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Major Article

Cross-contamination of bacteria-colonized pierced earring holes and fingers in nurses is a potential source of health care-associated infections

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Background: In recent years, the wearing of pierced earrings for personal adornment has increased among health care workers in Japan. However, the transmission dynamics between bacteria in pierced earring holes and fingers has not been clearly shown.
Methods: Earlobes and fingers of 200 nurses (128 nurses with pierced earlobes and 72 nurses with unpierced earlobes) working at a university hospital were sampled to determine whether cross-transmission of bacteria-colonized pierced earring holes and fingers in nurse is possible.
Results: Of 128 nurses who had pierced earring holes, *Staphylococcus aureus* was recovered from earlobes of 24 nurses (18.8%) compared with 7 of 72 nurses without pierced earring holes (9.7%) ($P = .09$). Of those 15 nurses yielding *S aureus* from both earlobes and fingers, 12 were from nurses who had pierced earring holes compared with 3 nurses without pierced earring holes. Excluding 1 nurse, antimicrobial susceptibility patterns and genotypes of *S aureus* from both earlobe and fingers of each nurse were identical.
Conclusion: Pierced earlobes can be a source of health care-associated infection via cross-transmission of bacteria from earlobe holes to fingers.

Although there have been reports of serious auricular infections caused by *Staphylococcus aureus* and *Pseudomonas aeruginosa* from infected pierced earlobes,[1-3] there are many routine minor inflammatory conditions involving the pierced ear that do not require a visit to a medical facility. In the presence of pruritus or pain in the pierced earlobe site, unintentional contact of the infected earlobe with the fingers can often occur. When health care workers do not wash their hands, transmission to patients can occur from contaminated fingers.

During recent years, the wearing of pierced earrings for personal adornment has increased among health care workers in Japan. However, the transmission dynamics between bacteria in pierced earring holes and fingers has not been clearly shown. This was a bacteriologic study characterizing bacteria recovered from pierced earring holes and fingers of nurses to determine whether cross-transmission from either site is possible.

METHODS

Subject sampling protocol and bacteriologic analysis

During the period October 2013-January 2014, earlobes of 200 nurses working at a university-affiliated hospital were sampled using a sterile cotton swab. Informed consent for participation in the study was obtained after verbal and written explanation of the objectives of the study. The 200 nurses sampled in the study reflected all 12 wards of the hospital with 6-27 nurses per ward. Sampling was not focused on any particular ward or wards.

For the 128 nurses (64.0%) who had pierced earring holes, the earlobe located on the same side as the dominant hand was sampled. For the 72 nurses (36.0%) without a pierced earring hole, the earlobe

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on the dominant hand was also sampled. Swab samples were plated onto CHROMagar Orientation (Becton Dickinson, Tokyo, Japan). In addition, the fingers on the dominant hand of the 200 nurses were also pressed lightly on the surface of CHROMagar Orientation. Inoculated media were incubated at 35°C for 18-24 hours. Colonies exhibiting typical colony appearances were identified using BD Phoenix (Becton Dickinson, Tokyo, Japan).

Antimicrobial susceptibility testing

Susceptibility to antimicrobial agents was determined using the agar dilution and disk diffusion methods according to Clinical and Laboratory Standards Institute M7-A9[4] and M2-A11,[5] respectively. A multiplex polymerase chain reaction assay was used for detection of the Panton-Valentine leukocidin gene and SCC*mec* typing of methicillin-resistant *S aureus* (MRSA).[6]

Pulsed-field gel electrophoresis

Isolates were analyzed for clonality by pulsed-field gel electrophoresis (PFGE). Total genomic DNA was isolated in an agarose-embedded form and subjected to enzymatic digestion as described previously.[7,8] Chromosomal DNA restriction patterns produced by PFGE were analyzed according to the Tenover criteria.[8]

RESULTS

Of 128 nurses who had pierced earring holes, *S aureus* was recovered from earlobes of 24 nurses (18.8%) compared with 7 of the 72 nurses without pierced earring holes (9.7%) ($P = .09$). Of those 15 nurses yielding *S aureus* from both earlobes and fingers, 12 were from nurses who had pierced earring holes compared with 3 nurses without pierced earring holes. Of 128 nurses with pierced earring holes, MRSA was recovered from earlobes and fingers of 6 (4.7%) and 5 (3.9%), respectively. Of 72 nurses with nonpierced earring lobes, MRSA was recovered from earlobes and fingers of 2 (2.8%) and 1 (1.4%), respectively. Three MRSA isolates were recovered from both the earlobe and fingers of nurses with pierced earring holes, whereas 1 MRSA sample was isolated from the earlobe and fingers of a nurse without a pierced earring hole (Table 1).

There was 1 nurse in which *Enterococcus faecalis* was isolated from both the earring hole and fingers. No vancomycin-resistant *Enterococcus* sp was isolated. Of the gram-negative isolates, *Morganella morganii* was isolated from the pierced earring hole of 1 nurse. Both *P aeruginosa* and *Acinetobacter* species were recovered from the fingers of 6 nurses, although there were no nurses positive for these organisms in both earlobe and fingers. No multidrug-resistant *P aeruginosa* and *Acinetobacter* sp were isolated (Table 2).

