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Concise Communication

Effectiveness of umbilical culture for surveillance of methicillin-resistant *Staphylococcus aureus* among neonates admitted to neonatal intensive care units

Toshinori Nakashima MD[1], Hirosuke Inoue MD, PhD[2], Yoshihiro Sakemi MD[1] and Hironori Yamashita MD, PhD[1]

[1]Department of Pediatrics, National Hospital Organization Kokura Medical Center, Fukuoka, Japan and [2]Department of Pediatrics, Graduate School of Medical Sciences, Kyushu University, Fukuoka, Japan

Abstract

To compare the culture sensitivities of MRSA detection, we collected 988 paired umbilical and nasal cultures from screened neonates. MRSA positivity rates were 79.1% from umbilicus and 41.9% from nares ($P = .01$). The umbilicus was a more useful culture site than the nares for surveillance of MRSA among neonates upon admission.

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Methicillin-resistant *Staphylococcus aureus* (MRSA) plays a significant role in healthcare-associated transmission,[1] and patient colonization with MRSA increases the risk of infections in neonatal intensive care units (NICUs).[2] Most hospitalized neonates are premature, have low birth weight, and require invasive medical devices; therefore, performing active surveillance cultures and placing MRSA-colonized neonates under contact precautions is essential to preventing transmission and outbreaks in the NICU.

Some variability exists between culture sites, including the nares, umbilicus, rectum, axilla, groin, and oropharynx. Although nasal culture is used most often for surveillance,[3] the efficacy of extranasal sites for MRSA detection remains unknown. In the current study, umbilical and nasal cultures were collected for the surveillance of MRSA upon NICU admission. The sensitivities of those cultures were compared.

Methods

Inclusion and exclusion criteria of study population

This study included neonates who were admitted to the Kokura Medical Center level 3 NICU in Fukuoka, Japan, within 14 days of life from January 2010 to June 2015. Neonates admitted after the first 14 days of life, or those whose umbilical or nasal cultures were not obtained upon admission, were excluded.

MRSA surveillance

Nare culture samples were collected from the nasal vestibule (Fig. 1A), and umbilical culture samples were collected from the umbilical stump during the first 2 days of life (Fig. 1B). The umbilical cord dries out at ~48 hours after birth, so the stump and base around the umbilicus were collected after the first 2 days of life (Fig. 1C). The samples were collected and incubated at 36°C for 18–20 hours. After colonies were subcultured, direct rapid identification and antimicrobial susceptibility testing were performed using the VITEK 2 system (BioMerieux, Craponne, France). MRSA was detected by the automated system (VITEK 2) using a cefoxitin screen and confirmed with the select agar (Eiken Chemical, Tokyo, Japan).

Statistical analyses

Differences in the positivity rate were estimated using the McNemar test. Because there were no false-positive results in the bacterial culture, the sensitivity and the negative predictive value (NPV) were calculated using specificity and positive predictive values of 100%. Results with a 2-sided P value <.05 were considered significant. We used the software program EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan). This study was approved by the internal review board of Kokura Medical Center. Written informed consent was obtained from the parents or guardians of the neonates.

Results

In total, 2,090 neonates were admitted to the NICU during the study period. We excluded 1,050 neonates whose cultures were not taken from either the umbilicus or the nare and 52 neonates who were admitted after the first 14 days of life. Paired nasal and umbilical cultures were collected from the remaining 988 neonates. The neonates were born at a median gestational age of 37.4 weeks (interquartile range [IQR], 35.9–39.3) and had a median birth weight of 2,608 grams (IQR, 2,182–3,038). Fewer than half (44.8%) were outborn, and the median age on admission was 2 days (IQR, 2–4). The rate of vaginal delivery was 60.5%. Of the study neonates, 43 (4.4%) were colonized with MRSA, but none were infected.

Author for correspondence: Toshinori Nakashima, E-mail: nakashima.toshinori.jq@mail.hosp.go.jp

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Table 1. Sensitivity and Negative Predictive Value of Umbilical and Nasal Culture for MRSA

	No. of Positive/No. of Colonized Neonates	*P* Value[a]	Sensitivity, % (95% CI)	Negative Predictive Value, % (95% CI)
All colonized neonates (n=988)				
Umbilicus	34/43	.01	79.1 (64.0–90.0)	99.1 (98.2–99.6)
Nares	18/43		41.9 (27.0–57.9)	97.4 (96.2–98.3)
Neonates admitted during the first 2 days of life (n=739)				
Umbilicus	3/6	1.0	50.0 (11.8–88.2)	99.6 (98.8–99.9)
Nares	3/6		50.0 (11.8–88.2)	99.6 (98.8–99.9)
Neonates admitted after the first 2 days of life (n=249)				
Umbilicus	31/37	<.01	83.8 (68.0–93.8)	97.2 (94.1–99.0)
Nares	15/37		40.5 (24.8–57.9)	90.6 (86.1–94.0)
Colonized inborn neonates (n=545)				
Umbilicus	17/20	.10	85.0 (62.1–96.8)	99.4 (98.3–99.9)
Nares	10/20		50.0 (27.2–72.8)	98.1 (96.6–99.1)
Colonized outborn neonates (n=443)				
Umbilicus	17/23	.08	73.9 (51.6–89.8)	98.6 (97.0–99.5)
Nares	8/23		34.8 (16.4–57.3)	96.6 (94.4–98.1)

[a]McNemar χ^2 test.Note. CI, confidence interval.

