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Nosocomial Infection in the Neonatal Ward of a Tertiary Care Hospital: The Role of Active Surveillance in the Control of *Klebsiella pneumoniae* Outbreak

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Authors' contributions

This work was carried out in collaboration between all authors. Author PG designed the study, author SS wrote the protocol and the first draft of the manuscript. Authors MJ and SN investigated the outbreak, analyzed the data and corrected the final manuscript. Author SG managed the literature searches, author SKA managed compilation of data. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To describe an outbreak which occurred in a neonatal ward and the role of active surveillance in the control of further outbreaks.
Study Design: Cross Sectional Observational Study.
Place and Duration of Study: Lady Hardinge Medical College and Associated Hospitals, between May 2013 and June 2014.
Methodology: The Infection Control Team (ICT) conducts active surveillance in the neonatal ward (NNW) routinely every year. The data regarding the above mentioned period were analysed and

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infection rates were calculated on monthly basis and compared. Attack rate was calculated as number of patients who acquired hospital acquired infections/ total number of admissions during that month.

Results: A sudden increase in bloodstream infection (BSI) from 2 cases to 16 cases were observed over a period of 2 months (November 2013, and December 2013). Therefore an outbreak was suspected. Sixteen cases of primary blood stream infections caused by ceftazidime/ amoxicillin – clavulanic acid -resistant *Klebsiella pneumoniae* were observed over a two month period. Case definition was made. Recommendations for Infection control practices with immediate effect were sent. The ICT visited NNW and main labour room. Relevant samples were collected and *Klebsiella* species was isolated from suction tubing, baby cot, feeding katori, fingertip of health care worker (HCW) and soap sludge. Bacterial identification and antimicrobial susceptibility testing was performed by using the automated Vitek 2 instrument. The antibiogram of *Klebsiella* species from the samples and cases was found to be similar. It was found that NNW staff was changed recently without any training in Infection control practices. There was breach in Infection control practices.

Conclusion: Active surveillance plays a very important role in detection of early onset of outbreak. All the HCWs including resident doctors, nursing and subsidiary staff and others must be trained in Infection control practices before they are posted to high risk areas.

Keywords: Klebsiella pneumoniae; neonatal ward; disease outbreak; infection control practices.

1. INTRODUCTION

Neonates are at risk of hospital acquired infections as a result of their relatively immature immune system, colonisation of mucous membranes and skin with nosocomial microorganisms, frequent use of antibiotics and invasive devices as well as contacts with healthcare workers. Healthcare associated infections are the major source of morbidity and mortality in neonatal wards [1,2]. Transmission is usually from patient to patient via the hands of healthcare personnel. Neonatal septicaemia presents with non-specific and usually subdued signs and symptoms making it difficult to diagnose. Nevertheless, septicaemia remains a significant cause of morbidity and mortality in the newborns, more so in the developing countries [2].

Klebsiella pneumoniae is an opportunistic pathogen responsible for nosocomial infections. It survives undoubtedly in hospitals, environmental surfaces and colonizes the human skin, bowel, bladder and respiratory tract [3]. Bloodstream infections caused by *K. pneumoniae* are also often reported in the neonatal intensive care units [4]. Neonatal hospital acquired infections, in addition to being the cause of a significant number of perinatal, neonatal, and postnatal deaths, are also associated with increased healthcare costs [1]. Therefore active surveillance is necessary to identify outbreaks. The aim of this paper is to describe an outbreak which occurred in a neonatal ward and the role of active surveillance in the control of further outbreaks.

2. MATERIALS AND METHODS

The Infection Control Team (ICT) conducted active surveillance for nosocomial infections in the neonatal ward (NNW) routinely. The data are analysed and infection rates are calculated on monthly basis and compared. Attack rate is calculated as number of patients who acquired HAI/Total number of admissions during that month [5]. The attack rate of BSI in the last 6 months ranged from 1.27-3%.

2.1 Setting

NNW was staffed by 14 pediatricians and 18 nurses on rotation basis. Data were collected and regular rounds were taken by the ICT. Routine sampling of the patients is done at time of admission and every 72 hours.