Table 3 displays antimicrobial susceptibilities and PFGE types of the *S aureus* isolates recovered from both fingers and earlobes of 15 nurses (both pierced earlobe nurses and unpierced earlobe nurses). Excluding nurse number 127, antimicrobial susceptibility patterns did not differ and PFGE types of *S aureus* of each nurse were identical. Of MRSA isolates recovered from 4 nurses, excluding nurse number 111, the 3 MRSA samples detected in both the fingers and pierced earlobe of nurses were Panton-Valentine leukocidin gene expressing and the same SCC*mec* type. In nurse number 111, 2 MRSA strains with different antimicrobial susceptibility patterns and SCC*mec* type were detected from the fingers. Of these 2 MRSA strains, 1 MRSA sample exhibited the same SCC*mec* and PFGE type as the MRSA sample from the earlobe of the nurse.

Table 1
Earlobe and finger cultures yielding *Staphylococcus aureus* (methicillin-sensitive *S aureus* and methicillin-resistant *S aureus*)

Earlobe cultures for *S aureus*	Finger cultures for *S aureus*		Total n (%)
	Positive	Negative	
Pierced earring holes (n = 128)			
Positive	12 (3)	12 (3)	24 (18.8)
Negative	10 (2)	94	104
Earlobes without earring holes (n = 72)			
Positive	3 (1)	4 (1)	7 (9.7)
Negative	6 (0)	59	65

NOTE. Number in parentheses represents samples positive for methicillin-resistant *Staphylococcus aureus.* Values are n (MRSA) or as otherwise indicated.

Table 2
Culture results of earlobes and fingers yielding bacteria other than *Staphylococcus aureus*

Population	*Enterococcus*		Gram-negative bacteria	
	Earlobes	Fingers	Earlobes	Fingers
Nurses with pierced earring holes (n = 128)	3*	8*	1†	3‡
Nurses without pierced earring holes (n = 72)	1	6	0	3§

**Enterococcus faecalis* was recovered from the earlobe and fingers.
†*Morganella morganii* was recovered from the pierced earring hole.
‡*Acinetobacter* was recovered from the fingers.
§*Pseudomonas aeruginosa* was recovered from 1 nurse, and *Acinetobacter* was recovered from 2 nurses.

DISCUSSION

Over the past 20-30 years, the influence of ear ornament fashion trends abroad has led to earrings in Japan changing from earrings fastened with a clip to pierced earrings, especially among young women. At the present time, irrespective of age or sex, the wearing of pierced earrings has grown in popularity. Of the nurses in this study, 64% had pierced earring holes. It is expected that this trend will increase among nurses as well as others in the health care field.

A high rate of *S aureus* from pierced earring holes was isolated in this study. This included MRSA, which is the most epidemiologically important antibiotic-resistant bacteria associated with health care-associated infections (HAIs). Unlike *S aureus*, no evidence of cross-transmission from pierced earlobes to fingers were observed with other organisms. Permanent or intermittent nasal carriage of *S aureus* has been reported in 50% of adults.[9] Nasal carriers of *S aureus* have a high-rate of extranasal site carriage, with reports showing that hand carriage rates are almost equal to nasal carriage.[9] Because nasal carriage is considered the principal reservoir of *S aureus*, similar to hand carriage, pierced earlobe carriage of *S aureus* may be another example of extranasal carriage.

S aureus was recovered from 10% and 19% of samples, respectively, in nurses with unpierced earlobes compared with nurses with pierced earlobes reflecting a nearly 2-fold difference. One explanation for this observation is local environmental changes leading to increased moistness allowing for easier attachment of *S aureus* following piercing.[10] After piercing of an earlobe, the skin around the puncture hole would be moist compared with the earlobe surface. Although statistical significance was not shown, our data show a trend toward higher *S aureus* colonization rates in pierced earlobe nurses supporting the view that pierced earrings holes are a risk factor.

The spread of *S aureus*, including MRSA, within health care settings via the hands of health care workers is well known. In this study, we showed that *S aureus*, including MRSA, with identical PFGE profiles from pierced and unpierced earlobes of nurses were also found on the fingers of half of the nurses sampled. These results

Table 3
Antimicrobial susceptibility and pulsed-field gel electrophoresis (PFGE) typing results of *Staphylococcus aureus* recovered from earlobes and fingers of nursing staff

