An outbreak of hospital-acquired Staphylococcus aureus skin infection among newborns, Nan Province, Thailand, January 2008

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In January 2008, we investigated a cluster of neonates with bullous impetigo in a hospital of northern Thailand in order to control the outbreak and identify a potential source of the infection. We reviewed medical records and working timetables of healthcare workers (HCWs) and conducted a case-control study. We performed an environmental study and took bacteriological samples from HCWs and equipments. According to our case definitions, we identified 16 confirmed cases and 14 probable cases. The attack rate was 42%. Most cases had skin blisters (28 cases) followed by pustules (five cases) and exfoliation (three cases). The location of the lesion was the trunk (17 cases), neck (14 cases) or armpits (nine cases). Nineteen cases had symptoms onset after discharge from hospital. Median age at onset was 4 days. The strain isolated from an infected newborn shared the same phage type as the contaminated equipment. Insufficient hand hygiene was an observed risk behaviour of HCWs and visitors. Exposure to a nasal carrier of *Staphylococcus aureus* (adjusted OR: 80.3, 95% CI: 4.8 – 1350.3) and ward sharing with a symptomatic case (adjusted OR: 35.6, 95% CI: 1.9 – 654.7) increased the risk of acquiring the infection. The outbreak ended abruptly after implementation of hand hygiene practices and equipment cleaning.

Introduction

Bullous impetigo is a superficial bacterial skin infection, mainly affecting infants and small children, usually caused by *Staphylococcus aureus* which can lead to severe illness in the form of staphylococcal scalded skin syndrome (SSSS), septicaemia, or pneumonia [1,2]. Newborn infants are prone to skin infection due to the vulnerability of their skin [3]. Healthy carriers of S. aureus such as healthcare workers (HCWs) [4,5] can transmit the bacteria to others [6,7]. Thai Ministry of Public Health included nosocomial infections in mandatory reporting in 1982 [8]. The prevalence of nosocomial infections in Thailand was 11.7% in 1988, it diminished to 7.4% in 1992, to 6.4% in 2001 and slightly increased to 6.5% in 2006 [9]. Most hospitals in Thailand have targeted surveillance systems in place for high risk population such as intensive care patients, post-surgery patients and patients with invasive devices. However, staff shortage and high workload are the main problems in tackling nosocomial infections in Thailand [10-12].

Hospital A is a district hospital with 90 beds and 50-60 births take place here on average, every month. This hospital takes care of seemingly uncomplicated pregnancies. If the woman is considered at high risk, she is transferred to the provincial hospital, which offers better facilities for critical care.

A pregnant woman close to delivery stays in the pre-delivery room until delivery is imminent, when she is transferred to the delivery room. If caesarean section becomes necessary, she is transferred to the operating room. After delivery, mother and newborn stay in the same room and bed at the postpartum ward. There are two postpartum wards, ward A and ward B. Ward A is the first priority for hospital stay after the delivery because it is located in the same building with the delivery room. Ward B is usually empty and the room is used as the alternative ward if ward A is full. Newborns delivered by caesarean section stay in the nursery for approximately one hour for close observation of vital functions. If their condition is stable, they are sent to the postpartum ward immediately. After uncomplicated deliveries, mother and child may be discharged from hospital even after 48 hours.

Methods

On 25 January 2008, a medical officer at hospital A notified the Bureau of Epidemiology, Department of Disease Control in the capital, of an increasing number of neonates with bullous impetigo and requested assistance for an outbreak investigation. In this report we describe an outbreak of the staphylococcal bullous impetigo occurring in a district hospital in northern Thailand between 11 and 27 January 2008. Our objectives were to control the outbreak, to identify potential sources of infection and to investigate risk factors for illness.

