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Methicillin-susceptible *Staphylococcus aureus* Outbreak of Skin Infection among Neonates in a Private Hospital in Bangkok, 2013

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Abstract

On 27 Jul 2013, the Bureau of Epidemiology, Thailand was notified by a private hospital in Bangkok of abnormally increasing number of neonates with *Staphylococcus aureus* skin infection. An investigation was conducted to determine source of infection and risk factors. Medical records of 101 neonates born during 29 Jun to 31 Aug 2013 were reviewed. The workplaces, including a delivery room, an operating room, a nursery ward and a washing area, were inspected. Clinical and environmental samples were obtained and examined for bacterial culture. Total 40 neonates had clinical features that met the case definition, giving an attack rate of 39.6%. Methicillin susceptible *S. aureus* was isolated from seven (87.5%) out of eight specimens from skin lesions and three (10.7%) out of 28 nasal swab samples from health care personnel. The infection rate was significantly higher in male neonates (50.0%) than females (27.7%). The outbreak rapidly curtailed after massive control measures, including strengthening contact precaution among health care personnel, provision of health education to mothers and improving the hospital environment.

Keywords: *Staphylococcus aureus*, neonate, Bangkok

Introduction

Staphylococcus aureus is the most common cause for pyogenic infection of skin and soft tissues, with humans and mammals as the natural reservoirs. About 30% of normal population has *S. aureus* colonization in their nares which may result in hand carriage and nosocomial spread. Even neonates, they can be colonized within the first few weeks of life.[1] The organism usually spreads by direct contact with the lesion or asymptomatic carrier. Although the incubation period is around 4-10 days, the disease may occur several months after colonization as well.[2] Not only the incubation period, but also the survival time of *S. aureus* outside hosts vary in different environment.[3]

There are many types of disease presentation when humans are infected with *S. aureus* such as skin infection, pneumonia, osteomyelitis, toxic shock syndrome, food poisoning and staphylococcal scalded skin syndrome (SSSS).[1,4] *S. aureus* skin infection may result in abscess, carbuncle, furuncle, folliculitis, impetigo and bullous impetigo. Neonates are prone to have skin infection because of their immature skin formation and relative immunodeficiency status.[4]

On 27 Jul 2013, the Bureau of Epidemiology, Ministry of Public Health, Thailand was notified by an infection control nurse from a private hospital in Hospital A of an abnormal increase in suspected *S. aureus* skin infection among neonates during follow-up visits after birth. The Bureau of Epidemiology, the responsible Bangkok Health Center and Hospital A jointly conducted an investigation from 30 Jul to 31 Aug 2013. Objectives were to confirm the outbreak, identify source of infection and risk factors, and provide appropriate measures to control the outbreak.

Methods

Descriptive Epidemiology

Medical records of the neonates born in Hospital A from January to August 2013 were reviewed. Physicians and nurses were interviewed about clinical features and diagnosis of the cases. Active case findings were conducted among the neonates in August 2013. A suspected case was defined as a neonate who was born in the hospital between 29 Jun and 7 Aug 2013, and had skin lesions of pustules, vesicles, abscess or exfoliation on any part of body, or had diagnosis of pyoderma, bullous impetigo, furunculosis, SSSS or bacterial skin infection. A

confirmed case was defined as a suspected case with laboratory-confirmed *S. aureus* from skin lesion by bacterial culture.

Environmental Study

The workplaces, including a delivery room, an operating room, a nursery ward and a washing area, were inspected. In each place, working process of health care personnel was observed and hygiene survey among the staff was conducted using questionnaires modified from the infection prevention checklist of United States Centers for Disease Control and Prevention (US CDC).[5]

Laboratory Study

Clinical and environmental samples were obtained and examined for bacterial culture. Specimens were collected from skin lesions of suspected cases to confirm the diagnosis. Hand and nasal swabs were obtained from health care personnel, including physicians, nurses and patient assistants working in the delivery room, the operating room and the nursery ward during June to July 2013. Equipment and devices in the workplaces such as incubators, radiant warmers, cribs, stethoscopes, weight scales, bath tubs, clothes, closets and air conditioners were swabbed and examined for bacterial contamination. The specimens were collected by swab with Stuart's media and sent to National Institute of Health within 48 hours for bacterial culture and drug susceptibility testing. All *S. aureus* isolates were examined for genetic patterns by pulsed field gel electrophoresis (PFGE) testing.

