Investigation of a Methicillin-Resistant *Staphylococcus aureus* (MRSA) Outbreak in a Neonatal Intensive Care Unit — Kansas, July 2016

Background

On July 28, 2016, at 8:44 AM, the Kansas Department of Health and Environment's Infections Disease Epidemiology and Response section (KDHE) received a report from the infection control practitioner (ICP) at a large acute care hospital that two of 24 infants in the neonatal intensive care unit (NICU) were determined to be infected with methicillin-resistant *Staphylococcus aureus* (MRSA). Actions were immediately underway to prevent further transmission and to investigate the potential cluster.

Methods

Epidemiologic Investigation

KDHE worked closely with the ICP to investigate the cluster in the NICU. The hospital established an outbreak management team led by the pediatric hospitalist with representatives from the NICU, respiratory therapy, environmental services, laboratory, and infection control. KDHE consulted with the Centers for Disease Control and Prevention (CDC) to facilitate conference calls with hospital representatives and to arrange for specimen transport to CDC's Clinical and Environmental Microbiology Branch. The ICP performed a retrospective analysis of NICU medical records for MRSA infections for the previous 18 months, reviewed the staffing patterns of nurses, hospital technicians, and respiratory therapists.

A case was defined as an infant admitted to the NICU between April 30 and August 23, 2016, with laboratory-confirmed MRSA characterized by a pulsed-field gel electrophoresis (PFGE) pattern indistinguishable from the outbreak strain. An infant was considered infected if a positive MRSA isolate was obtained from a sterile site and the infant was exhibiting clinical signs and symptoms of infection with no other etiologic cause. An infant was considered

colonized if there was a positive MRSA isolate from a non-sterile site and the infant was not exhibiting clinical signs and symptoms of infection.

Infection Control Measures

On July 27th, infected infants were isolated in a step-up unit. After preliminary screening results were available on July 28th, four patient cohorts were arranged. Infected and colonized infants were placed under droplet and contact precautions with infected infants remaining in the step-up unit and colonized infants placed in a separate area. Non-colonized and new admission "clean" areas were also arranged for infants. Each area was assigned designated staff. During that time, parents and visitors to the NICU were provided oral and written communications about MRSA and the importance of strict hand hygiene before, during, and after leaving the areas. Signage was posted throughout the NICU and in each patient's room.

In preparation for the cohorts, the NICU rooms, common areas, equipment, and caring devices were thoroughly cleaned and disinfected. To prepare rooms for new admissions, terminal cleaning supplemented by ultraviolet (UV) disinfection was utilized. All common areas including the pumping room for NICU mothers and all waiting areas were also treated with UV light.

Additional measures completed the first week of the investigation included policy review and staff training. Respiratory therapy, environmental services, and NICU policies and procedures were reviewed by the hospital outbreak management team to identify gaps and deficiencies. Monthly observation data assessing NICU staff compliance with hand hygiene policies was examined. Proper donning and doffing of PPE and the use of a three-minute scrub prior to caring for neonates was reinforced with a mandatory training for all staff members assigned to the NICU. Respiratory therapy policies were reviewed during face-to-face meetings with respiratory staff to ensure compliance.

MRSA Surveillance

The hospital followed set policies to perform MRSA screens on transfers to the NICU from an outside facility. In addition to these screens, prevalence screening for MRSA was started on July 27th with swabs obtained weekly on Tuesdays from the nares of infants who were previously MRSA negative. MRSA isolates were sent to the CDC laboratory for PFGE analysis, with subsequent whole genome sequencing performed on isolates with indistinguishable PFGE patterns.

Results

Epidemiological and Laboratory Findings

A retrospective analysis of medical records revealed that from 2015 through July 23rd of 2016, only one case of MRSA had been reported in the NICU. The two infants, identified with MRSA in their pleural and tracheal aspirates on July 24th and July 27th, had been treated for pneumatoceles and pneumothorax requiring intubation and chest tubes. Surveillance cultures were obtained from the remaining 22 infants on July 27th, and four infants were found to be colonized with MRSA.

PFGE results revealed that the two infected infants and three of the four colonized infants had an indistinguishable PFGE pattern which was similar to the USA300 strain that is associated to community-acquired MRSA (CA-MRSA), Table 1. All five case-infants had been exposed to endotracheal tubes and central venous catheters. Case-infant 5 had been transferred to an outside facility after 18 days in the NICU; the infant was readmitted to the NICU on June 26th. Upon readmission, the infant had a negative MRSA screen; a subsequent screen was MRSA positive on July 28th.