During the outbreak, hospital A had 34 HCWs of whom 19 were exposed to newborns (eight nurses, five student nurses, four nurses' aids and two doctors). These 19 HCWs worked in all the units of maternal and newborn care. Following the rules and policies of Hospital Accreditation, there was one infection control nurse (ICN) responsible for hospital infection control activities which included surveillance for hospital-acquired infections, supervision of infection control practices for healthcare workers, and evaluation of medical products that could increase the risk for infection. Due

to shortage of staff, this nurse was also involved in direct patient care.

Descriptive epidemiology

We started our study by reviewing medical records of the cases occurring in hospital to identify the first case of the cluster. We determined the investigation period by counting backward ten days from the onset of the first case [13]; thus the observation period began on 1 January 2008. A probable case was defined as a newborn infant (age ≤30 days) with skin pustule, blister or exfoliation on any part the body who was born between 1 January and 25 January 2008. A confirmed case had in addition methicillin-sensitive *Staphylococcus aureus* isolated from the skin lesion. We contacted the parents of all 71 neonates who were born during 1-25 January 2008. Sixty of them responded. The paediatrician was asked to collect date of onset of each case and to describe the skin lesion by anatomical location. In addition, all parents of cases were interviewed about potential community infection risk factors.

Environmental and laboratory investigation

We interviewed eight HCWs who worked in the delivery room and post partum wards and observed their routine neonatal care practice. We inspected the delivery room, the neonates' room and the disinfection unit where we observed the adherence to standard infection control procedures. We enquired about schedules for room cleaning and requested disinfection protocols from the ward's chief nurse. A laboratory technician collected samples from the most frequently used neonatal care equipments, such as radiant warmer, weight scale, baby-crib and stethoscopes. Environmental samples, 37 specimens, from the bathing counter, soap and washing water for instance were also collected for bacterial culture. Hand swab and nasal swab samples were collected from all HCWs. We took swabs on the first web space between the thumb and index finger and in the right nostril. In order to confirm the epidemiological links between positive culture samples from cases and environmental samples, we performed limited phage typing.

Analytic epidemiology

We conducted a case-control study by comparing 16 laboratory-confirmed cases with 30 healthy neonates (no skin lesion) that were born in the same hospital during the same period. Type of birth, room location for neonates, exposure to neonatal equipment and exposure to each HCW were tested for statistical association with case status by calculating odds ratio (OR) and 95% confidence interval (CI). We used the working timetable of each HCW as a proxy of newborn exposure by matching their schedule to the first 24 hours after birth of each neonate. We used multiple logistic regression technique to diminish the effect of possible confounding factors. The variables with significant p-value, less than 0.05, from the univariate analysis were put in the model. We used Excel 2003 and STATA 10.0 programmes for data analysis.

Results

Descriptive results

The onset date of the index case was on 11 January 2008. Sixty (84.5%) out of 71 neonates were physically examined again from 25 January to 27 January 2008, of which we identified a total of 30 cases (attack rate = 42%): 16 confirmed and 14 probable cases. Skin blister was the most common symptom (28 cases), followed by skin pustule (five cases) and skin exfoliation (three cases). Skin lesions were located at the trunk (17 cases), neck (14 cases), armpits (9 cases), groins (seven cases), upper extremities (seven cases) and lower extremities (five cases).

No serious case or complication has been recorded during this outbreak. The age of illness onset ranged from 1 to 12 days; median age was 4 days. Eleven of the 30 cases had symptoms during hospitalisation and 19 showed symptoms only after discharge from hospital. From the interviews with the parents, we found out that no other family members had skin infections during that time. The sex specific attack rate was 46% (16/35) for male and 56% (14/25) for females. The attack rate by room location was highest in ward A (61%) followed by the nursery (44%) and zero in ward B.