Analytic Study

A retrospective cohort study was conducted to determine risk factors of the infection. There were total 107 neonates born in the Hospital A during 29 Jun to 7 Aug 2013. Study variables included gender, birth weight, gestational age, maternal age, number of pregnancy, number of childbirth, type of labor and presence of premature rupture of membrane, length of stay at birth episode. Attack rate, infection rate and relative risk were also calculated by univariate analysis, and 95% confidence interval (CI) was calculated to determine the strength of association. Epi Info version 7 was used for statistical analysis.[6]

Results

Descriptive Epidemiology

Hospital A was a 30-bed private hospital in Bangkok, with two pediatricians and one obstetrician. They provided delivery service for mothers with normal pregnancy. From January to May 2013, median number of childbirth per month in the hospital was 32, with range of 26-37. Most of the mothers who gave birth in this hospital were foreign workers. The monthly number of birth increased to 82 in June 2013 and 85 in July 2013. Proportion of neonates with skin infection increased to 44.7% in July 2013 (Table 1).

Table 1. Skin infection by month among neonates born in Hospital A, Bangkok, Thailand, January to July 2013

Month	Number of neonate	Number of infected neonate	Attack rate (%)
January	37	2	5.4
February	36	4	11.1
March	26	2	7.7
April	28	1	3.6
May	32	3	9.4
June	82	4	4.9
July	85	38	44.7

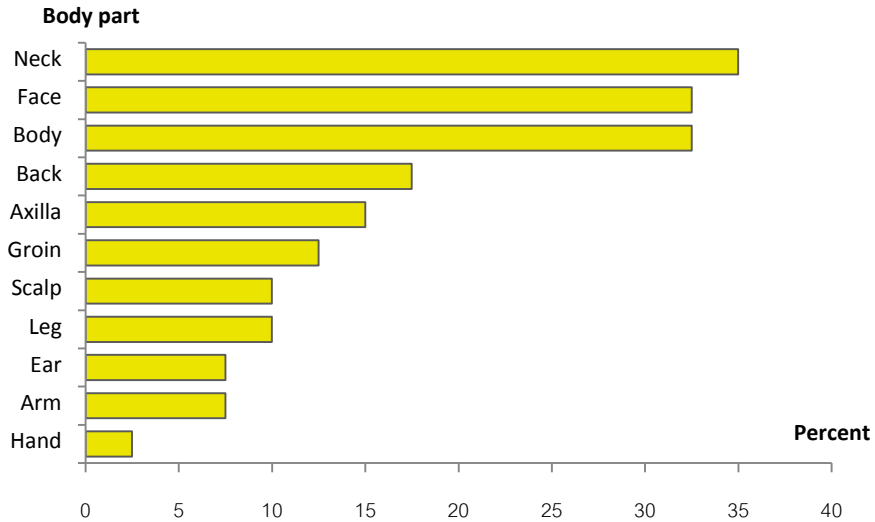

Figure 1. Infected body parts of neonates with skin lesion in Hospital A, Bangkok, Thailand, 29 Jun to 7 Aug 2013 (n = 40)

Table 2. Characteristics and infected neonates and their mothers in Hospital A, Bangkok, Thailand, 29 Jun to 7 Aug 2013

Characteristic	Total	Number of case	Infection rate (%)	Relative risk	95% CI
Sex					
Male	54	27	50.0	1.8	1.06-3.08
Female	47	13	27.7	Reference	
Birth weight (gram)¶					
< 2,500	2	0	0	Undefined	-
≥ 2,500	99	40	40.4	Reference	
Gestational age (week)*,¶					
< 37	4	0	0	Undefined	-
≥ 37	95	40	42.1	Reference	
Maternal age (year) *					
≥ 35	84	32	38.1	0.8	0.46-1.43
< 35	17	8	47.1	Reference	
Number of pregnancy					
1st	59	26	44.1	1.3	0.79-2.31
2nd or more	42	14	33.3	Reference	
Number of delivery					
1st	66	29	43.9	1.4	0.80-2.45
2nd or more	35	11	31.4	Reference	
Type of delivery					
Abnormal**	57	20	35.1	0.8	0.48-1.25
Normal	44	20	45.5	Reference	
Present	20	9	45.0	1.2	0.66-2.00
Absent	79	31	39.2	Reference	
Length of stay (day)					
> 3	10	3	30.0	0.74	0.28-1.98
≤ 3	91	37	40.7	Reference	
Maternal race					
Lao	7	2	28.6	0.7	0.21-2.30
Cambodia	2	1	50.0	1.2	0.30-5.00
Thai	2	0	0.0	0	
Myanmar	90	37	41.1	Reference	

* *Excluding those with no information*
** *Including caesarean section and vacuum extraction*
¶ *p > 0.1*

Normally, those normal neonates would stay in the hospital for two days after birth, and then, were discharged. The doctor would make a follow-up appointment on the 7th day after discharge.

In June 2013, only four neonates with skin infection were detected during the early week and no cases were found until the end of the month. During the study period from 29 Jun to 7 Aug 2013, there were total 107 neonates in the nursery ward, including 105 neonates born in the hospital and two born before admission. Six neonates lost follow-up after birth. Of total 101 neonates included in this study, 96 (95.0%) were full term. Only two (2.0%) had low birth weight (less than 2,500 gm) and one (1.0%) had birth weight more than 4,000 gm.

