيجيات الوقائية أكثر فعالية في الوقاية من عدوى الكلبسيلا التي تبرز باعتبارها الكائنات الحية الدقيقة الرئيسية التي تؤدي إلى العدوى في وحدة العناية المركزة لحديثي الولادة. حيث هدفت هذه الدراسه الي تقييم أثر الإستراتيجيات الوقائية للممرضات بخصوص عدوى الكلبسيلا في وحدة العناية المركزة لحديثي الولادة. و تم استخدام تصميم بحث شبه تجريبي لإجراء الدراسة. حيث أجريت هذه الدراسة في وحدة العناية المركزة لحديثي الولادة بمستشفى جامعة بنها. على عينة ملائمة قوامها (٩٠) ممرضة ، وعينة هدفيه قوامها (٩٠) مولوداً. حيث خلصت الدراسة بوجود تحسين في معلومات الممرضات وممارساتهم واتجاهاتهم فيما يتعلق بالاستراتيجيات الوقائية لعدوى الكلبسيلا أثرت بشكل إيجابي على معدل الإصابة بالكلبسيلا بين حديثي الولاده. كما اوصت الدراسة بضرورة التأكيد على أهمية الاستراتيجيات الوقائية فيما يتعلق بعدوى الكلبسيلا لحديثي الولادة في بيئة الدراسة.