The epidemic curve (Figure) illustrated a gradually increasing number of cases at the beginning of the outbreak, a sharp increase

Table 1

Phage typing from one case, from neonatal care equipment and from carriers among healthcare workers, hospital A, Nan Province, Thailand, January 2008

Sample	Result
Case 1	MSSA- phage type 29/52/80/3C/55/95/81/94/96
Radiant warmer in the delivery room	MSSA- phage type 29/52/80/3C/55/95/81/94/96
Weighting scale in the delivery room	MSSA- phage type 29/52/80/3C/55/95/81/94/96
Baby crib in ward A	MSSA- phage type 29/52/80/3C/55/95/81/94/96
Bathing counter in ward A	MSSA- phage type 29/52/80/3C/55/95/81/94/96
Nurses' aid A4 (nasal swab)	MSSA- phage type 29/52/80/3A/3C/55/6/47/53/54/75/77/83A/94/96
Nurse R5 (hand swab)	MSSA- phage type 29/52/52A/80/3A/71
Student nurse S5 (nasal swab)	Non-typable

Table 2

Univariate analysis of potential exposures of neonates with bullous impetigo, hospital A, Nan Province, Thailand, January 2008 (n=46)

Exposures	Crude OR (95% confidence interval)	p-value
Admission in ward A	11.3 (1.3 – 512.2)	0.011
Ward sharing with symptomatic cases	5.4 (0.9 – 54.9)	0.034
Exposure to nurses' aid A4 (carrier)	12.1 (2.0 – 122.0)	0.001
Exposure student nurse S2 (non carrier)	7.0 (1.5 – 36.6)	0.004
Exposure student nurse S4 (non carrier)	4.6 (1.1 – 20.5)	0.018

Table 3

The association between neonates with bullous impetigo and five exposures, significant p-value (p<0.05) from univariate analysis, by multiple logistic regression, hospital A, Nan Province, Thailand, January 2008 (n=44)

Exposures	Adjusted OR (95% confidence interval)	p-value
Admission in ward A	14.5 (0.4 – 578.2)	0.156
Ward sharing with symptomatic cases	35.6 (1.9 – 654.7)	0.016
Exposure to nurses' aid A4 (carrier)	80.3 (4.8 – 1350.3)	0.002
Exposure to student nurse S2 (non carrier)	0.8 (0.08 – 7.9)	0.860
Exposure to student nurse S4 (non carrier)	6.2 (0.6 – 60.5)	0.116

in the second week, and a peak on 25 January. The outbreak ended rapidly after ward closure for two days during 26 and 27 January. A week before the outbreak started, five student nurses had arrived at the maternal and neonatal care unit for nursing practice and they left in February 2008. When an increasing number of bullous impetigo cases was noticed, the ward nurses began to strengthen hand washing. However, they did not report the cases to the hospital infection control nurse until 25 January, because previously, newborn skin infections had not been included in the hospital infection surveillance protocol.

Environmental investigation and laboratory results

Our investigation revealed that the delivery room was cleaned with household detergent three times per week. We found that some equipment such as radiant warmers and the weight scale were cleaned only on superficial surfaces after utilisation. Postpartum wards, where the newborns stayed, were usually crowded with many visitors, who could easily touch and play with newborns without having properly washed hands.

Laboratory results

Methicillin-sensitive *Staphylococcus aureus* (MSSA) from all 16 confirmed cases had the same antibiotic sensitivity pattern and all were resistant to penicillin. Only one isolate was phage typed because the other isolates had already been discarded. Among 37 samples from neonatal care equipments, four specimens were positive for S. aureus. Two positive items, a radiant warmer and a weight scale, were found in the delivery room and three, a bathing counter, a baby-crib and a bed sheet of a case, were found in ward A. Three out of 34 healthy HCWs had positive cultures for S. aureus. Nurses' aid A4 and student nurse S5 had nasal carriage of S. aureus and nurse R5's hand swab was positive for S. aureus. None of the three carriers had a skin lesion.