Total 40 neonates had clinical features which met the case definition, giving an attack rate of 39.6%. The first case born on 29 Jun 2013 developed onset of skin infection on 1 Jul 2013, with subsequent 37 cases clustered in the same month and the other two in August 2013. All cases were full term and healthy neonates who lived in different communities. Majority of them were detected during the first week follow-up.

For the skin presentation, neck was the most affected part (35.0%), followed by face (32.5%) and body (32.5%) (Figure 1).

The most common diagnosis of the cases was pyoderma (52.5%), followed by bullous impetigo (20.0%) and furunculosis (12.5%) (Figure 2). One patient with skin lesion was not recorded for any diagnosis.

Total 31 (77.5%) cases were treated as out-patients, eight (20.0%) were admitted, and one (2.5%) was referred to an ophthalmologist due to skin lesion close to eyes.

The infection rate was significantly higher in male neonates (50.0%) than females (27.7%). Neonates born to mothers with first pregnancy or first delivery had a slightly higher rate of infection than those of mothers with second or more (Table 2). There were no other variables significantly associated with the infection.

Laboratory Results

Among eight specimens of skin lesion examined, seven were positive for *S. aureus* (Table 3). Nasal and hand swabs from 28 health care personnel were collected.

Table 3. *Staphylococcus aureus* isolated from infected neonates, health care personnel and environment samples in Hospital A, Bangkok, Thailand, 29 Jun to 7 Aug 2013

Type of sample	Number of sample tested	Number of sample tested positive	Percent
Infected neonate (n = 8)			
Skin lesion	8	7	87.5
Conjunctiva	1	1	100.0
Health care personnel (n = 28)			
Nasal	28	3	10.7
Hand	28	0	0
Skin lesion	1	0	0
Environment			
Delivery room	3	0	0
Nursery room	28	0	0

S. aureus was found in nasal swabs of three (10.7%) health care personnel. All the swabs from equipment and devices in the delivery room, the operating room and the nursery ward were negative for *S. aureus*. All the *S. aureus* isolates from the cases and three nurses with nasal colonization were methicillin susceptible. PFGE showed that one health care person and two cases shared the 100% compatible phage type pattern. However, they had different drug susceptibility. From the two cases, the organism was susceptible to clindamycin and erythromycin whereas the organism isolated from the health care person was resistant to both drugs. For other cases and health care persons, genetic patterns of the organisms were different at 50-75% compatibility.

Environmental Study

The delivery room, the operating room and the nursery ward all were on the second floor of the building, approximately 20 meters from each other. The delivery room was connected to the operating room. There was limited space in the delivery room with one delivery bed, one waiting bed and one radiant warmer. The radiant warmer was shared with the operating room in case of cesarean section. No one in the delivery room had skin infection during the previous two months. The neonates born in the delivery room were tagged and umbilical cord tied. This process lasted for about 15-20 minutes before they were taken to the nursery ward. Wearing a gown, a cap, a mask and shoes was required before entering the delivery room and the nursery ward.

Floor and equipment in both rooms were cleaned twice daily with phenol-derivative solution. Cribs were cleaned every time after a neonate was discharged. The nursery ward, if unfurnished, was approximately 30-35 sq m. But there were equipment placed inside such as table, procedure bed, incubators, etc. Then, the baby cribs were placed together. Maximum capacity of the nursery ward was 20. There were usually 2-10 babies admitted in the ward every day. The space between each cribs were less than one meter. Before the outbreak, mothers were allowed to enter the nursery ward for breastfeeding after hand washing. Lastly, we visited the laundry area. There was one staff operating a washing machine. Clothes were washed every day separately from other wards. After drying and ironing, the staff returned clothes to the ward in the afternoon.

Hygiene survey among health care personnel showed that they did not perform hand washing or use personnel protective equipment regularly such as gloves, goggles and gowns (Table 4). There was no difference between male and female neonates in term of caring in the nursery. Moreover, no male neonates were circumcised during that period.

Analytic Study

Being a male neonate was found associated with *S. aureus* infection while the other variables were not statistically associated with the infection as shown in table 2.

