Bacterial Colonization of Toys in Neonatal Intensive Care Cots

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ABSTRACT. *Objectives.* **To investigate the bacteria and fungi contaminating toys in neonatal intensive care unit (NICU) cots, the colonization rates, and factors that influence them.**

Methods. **A cross-sectional, longitudinal bacteriologic survey of all toys in the cots of infants in an NICU. All the toys in an infant's cot were cultured weekly for 4 weeks. Data were collected on the infant's postnatal age, the type of cot, whether humidity was added, characteristics of the toy, and any infant infections.**

Results. **Over the 4-week period, there were 86 cultures from 34 toys of 19 infants. Bacteria were grown from 84/86 (98%): 84 of the cultures grew coagulase-negative *Staphylococcus*, 50 *Micrococcus* sp, 21 *Bacillus* sp, 13 methicillin-resistant *Staphylococcus aureus*, 12 diphtheroids, 4 group B streptococcus, 3 *S aureus*, 3 nonhemolytic streptococci, 3 group D streptococci, 4 α-hemolytic streptococci, and 2 coliforms. None grew fungi. The colonization rate did not differ with cot type, presence of humidity, size of the toy, toy fiber length, or the fluffiness score. Eight (42%) of the infants had positive blood culture results and 5/8 of the isolates (63%) were of the same type as that colonizing their corresponding toy.**

Implications. **With time, all the toys in NICU cots became colonized with bacteria. Many were potentially pathogenic. Toys may be reservoirs for potential infantile nosocomial sepsis. *Pediatrics* 2000;106(2). URL: http://www.pediatrics.org/cgi/content/full/106/2/e18; *infant, newborn, toys, infection, neonatal intensive care.***

ABBREVIATION. NICU, neonatal intensive care unit.

Toys are commonly put in the incubators of ill neonates because it is considered by parents and staff to make the harsh neonatal environment friendlier.[1] A literature search revealed nearly no evidence to support or refute this practice.

It is well-recognized that nosocomial sepsis of infants in intensive care units can originate from equipment[2,3] and particularly via the hands of staff or parents.[4] The concern with toys in intensive care cots is that they may be a reservoir of potentially pathogenic bacteria.

Toys have been implicated to cause outbreaks of infection in children. In 1972, it was stated that teddy bears could act as transitory mechanical vectors of human pathogens.[5] In 1998, Buttery et al[6] described infection of high-risk children in hospital with a multidrug-resistant *Pseudomonas aeruginosa* from water containing bath toys. Hughes et al[7] described a prospective study of 39 sterilized teddy bears. The bears all became colonized with bacteria, fungi, or both within 1 week of being given to children in the hospital. From our literature searches, there seems to be only 1 other limited report of bacterial colonization of toys in neonatal intensive care cots.[1]

The aims of this study were to determine whether toys placed in intensive care cots carry bacteria or fungi, how many of the toys were colonized, and whether the rate of acquisition changes with time. Secondary aims were to determine whether there was any relationship between the incidence of colonization and the type of toy, and the nature of the incubator or its humidity level.

METHODS

In the 20-bed, level 3, neonatal intensive care unit (NICU) at the Royal Women's Hospital, in Melbourne, all the toys of all infants were swabbed and cultured weekly for 4 weeks. Each toy was removed from the incubator using a sterile glove. The entire surface was then swabbed with a cotton-tipped bacteriologic swab moistened with sterile saline. This was immediately plated onto 5% horse blood agar and Sabouraud's medium and incubated at 36°C to 37°C for 24 to 48 hours. Bacteria and fungi were identified by conventional methodology.[8]

Not all infants had their toys swabbed on all 4 occasions, because some infants were discharged and others admitted during this study. Some infants were cared for in incubators and others under radiant heaters. Data collected included the gestational age, birth weight, and postnatal age of each infant; the type of cot; whether the infant's environment was humidified; and any positive microbiologic isolates during periods of clinical sepsis from the infants during their stay in the NICU.

Data were collected on the physical characteristics of each toy at the time it was first swabbed. The material it was made of, the length of any external fibers, and a fluffiness score was allotted on the scale: 0 = plastic, 1 = material but not fluffy, 2 = minimal fluffiness, 3 = moderate fluffiness, and 4 = very fluffy.