MSSA phage type 29/52/80/3C/55/95/81/94/96 was identified from all four samples of contaminated neonatal care equipment. In addition, we identified phage type 29/52/52A/80/3A/71 and 29/52/80/3A/3C/55/6/47/53/54/75/77/83A/94/96 from nurse R5 and nurses' aid A4 respectively while phage type of Student nurse S5 was non-typable due to the limitations of laboratory technique (Table 1). The phage type of the newborn case was 29/52/80/3C/55/95/81/94/96, the same as the contaminated equipments and shared the same group as the carriers.

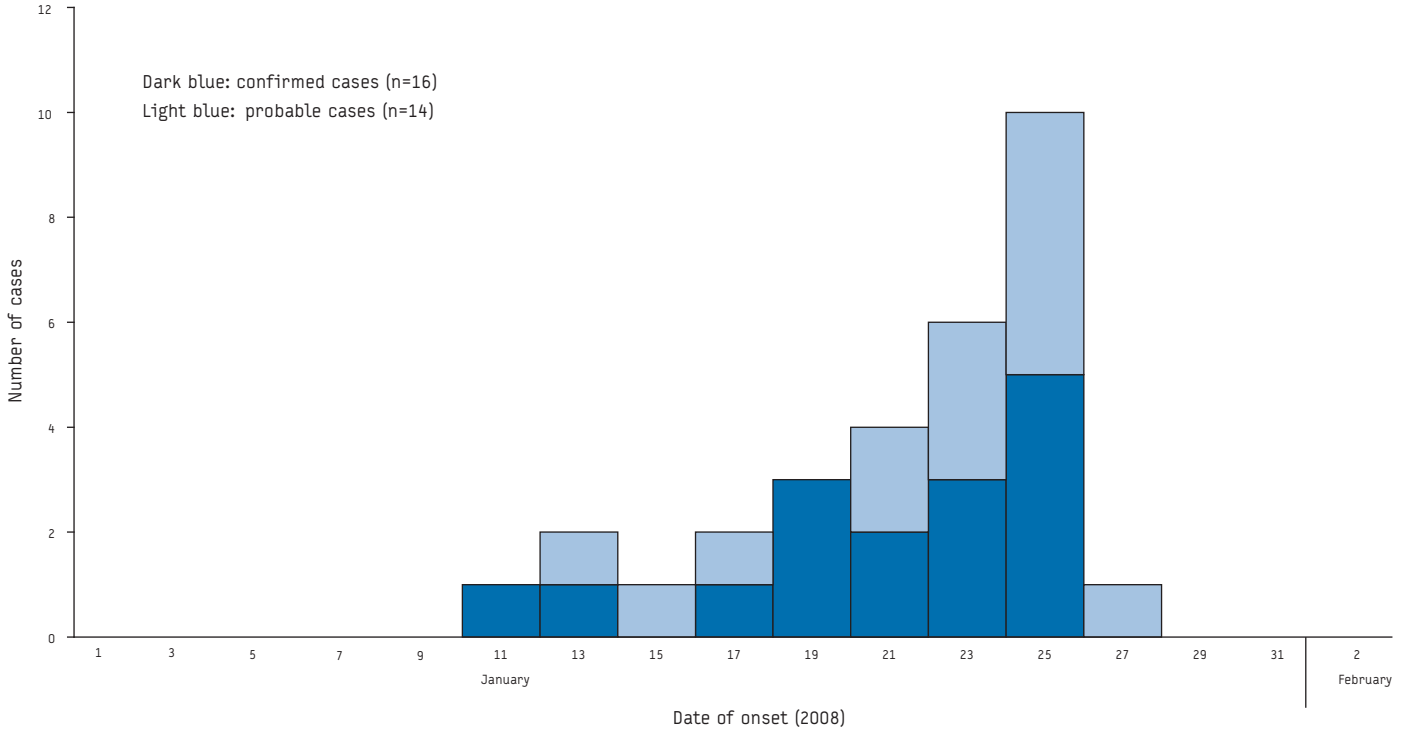
Analytic results

In the case-control study, neonates exposed to nurses' aid A4, who was a nasal carrier of *S. aureus*, had the highest risk of illness [crude OR: 12.1 (95% CI: 2.0 – 122.0), p=0.001]. In the analytic study, 36 potential exposures were tested for association; among these, only five variables as displayed in Table 2 had p value less than 0.05.Univariate analysis (Table 2) also indicated an association between illness and four other variables: staying in ward A [crude OR: 11.3 (95% CI: 1.3 – 512.2), p=0.011], exposure to non-carrier student nurse S2 [crude OR: 7.0 (95% CI: 1.5 - 36.6), p=0.004], sharing ward with the symptomatic case during hospitalisation [crude OR: 5.4 (95% CI: 0.9 - 54.9), p=0.034] and exposure to non-carrier student nurse S4 [crude OR: 4.6 (95% CI: 1.1 - 20.5), p=0.018].

In the multiple logistic regression model shown in Table 3, we found that both exposure to nurses' aid A4 and sharing ward with a symptomatic case remained significantly associated with illness

Figure

Epidemic curve of staphylococcal bullous impetigo cases by date of onset in a district hospital, Nan Province, Thailand, January 2008 (n=30)



in our model with adjusted OR equal to 80.3 [(95% CI: 4.8 – 1350.3), p=0.002] and 35.6 [(95% CI: 1.9 – 654.7), p=0.016] respectively.

Control action and outbreak response

After confirmation of the outbreak, the following measures were taken:

- Cases were treated and isolated in ward B;
- Delivery room and ward A were closed between 26-27 January 2008 for cleaning and disinfection;
- Medical devices such as the radiant warmer and newborn weight scale were cleaned with detergent and disinfected with 70% alcohol;
- HCWs carriers of *S. aureus* were treated with the topical antibiotic Muropicin, and required to abstain from nursing until nasal swabs were negative, i.e. seven days;
- Adherence to infection control measures was enforced such as hand hygiene, wearing masks and hair caps during routine nursing care;