2.2 Case Definition

Case definition was prepared. A case was defined as isolation of *Klebsiella pneumoniae* from blood culture with signs and symptoms of a BSI [fever (>38°C), chills or hypotension] according to the Centers for Disease Control. Line listing of all the cases was done and general Infection control measures according to guidelines were reviewed.

Investigations were extended to the main labour room from where neonates with early onset sepsis were transferred. All the babies were on IV line as soon as they were transferred to the NN ward. Relevant environmental samples were taken from the NN ward and main labour room to identify the probable source of infection.

2.3 Microbiological Diagnostic

2.3.1 Microbiological investigation and environmental samples

The blood samples were inoculated first into an aerobic BACTEC 9240 and susceptibility testing was done by Vitek 2. Bacterial identification was performed by using semiautomated Vitek 2 instrument. Antimicrobial susceptibility testing was performed by Vitek 2 (AST-GN26 and AST-N090) and the results were interpreted according to the breakpoints established by the Clinical and Laboratory Standards Institute [6].

Relevant environmental samples were taken from 35 different sites in the neonatal ward in an attempt to identify any possible source of infection. Investigations extended to the main labour room and relevant environmental samples were collected from 20 different sites. Environmental samples were collected and immediately inoculated in nutrient broth and incubated at 24 hours at 37ºC. The broth which were turbid next day were subcultured on blood agar and macconkey agar and incubated for 24 hours. Further identification and antimicrobial susceptibility testing was done by conventional methods and Vitek 2.

3. RESULTS

A sudden increase in early onset bloodstream infection (BSI) of *Klebsiella pneumoniae* infection was observed in the month of November and December 2013 (Table 1 and Fig. 1).

Attack rate increased to 19.6% and 12.5% respectively, therefore an outbreak was suspected.

A total of sixteen cases of bloodstream infections caused by *Klebsiella pneumoniae* resistant to ceftazidime and amoxicillin-clavulanic acid and sensitive to amikacin, meropenem, imipenem and piperacillin tazobactam were observed over a two month period (November - December 2013). The antibiogram of the isolates from the sepsis cases and the environmental samples collected from the NNW were identical. *Klebsiella pneumoniae* was not isolated from the main labor room.

Table 1. Shows attack rate and distribution of BSI cases from May 2013 to June 2014

Month	Attack rate	No. of cases detected	Total no. of babies
May-13	3	2	66
Jun-13	2.9	2	68
Jul-13	2.5	2	80
Aug-13	1.08	1	92
Sep-13	1.21	1	82
Oct-13	2.7	2	74
Nov-13	19.6	10	51
Dec-13	12.5	6	48
Jan-14	3	2	66
Feb-14	2.7	2	74
Mar-14	2.5	2	80
Apr-14	2.86	2	70
May-14	1.7	1	59
Jun-14	1.85	1	54

The affected neonates assigned to the following birth weight categories adopted by NHSM [7] (National Healthcare Safety Network) terminology (Table 2).

The distribution of patient samples and the different sites of the environmental samples from the neonatal ward and the labor room are indicated in Tables 3 and 4.

Recommendations for urgent implementation were sent in the NNW. It was also found that the staff in NNW was changed recently without any training in infection control practices in high risk areas which led to breach in hygiene-disinfection regime. Disinfection guidelines were provided and onsite training to nursing staff imparted. Disinfection practices and hand hygiene practices were monitored daily for a month. Subsequently as a result of infection control measures the attack rate of BSI for the further six months of the period studied has been reduced to 1.3–3%.

4. DISCUSSION

Klebsiella pneumoniae is a well-known causative agent of hospital acquired infections and can be the source of an epidemic outbreak in NICU. Recently, there have been several reports of

Klebsiella pneumoniae outbreaks in NICUs [1,9] due to poor immune response, use of invasive devices and frequent contact with health care workers. Outbreaks of *Klebsiella pneumoniae* have been reported to spread very rapidly with significant morbidity and mortality [8,9,10-14].