RESULTS

Nineteen infants were studied and 86 cultures were taken from their 34 toys. The gestation, birth weight, numbers of infants studied each week, and their postnatal ages at the time of each swab are shown in Table 1.

Overall, 84 of the cultures (98%) grew bacteria. Often >1 organism was grown from each swab of a toy. The number and proportions of different bacteria grown from the toys are shown in Table 2. The 2

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TABLE 1. Gestational Age and Birth Weight of Infants and Postnatal Ages at the Time of the Four Weekly Swabs

	No.	Mean (Standard Deviation)	Range
Gestational age at birth (wk)	19	28.2 (4.0)	23.0–41.0
Birth weight (g)	19	1114 (534)	480–2710
	No.	Median (IQR)	Range
Week 1 swabs—postnatal d	12	19 (10–33)	2–58
Week 2 swabs—postnatal d	16	20 (8–29)	1–65
Week 3 swabs—postnatal d	18	23 (10–34)	1–72
Week 4 swabs—postnatal d	19	29 (16–41)	4–79

IQR indicates interquartile range.

TABLE 2. Organisms Grown From Toys

Bacteria	Number (Percent of the Cultures)
Coagulase-negative staphylococci	84 (98%)
Micrococcus species	50 (58%)
Bacillus species	21 (24%)
Methicillin-resistant *Staphylococcus aureus*	13 (15%)
Diphtheroids	12 (14%)
Group B streptococcus	4 (5%)
S aureus (methicillin-susceptible)	3 (4%)
Nonhemolytic streptococcus	3 (4%)
Group D streptococcus	3 (4%)
α-hemolytic streptococcus	4 (4%)
Coliforms	2 (2%)
Fungi	0 (0%)

toys with negative cultures eventually grew bacteria in subsequent weeks of the study. There were no culture results positive for fungi.

Table 3 shows the data for each infant, their postnatal age at the time of the first culture from the toys, the number of their toys, the fluffiness score of each toy, and the bacteria cultured from the toys at each weekly swab. The final column shows any positive bacterial cultures collected during periods of potential sepsis from the infants.

Sixteen toys (19%) were in open radiant warmer cots. Five toys (6%) were in humidified incubators. Thirty-one of 34 of the toys (92%) were synthetic. Because 98% of cultures from toys grew bacteria, colonization rates could not be compared for any of the factors investigated (the type of incubator, humidity of the incubator, fabric of the toy, or the fluffiness score).

During the study, 8 of the infants (42%) had positive blood cultures and 5/8 (63%) had the same species of organism as that on the toy, although no specific bacterial DNA fingerprinting of the isolates was performed.

DISCUSSION

This study has shown that 98% of cultures from toys in infant's cots in an NICU are contaminated with bacteria. All toys cultured coagulase-negative staphylococcus at some stage, and in addition, 44% grew bacteria that can be potentially pathogenic even to healthy infants.

Infection is 1 of the major problems in NICUs. It occurs in 7% of all infants admitted to NICUs, and between 22% and 30% of infants weighing <1000 g.[9,10] Coagulase-negative staphylococcus is the major cause of blood culture-positive infections in NICUs.[9] Up to 68% of episodes of late-onset nosocomial sepsis in Australian neonatal units are caused by such *Staphylococci*.[10]

The bacterial impact and safety of placing toys in neonatal intensive care cots has not been studied. Only 1 report has studied the bacterial colonization of toys in cots in an NICU.[1] They cultured 12 toys from 12 infants and found that the predominant organism was coagulase-negative staphylococcus. They did not report the proportion of the toys colonized or of any associated sepsis of infants.

The concern about colonization of toys in NICU cots is that they may act as a reservoir of organisms that may cause serious infection. The toys stay in the cot for many weeks and may be the only items in an infant's immediate environment that are not disinfected or washed regularly. The nurses, doctors, and parents may diligently wash their hands to prevent the spread of infection to the infants and then inadvertently handle a contaminated toy before handling the infant or before an invasive procedure. This may then lead to colonization with subsequent infection of the infant. Furthermore, potential pathogens could be transmitted via the hands of health care workers to other infants in the unit.

In this study, the infant's cot and bedding was not cultured and so it is not possible to comment on whether they were contaminated with the same organisms as the toys. However, all these items undergo regular cleaning and are, therefore, much less likely to be a source of infection than are the toys.