- Alcohol hand rub was provided at each bed in postpartum wards.

Furthermore, we also recommended strengthening the hospital infection surveillance system with competency building for ward nurses to detect outbreaks and early report them to the hospital infection control practitioners.

On the last day of our investigation we joined the hospital meeting, presented the investigation results and discussed the infection control breaches such as insufficient hand hygiene and personal protective equipment. This meeting led to cleaning of the delivery room on a daily basis and cleaning neonatal care equipments after every use with detergent and 70% alcohol. Moreover, the chief ward nurse decided to implement new strategies such as limiting the number of visitors permitted to stay in the postpartum wards. Surveillance of newborns' skin infection was included in the infection control policy.

Discussion and conclusion

This outbreak of staphylococcal skin infections in newborns was detected late because most of the cases developed symptoms only after discharge. We implicated the environmental equipment as possible source of infection because it had the same phage type as the one from a case. Contact with a HCW who was a staphylococcal carrier was an important risk factor in our study, as has been seen in previous studies (7,14,15). With our limited resources it was impossible to determine if, and if so, which HCW could have been the source of the outbreak, although two of them were suspected. The high attack rate may be due to the circumstance that all newborns were exposed to the same equipment, such as the radiant warmer, weight scale and baby crib.

In a review by Williams [4] nose was the most frequent body site yielding staphylococci (40 to 44%) and the carrier rate among nurses in hospital ranged between 21 to 70%. Our study suggested a low prevalence (9%) of carrier status. However, our carrier rate may be underestimated because of a different technique of specimen collection and the limited laboratory capacity in a Thai district hospital.

Our investigation demonstrates that deficient infection control procedures may lead to outbreaks of staphylococcal infections among newborns. However, implementation of recommended infection control methods, such as proper hand washing and thorough cleaning of equipment, can quickly control an epidemic outbreak as demonstrated in this case and other similar cases [14,15]. The insufficient budget allocation for infection control is however a major problem in Thai medical system.

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