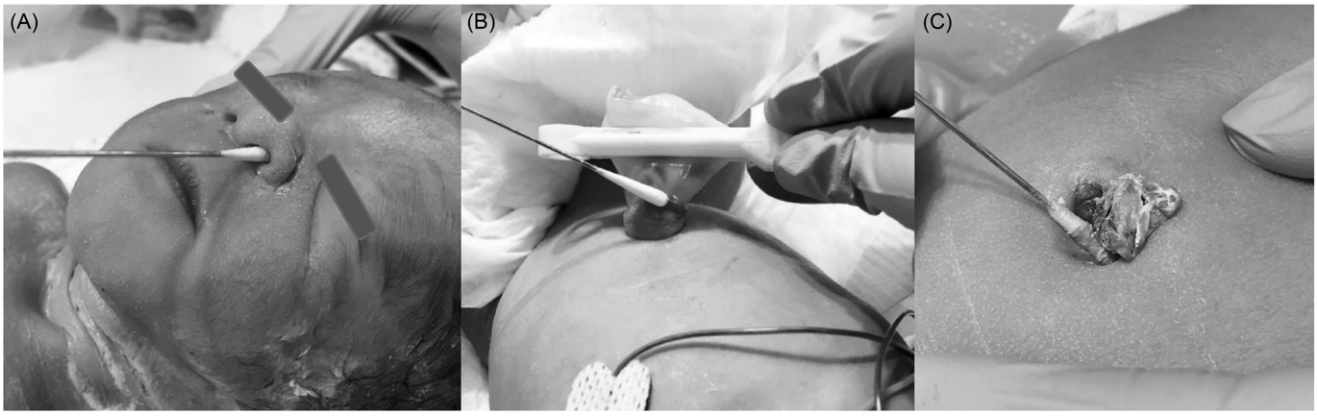

Fig. 1. Collection from sample sites for surveillance of methicillin-resistant *Staphylococcus aureus* at admission. (A) nares at day 0, (B) umbilicus at day 0, (C) umbilicus at day 3.

Of the 43 colonized neonates, 34 (79.1%; 95% confidence interval [CI], 64.0%–90.0%) had MRSA-positive umbilical swabs and 18 (41.9%; 95% CI, 27.0%–57.9%) had positive nasal swabs. Differences in the frequency of MRSA detection were statistically significant ($P = .01$). The NPVs were 99.1% (IQR, 98.2%–99.6%) at the umbilicus and 97.4% (IQR, 96.2%–98.3%) at the nares (Table 1). Different collection methods were used to obtain umbilical cultures during and after the first 2 days of life; therefore, the sensitivities and NPVs of neonates admitted were obtained at both time points. The results were similar during the first 2 days of life but differed significantly after the first 2 days of life. Of 37 colonized neonates, 31 (83.8%; 95% CI, 68.0%–93.8%) had a positive umbilical swab and 15 (40.5%; 95% CI, 24.8%–57.9%) had a positive nasal swab ($P < .01$). When the infants were divided into inborn and outborn groups, the umbilical culture had a higher positive rate than the nasal culture in both groups. However, the difference did not reach statistical significance.

Discussion

The umbilicus is a common reservoir for *S. aureus*,[4] which first colonizes the umbilical stump and then spreads to the other sites in the body.[5] However, no prior studies have compared the efficacy of umbilical and nasal cultures at the time of NICU admission. This study assessed the usefulness of screening neonate umbilical cultures for MRSA upon admission to the NICU. The sensitivity for MRSA detection was higher for umbilical cultures than for nasal cultures.

Previous consensus statements for the management of MRSA outbreaks in NICUs have recommended using only nares or

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nasopharyngeal cultures for MRSA detection.[6] Although different institutions have obtained MRSA surveillance cultures from a range of body sites, the nasal culture is the most frequently used.[3,7] There is no general consensus about the most cost-effective and optimal culture sites for MRSA surveillance among neonates. Because the sampling tools and culture methods for umbilical and nasal cultures are the same, if one sampling site is selected as the MRSA screening at the time of NICU admission, the umbilicus may be a better choice than the nare from a cost-effectiveness perspective.

Few studies have assessed effective culture sites for MRSA screening at the time of NICU admission, and none have included umbilical culture, to the best of our knowledge. Although the detection rate of MRSA at the time of admission is dependent on its prevalence in the geographic area and the sampling methods, it may be possible to detect additional MRSA carriers using umbilical culture.

The present study indicated that umbilical culture was more sensitive especially after the first 2 days of life. A wet pocket-like structure between the base of the umbilicus and the surrounding skin appears shortly after the first 2 days of life (Fig. 1C), which may be suitable for bacterial propagation including MRSA.

It has been reported that MRSA is frequently detected in neonatal umbilical omphalitis.[8] Furthermore, MRSA screening by nasal culture has been reported to be helpful as an antimicrobial stewardship tool with a high NPV to avoid the administration of empiric anti-MRSA drugs.[9,10] In this study, we detected no MRSA infections on admission or subsequent infections in the carriers. However, the umbilical culture showed higher sensitivity and NPV than the nasal culture, suggesting that the umbilical culture might be more beneficial than the nasal culture for identifying MRSA infection and avoiding the use of empiric anti-MRSA drugs in the early postnatal period if the prevalence of MRSA is low.

This study had several limitations. First, it was performed with patients from a single institution, and the sensitivity of umbilical culture may differ between epidemic situations and environments. Second, almost half of the admitted neonates were excluded because data on umbilical and/or nasal culture was lacking.

In conclusion, umbilical culture detected MRSA at the time of NICU admission at a higher rate than nasal culture, and it would be helpful for identifying carriers and preventing horizontal transmission. Further studies are needed to determine whether MRSA screening by umbilical culture is beneficial not only to prevent the spread of MRSA colonization but also as a tool for antimicrobial stewardship.

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