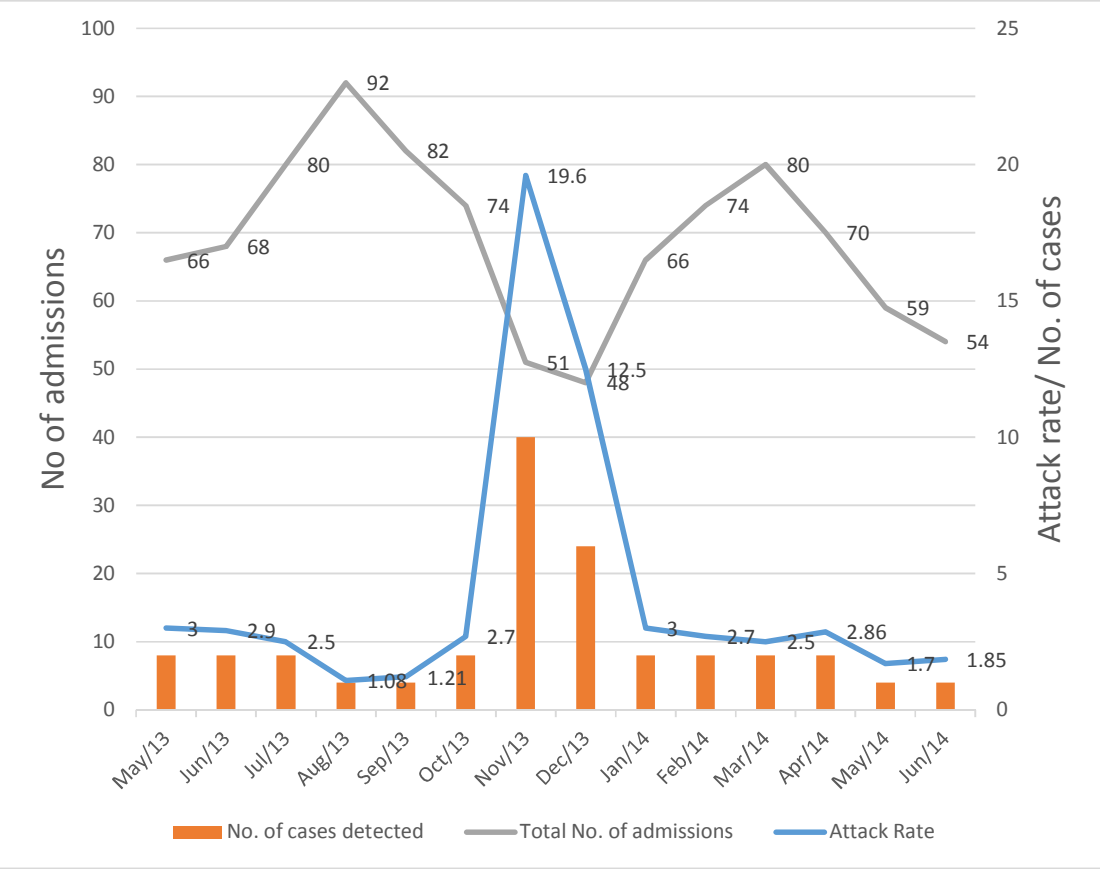

Fig. 1. Bar diagram showing distribution of BSI cases from May 2013 to June 2014

Table 2. Birth weight categories of neonates with BSI (*Klebsiella pneumoniae* ceft/amoxi-cl acid resistant)

A=≤750 g	B=751-1000 g	C=1001-1500 g	D= 1501-2500 g;	E=>2500 g	Total
1	1	8	4	2	16

Table 3. Sampling of the neonates in the neonatal ward

Type of sample-*Klebsiella pneumoniae* cef/amoxi-cl acid resistant	November 2013		December 2013		Nov-Dec 2013	
	Number of patients with a positive sample	% of total number of inpatients	Number of patients with a positive sample	% of total number of inpatients	Total number of patients with a positive sample	% of total number of inpatients
Blood culture	10	19.6	6	12.5	16	16.16