Control Measures

Surveillance and reporting systems were set up in the pediatric out-patient unit to detect new cases. The hospital strengthened contact precaution among

Table 4. Universal precaution practices of health care personnel in the delivery room and the nursery ward in Hospital A, Bangkok, Thailand, 29 Jun to 7 Aug 2013

Type of practice	Delivery room (n = 5)	Nursery ward (n = 18)
Washing hands before contact with patient	100.0	61.1
Washing hands after contact with patient	100.0	77.8
Washing hands before procedure	60.0	83.3
Washing hands after procedure	80.0	88.9
Washing hands after contact with blood/secretion	80.0	83.3
Washing hands before moving from contaminated site to other area	80.0	66.7
Taking off a cap, gloves and a mask before leaving from patients' areas	60.0	72.2
Washing hands after taking off a cap, gloves and a mask	20.0	61.1
Wearing gloves when having chance to contact with blood, secretion or soft tissue	60.0	72.2
Changing gloves before contact with another patient	80.0	72.2
Wearing a gown before doing procedure	60.0	33.3
Changing a gown before contact with another patient	40.0	22.2
Wearing goggles and a mask when working with possible blood or fluid splash	60.0	33.3

health care personnel and gave health education to mothers during admission. For environmental control, the nursery room, the delivery room and the operating room were adequately cleaned. A new room for breast-feeding and a cohort ward for sick neonates were set up. The carriers were treated with mupirocin ointment for one week and allowed to stop working with neonates for three weeks. Repeated nasal swabs from those carriers were all negative. The latest case was the case born on 7 Aug 2013, and no further case was found until 31 Aug 2013.

Discussion

This outbreak of *S. aureus* skin infection in neonates was likely to be nosocomial spread on account of four reasons. First, the dates of onset were early (within seven days of life). Hence, time of exposure was likely to be during the time when the neonates were admitted to the nursery ward. Another reason was that as the cases came from different communities, the epidemiological linkage in the aspect of place was only in the nursery ward. In addition, the laboratory testing also showed the evidence that one nurse and two cases had the same phage type patterns of the organism. Lastly, the outbreak curtailed after control measures were implemented in the hospital. Despite the facts mentioned above, since the laboratory study showed various strains of *S. aureus* both in cases and carriers, some cases might also acquire infection in the communities.

In a previously published outbreak in Nan Province of Thailand, equipment in the environment was implicated in the transmission of infection.[7] Therefore, we implied that equipment could contribute to this outbreak as the two cases stayed in the nursery ward might have direct contact with the equipment after the nurse left the ward. However, negative results from the environmental swabs might result from interventions in place before the specimen collection. Allowing mothers coming into the nursery ward might also increase the number of carrier to spread the organism. Carrier-case pairs which had the same PFGE patterns with different drug susceptibility could be explained by the pattern of drug susceptibility that might be lately developed in the carriers after spreading the organism to the cases. In addition, the gene responsible for these drug susceptibility patterns might be too small to be differentiated by PFGE study. This interesting finding suggested more attention to multi-drug resistant nosocomial infection in the future.

Due to the newly launched campaign of health insurance for foreigners, the number of pregnant women giving birth in the hospital started to increase in June 2013, a month before the outbreak. A standard nursery ward should have at least 2.32 square meters for each crib and distance between edges of each crib should not be less than one meter.[8,9] However, the remaining limited space in the nursery ward did not allow as such. Then, the baby cribs were placed closely. In the hygiene survey, some health care personnel did not maintain standard hygienic practice. High workload of health care worker rendering inappropriate hand washing and crowding in the nursery ward might increase risk of infection spread and contribute to nosocomial spread. However,

after this outbreak, the hospital restricted the number of neonate admitted in the nursery ward.

Univariate analyses showed that male gender was associated with the infection. This finding was consistent with previous studies[10,11]. Despite that, mechanism of infection for gender of neonates and immunity difference should be studied further. Since most of the study population in this outbreak were full term and healthy neonates, our investigation indicated that outbreak of *S. aureus* skin infection could occur even among full term and healthy neonates. Therefore, all measures of universal precaution should adequately be in place for all neonates.

Limitations

We could not obtain the exact onset date of each case due to lack of information in medical records and thus, could not determine the association between health care personnel and cases. We also faced language problem because most of the mothers were foreigners. In context of the private hospital, some staff were part-time and not always available for data collection. Information bias might occur in the hygiene survey among health personnel as we used the self-administered questionnaire. In this study, since only univariate analysis was used due to statistical non-significance of other variables, confounding factors could not be adjusted.

Recommendations

The issue of *S. aureus* infection should be added into the routine infection surveillance and control program among neonates in the hospital, including strengthening contact precaution, health education to health care personnel and mothers, close monitoring of neonates during follow-up and surveillance for drug resistant *S. aureus*.

Conclusion

The methicillin susceptible *S. aureus* skin infection outbreak occurred among neonates in Hospital A was caused by different strains of *S. aureus*. The sources of infection might be the hospital and the communities. In the hospital, the investigation identified nasal carriers who could transmit the organism through equipment in the set-up. The number of case markedly decreased after implementing strong contact precaution, isolation of cases, treating carriers and providing education to mothers before returning to communities.

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Suggested Citation

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