Table 1: Characteristics of infants infected or colonized with USA300 strain of MRSA in a Kansas NICU, 2016 (n=5)

Case	*Sex*	*Gestational age at birth (week)*	*Weight at birth (g)*	*Delivery method*	*Nutrition source(s)*	*MRSA first isolated date*	*Symptom Onset date*	*Specimen type analyzed*
1	M	26	895	CS	BM,TPN	July 24	July 22	Nasal
2	F	24	550	VD	BMD,TPN	July 27	July 19	Pleural fluid
3	M	26	552	CS	BMD,TPN	July 28	-	Nasal
4	F	25	902	CS	TPN	July 28	-	Nasal
5	M	25	887	CS	BM	July 28	-	Nasal

CS=caesarian section, VD= vaginal delivery, BM=breast milk, BMD=breast milk donor source, TPN=total parenteral nutrition

The colonized infant with the distinct PFGE pattern had been transferred to the NICU after a two-day stay in the newborn nursery; unlike the case-infants, this infant did not have an endotracheal tube or central catheter, and the primary nutrition source was formula.

Whole genome sequencing was completed on the five indistinguishable isolates. The pleural fluid isolate from case-infant 2 had seven single-nucleotide polymorphism (SNP) differences from the other case-infants whose MRSA was isolated from nasal swabs. Those four isolates had only a few SNP differences between them.

Weekly point prevalence testing for all NICU infants continued for four weeks, ending on August 23rd, with no additional MRSA detected.

Respiratory therapist, nursing, and technician staffing patterns from the weeks prior to the outbreak revealed no overlapping of a staff member who cared for all the cases of both colonized and infected infants. Both infected infants recovered with no additional MRSA infections occurring in the NICU during the outbreak investigation.

Infection Control Measures

The most recent undisclosed observation of NICU hand hygiene, obtained one month prior to the outbreak, showed 92% compliance with handwashing hygiene protocols within the unit. A gap was found in the NICU policy for surveillance screening of transfers, as only infants from one hospital were routinely screened for MRSA on admission. The policy was updated to include all transfers. It was determined that a detailed list on how to disassemble, adequately disinfect, and reassemble isolettes was needed; this was prepared by environmental services. An annual competency specific to the NICU was created for respiratory therapy and environmental service staff.

Conclusions

Outbreaks of MRSA infections in NICU have been reported since the early 1980s[1]. CA-MRSA was first recognized as a significant cause of infection in the late 1990s[2] and since then has become increasingly associated with NICU outbreaks resulting in the colonization and infection of neonates[3,4,5]. Infants in NICU are at high-risk for infection and colonization as many neonates are preterm or seriously ill with congenital birth defects requiring invasive procedures. Tracing transmission routes in these outbreaks is often difficult due to the complex epidemiology of CA-MRSA in the NICU where outbreaks may overlap with endemic circulation[6]. Understaffing and limited space can weaken MRSA control in NICU, but early recognition of outbreaks and immediate implementation of aggressive infection control measures can effectively limit the spread of infection[7].

This outbreak of MRSA was characterized by transmission occurring within the NICU. Five confirmed cases were identified. The two infants infected with MRSA represented an increase above the normal baseline for MRSA in the NICU. Additional findings of four infants colonized with a PFGE pattern indistinguishable from the infected infants and the finding of one infant with a negative MRSA screen followed by positive MRSA screen one month later and one day after admission was consistent with transmission occurring within the facility. It was unclear if the seven SNP difference in one infected infant's isolate represented a separate strain imported

into the NICU, or if it was associated with the cluster despite its slight genetic differences to the outbreak strain.

The implementation of aggressive, multifaceted infection control measures was successful in controlling this outbreak. The weekly point prevalence testing continued for four weeks with no evidence of further transmission of MRSA among the NICU population. The prevalence of MRSA among staff and family members was not obtained. The decision to forego surveillance cultures of staff and families was reached in collaboration with CDC due to no evidence of ongoing transmission. The lack of ongoing transmission was also a factor in deciding not to decolonize non-symptomatic neonates.

It was unfortunate that prevalence screening data was not available prior to the investigation to provide a background on the colonization rates normally seen within the NICU. The hospital should consider utilizing the prevalence screening data collected in this investigation as a baseline and examine the possibility of periodic prevalence studies in the NICU to assist with early outbreak recognition.

Overall, the hospital's coordinated response internally among department staff and externally with the county health department, KDHE, and CDC was successful in preventing further transmission of MRSA. The hospital outbreak response team fostered an environment where risks could be quickly and thoroughly assessed and polices could be promoted and modified to successfully contain the outbreak.

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