Forty-two percent of the infants had positive blood cultures, and 63% of these isolates were the same species of organism as that on the toy. The bacteria grown from the infants or toys were not DNA fingerprinted for clonality, and it cannot be assumed that the toy was the source of the bacteria causing the infection. It is possible that the source of infant's infection also contaminated the toys.

Coagulase-negative staphylococcus is a major skin commensal that colonizes infants soon after birth. Therefore, it is likely that the coagulase-negative staphylococcus on the toys reflected the infant's own bacterial flora.

The bacteria were not classified as pathogens or nonpathogens because very premature infants can be infected by organisms that are not pathogenic to older children and adults. The potentially more pathogenic organisms such as methicillin-resistant staphylococcus, *Staphylococcus aureus*, α-hemolytic streptococcus, group B streptococcus, and group D streptococcus are a cause for concern in the neonatal environment.

Because of the small number of toy cultures with no growth, we could not demonstrate: any consistent pattern of bacterial colonization of toys over time during the course of the study; any difference in colonization rates with postnatal age (a surrogate measure of how long the toy had been in the cot); or

TABLE 3. Details for Each Infant

Infant	Infant's Age (Days) at First Culture	Toy Fluffiness Score	Toy Cultures on Week 1	Toy Cultures on Week 2	Toy Cultures on Week 3	Toy Cultures on Week 4	Bacteria Cultured From the Infant During Cultures for Possible Infections
1	4	1	CNS				None
		4	CNS				
2	15	2	CNS and α-hemolytic streptococcus	No growth	CNS		ETT: CNS
3	2	1	CNS and *Bacillus*	CNS			None
4	29	1	CNS, *Bacillus*, and GBS	CNS and MRSA	CNS, MRSA, *Micrococcus*, and GDS	CNS and *Micrococcus*	ETT: *Pseudomonas* sp and *Ureaplasma urealyticum* Blood: GDS Pustule: MRSA; ICC: CNS
5	46	1	CNS	CNS and diphtheroids	CNS, MRSA, *Micrococcus*, and diphtheroids		ETT: *Salmonella*, CNS, MRSA, group A streptococcus
		4	CNS	CNS, GBS, and diphtheroids	CNS, *Bacillus*, and *Micrococcus*	CNS, MRSA, *Micrococcus*, and diphtheroids	Blood culture and urine: *Candida albicans* OPA: *Escherichia coli* and GBS NPA and umbilicus: MRSA Eye: group A streptococcus
6	8	1	CNS and *Staphylococcus aureus*	CNS and *Streptococcus viridans*	CNS and *Micrococcus*	CNS, *Micrococcus*, and coliform	Eye: CNS
		3	CNS and *S aureus*	CNS and *Micrococcus*	CNS	CNS, *Micrococcus*, and diphtheroids	
		1	CNS and *Micrococcus*				
7	17	4	CNS, *Bacillus*, and *S aureus*	CNS, *Bacillus*, and *Micrococcus*	CNS, *Bacillus*, and *Micrococcus*	CNS and *Bacillus*	Blood: CNS
8	20	1	CNS	CNS, MRSA, and *Micrococcus*	CNS, MRSA, *Bacillus*, and *Micrococcus*	CNS, MRSA, *Bacillus*, and *Micrococcus*	None
9	46	4	CNS and *Micrococcus*	CNS and *Bacillus*			ETT: *Acinobacter* sp
		4	CNS	CNS	CNS and *Micrococcus*	CNS, MRSA, and *Micrococcus*	Blood: CNS
		1	CNS and *Bacillus*	CNS	CNS, *Micrococcus*, diphtheroids, and Nonhemolytic streptococcus	CNS	UVC: *S aureus*
10	20	1	CNS and *Micrococcus*	CNS and *Micrococcus*	CNS, MRSA, *Bacillus*, and *Micrococcus*	CNS	None
11	10	1	CNS and *Micrococcus*	CNS and *Micrococcus*	No growth	CNS and *Micrococcus*	ETT: *Pseudomonas* sp
		1	*Micrococcus*				Blood: GBS and *E coli*
		3		CNS, *Bacillus, and Micrococcus*	CNS and *Micrococcus*	CNS	UVC: CNS
		4				CNS and *Micrococcus*	
12	58	3	CNS, hemolytic streptococcus, and *Streptococcus viridans*	CNS, *Micrococcus*, and diphtheroids	CNS, *Micrococcus*, and GDS		ETT: *Klebsiella* sp