Table 4. Environmental sampling of the neonatal ward and main labor room

Neonatal ward			Main labor room		
Type of sample-*Klebsiella pneu*moniae cef/amoxi-cl acid resistant	**Number/% of negative samples**	**Number/% of positive samples**	**Type of sample-*Klebsiella pneumonia* cef/amoxi-cl acid resistant**	**Number/% of positive samples**	**Number/% of negative samples**
Suction tubing	2 (50%)	2 (50%)	Baby cot	0 (0%)	3 (100%)
Suction jar	2 (50%)	2 (50%)	Ambu mask	0 (0%)	2 (100%)
Baby cot	1 (25%)	3 (75%)	Ambu bag connector	0 (0%)	1 (100%)
Feeding katori	1 (50%)	1(50%)	Delivery trolley	0 (0%)	2 (100%)
Finger tip of HCW	8 (100%)	0 (0%)	Incubator	0 (0%)	1 (100%)
Soap sludge	1 (50%)	1 (50%)	Cidex	0 (0%)	2 (100%)
Sterile water	2 (100%)	0 (0%)	Oxygen humidifier	0 (0%)	1 (100%)
5%Dextrose	4 (100%)	0 (0%)	Finger tip of HCW	0 (0%)	3 (100%)
10% Dextrose	4 (100%)	0 (0%)	Saline	0 (0%)	2 (100%)
Stethoscope	5 (100%)	0 (0%)	Suction liquid	0 (0%)	2 (100%)
Cell phones	5 (100%)	0 (0%)	5% Dextrose	0 (0%)	1 (100%)
Total (35)	35	9	20	0	20

The neonatal skin, respiratory tract, conjunctiva, gastrointestinal (GI) tract, and umbilicus become colonized from the environment and such colonization may lead to the possibility of sepsis from invasive microorganisms [3]. The portal of entry for colonization includes intravenous lines, urinary catheters, or contact with caregivers who have bacterial colonization. Bloodstream infections may be among the most frequent health care-associated infections in NICU outbreaks. Compliance with strict infection control practices is the most important means to control an outbreak in such high risk areas.In our study, environmental cultures from baby cot, soap sludge, suction jar, suction tubing were positive for *Klebsiella pneumoniae*, suggesting that there was a breach in infection control practices. The antimicrobial resistance patterns of these isolates matched those recovered from BSI cases and therefore, were thought to have a common origin.

Though molecular typing of these microorganisms could be very helpful in identifying the organisms that have originated from a single strain, it was not done due to lack of facilities at our institution. During the inspections performed by the hospital Infection Control Team in the neonatal intensive care unit (NICU), using the check-list for the evaluation of the NN ward staff compliance to the infection control measures, the following breaches in the infection control policy were identified: The staff in the NNW was changed recently without any training in infection control practices in high risk areas, hand hygiene practices were minimal, disinfection guidelines were not being followed.

Reinforcement for following proper infection control measures was done with regular visits by the ICT in the NNW. Emphasis was laid upon simple measures such as five moments of hand hygiene, asepsis during all invasive procedures, educating the staff regarding infection control practices, disinfection, and waste disposal. Standard precautions to be followed strictly like wearing of masks, gowns, gloves,isolation precautions, less use of invasive procedures, regular cleaning, disinfection and sterilization of all equipments. Onsite training was given regularly, disinfection guidelines were circulated to the entire hospital with special reference to the high risk areas.

5. CONCLUSION

One must understand the importance of active surveillance. It is suggested that every hospital must have a system for active surveillance which would help to detect the outbreak at an early stage so that investigations could be carried out and proper control measures could be initiated in time. Proper infection control measures helps to reduce the hospital acquired infections. It is also suggested that training of health care workers regarding hospital infection control practice is

very important especially in high risk areas. This training of HCWs and active surveillance are the key elements to prevent an outbreak in high risk areas. It is suggested that the training programme in infection control practices must be conducted regularly for all categories of HCWs. Only trained staff should be posted in such high risk areas.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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APPENDIX

Check list for evaluation of neonatal ward staff compliance to the infection control measures

Procedure	Yes	No
Adhesion to hand hygiene guidelines		
Use of personal protective equipment (gloves, masks ,gowns) during invasive procedures		
Disinfection and steliization of all equipments		
Strict adherence to asepsis during all invasive procedures		
Preparation of IV fluids on a dedicated work surface		
Proper segregation and disposal of biomedical waste		
Restriction of entries		
Cleaning and disinfection of suction tubing and jars		
Cleaning and disinfection of health care workers accessories		

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