TABLE 3. Continued

Infant	Infant's Age (Days) at First Culture	Toy Fluffiness Score	Toy Cultures on Week 1	Toy Cultures on Week 2	Toy Cultures on Week 3	Toy Cultures on Week 4	Bacteria Cultured From the Infant During Cultures for Possible Infections
		1		CNS, GBS and MRSA	CNS, *Bacillus*, *Micrococcus*, and GDS	CNS, MRSA, *Micrococcus*, and GBS	
		1		CNS, *E coli*, and nonhemolytic streptococcus			
13	2*	1		CNS	CNS and *Micrococcus*	CNS, *Bacillus*, *Micrococcus*, diphtheroids	Blood: CNS
		2		CNS	CNS and *Micrococcus*	CNS and *Micrococcus*	
		1				CNS and *Streptococcus viridians*	
14	2*	1		CNS and *Micrococcus*	CNS and *Micrococcus*	CNS and *Micrococcus*	ETT: CNS
		1		CNS and *Micrococcus*	CNS and *Micrococcus*	CNS and *Micrococcus*	ICC: CNS
		1				CNS and *Bacillus*	
15	4*	4		CNS, *Bacillus*, and *Micrococcus*			None
16	3†	3			CNS, *Bacillus*, *Micrococcus*, and Diphtheroids	CNS and *Micrococcus*	None
17	1†	3			CNS, MRSA, *Bacillus*, and *Micrococcus*	CNS, MRSA, *Micrococcus*, and diphtheroids	
18	1†	1				CNS and *Bacillus*	Blood: CNS; UVC; CNS
19	4‡	1				CNS, *Bacillus*, and *Micrococcus*	Blood: *Streptococcus viridans*

CNS indicates coagulase-negative staphylococcus; MRSA, methicillin-resistant *S aureus;* GBS, group B streptococcus; GDS, group D streptococcus; blood, blood culture; ETA, endotracheal tube aspirate culture; ICC, intercostal catheter (pleural cavity) aspirate; UVC, umbilical vein catheter; NPA, nasopharyngeal aspirate.

Included are: the age in days when the infant's toys were first swabbed, the fluffiness score of each toy, the type of bacteria cultured from each toy by study week, and the infant's infections. (Blank spaces indicate that the infant or the toy was not in the NICU at that time.)

Flufiness score: 0 = plastic, 1 = material but not fluffy, 2 = minimal fluffiness; 3 = moderate fluffiness, and 4 = very fluffy.

* Infant or toys not in the NICU until the second week.

† Infant or toys not in the NICU until the third week.

‡ Infant or toys not in the NICU until the fourth week.

any toy or environmental characteristic. This may be attributable to type 2 (β) error.

None of the toy cultures grew fungi. The low numbers of infants nursed in humidity during this study may have reduced the likelihood of fungal growth.

CONCLUSION

This study has demonstrated that nearly all the toys placed in neonatal intensive care incubators/cots carry the bacteria that most commonly cause infection in preterm infants. There is no direct evidence that the bacteria on the toys caused infection. However, it must be of concern that all the toys were contaminated with bacteria that might infect the immunodeficient neonate. The infant's toys form part of their immediate environment and are a potential source of cross-infection from the hands of health care workers and family members.

To prove that toys were a reservoir of potentially pathogenic organisms an extensive study would be needed to examine the timing of colonization of toys and infants, modes of transmission, sepsis outcome, and DNA fingerprinting of colonizing and infecting strains of isolates of toys and infants, respectively, in a population of neonates nursed with toys in and toys out of cots, in a matched population. Most parents and staff like to see toys in infants' cots to humanize the harsh environment of the NICU. Therefore, it would be inappropriate to remove toys from an infant's cot if it were unnecessary. Possible further investigations would include examining the effect of cleaning/decontaminating toys on bacterial colonization, or a randomized, controlled trial to determine whether removing toys from incubators is associated with a reduced incidence of infection in the infants.

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