Staff ID No.	*S aureus* isolation site	Minimum inhibitory concentration (μg/mL)						Additional characterization	PFGE type from both sites
		Cefoxitin	Ampicillin	Gentamicin	Clindamycin	Levofloxacin	Vancomycin		
3	Pierced earring hole	4	0.25	0.25	0.12	0.12	1		Identical
	Fingers	4	0.5	0.25	0.12	0.25	1		
6	Pierced earring hole	2	0.5	0.25	0.12	0.25	1		Identical
	Fingers	2	0.25	0.25	0.12	0.12	1		
20	Pierced earring hole	2	0.25	0.25	≤ 0.06	0.12	1		Identical
	Fingers	2	0.5	0.25	≤ 0.06	0.12	1		
25	Pierced earring hole	2	0.5	0.25	≤ 0.06	0.12	1		Identical
	Fingers	2	0.5	0.25	0.12	0.12	1		
69	Pierced earring hole	2	0.25	0.25	0.12	0.12	1		Identical
	Fingers	2	0.5	0.25	0.12	0.12	1		
80	Pierced earring hole	128	64	0.25	>128	128	1	MRSA (Sccmec type II), PVL: –	Identical
	Fingers	128	64	0.25	>128	128	1	MRSA (Sccmec type II), PVL: –	
86	Pierced earring hole	4	2	0.25	≤ 0.06	0.25	1		Identical
	Fingers	4	4	0.25	0.12	0.25	1		
89	Earlobe*	2	0.5	16	0.12	≤ 0.06	1		Identical
	Fingers	2	0.5	16	≤ 0.06	0.12	1		
111†	Earlobe*	16	16	16	0.12	0.12	1	MRSA (Sccmec type IV), PVL: –	Identical
	Fingers-1	16	16	16	0.12	0.12	1	MRSA (Sccmec type IV), PVL: –	
	Fingers-2	64	32	32	>128	4	1	MRSA (Sccmec type II), PVL: –	Different
116	Pierced earring hole	4	1	0.25	≤ 0.06	0.25	1		Identical
	Fingers	4	1	0.25	≤ 0.06	0.25	1		
127	Pierced earring hole	4	2	0.25	≤ 0.06	0.25	1		Different
	Fingers	2	0.25	32	0.12	0.12	1		
131	Pierced earring hole	4	≤ 0.06	0.25	≤ 0.06	0.12	0.5		Identical
	Fingers	2	≤ 0.06	0.25	≤ 0.06	0.25	0.5		
160	Pierced earring hole	64	8	0.25	≤ 0.06	4	1	MRSA (Sccmec type IV), PVL: –	Identical
	Fingers	64	8	0.25	≤ 0.06	4	1	MRSA (Sccmec type IV), PVL: –	
179	Pierced earring hole	64	8	64	>128	16	0.5	MRSA (Sccmec type II), PVL: –	Identical
	Fingers	32	8	64	>128	16	0.5	MRSA (Sccmec type II), PVL: –	
196	Earlobe*	4	0.12	0.25	0.12	0.25	0.5		Identical
	Fingers	4	0.12	0.25	≤ 0.06	0.25	0.5		

MRSA, methicillin-resistant *S aureus; PVL*, Panton-Valentine leukocidin; PVL: –, PVL gene negative.
*Nurses without pierced earring holes.
†For nurse No. 111, 2 methicillin-resistant *S aureus* isolates were recovered from the fingers.

suggest that contamination of earlobes with *S aureus* can occur when fingers contact earlobes and that cross-transmission can also occur. We previously reported mobile telephone transmission of identical PFGE types of *S aureus* used in health care settings through contaminated hands of health care employees.[11] Our findings revealed the presence of identical *S aureus* clones, including MRSA, on both the mobile telephone and fingers of the user. In addition, the same *S aureus* genotype was found on the fingers and mobile telephones of multiple users suggesting widespread transmission within the hospital via the fingers of contaminated mobile telephone users. Similarly, in this study, we have identified the potential for cross-transmission from earlobes to fingers as a means of clonal spread within health care settings. Because carriage of *S aureus* in the pierced earlobes of nurses are higher than unpierced earlobes, cross-transmission between earlobes and fingers would be expected to be higher. Although the number of MRSA samples recovered from earlobes were few in this study, MRSA carriage among nurses had pierced earring holes were higher compared with nurses without pierced earrings, suggesting that pierced earlobes are a risk factor for MRSA carriage.

Earrings may cause skin irritation as a result of metal allergies or a response to a physical stimuli. Skin rashes and redness of earlobes has been reported.[3,12,13] Even nonspecific symptoms can lead to pruritus and an uncomfortable feeling that health care workers respond to by unconsciously frequently touch their earlobes and facial area with their fingers.[14,15] For these reason, health care workers should keep in mind that unconscious contact of earlobes with the fingers can occur and place importance on hand hygiene before any patient contact. In addition to direct contact of pierced earring holes with fingers, it is possible that indirect transmission of *S aureus* to patients can occur when a health care employee removes his or her name badge strap. Contact of the strap with the earlobe may result in *S aureus* in the pierced earlobe to contaminate the strap. Subsequent handling of the name badge straps can potentially result in spread of *S aureus* via fingers. Although this type of indirect route of cross-contamination is difficult to recognize and demonstrate, contamination of name badge straps with MRSA and other microbes has been previously reported, strongly suggesting spread of bacteria from pierced earring holes through inanimate objects.[16]

Although our present study investigated the distribution of bacteria found in pierced earring-hole sites at a given time, we were not able to differentiate transmission from transient carriage versus long-term carriage. It is possible that long-term bacterial carriage can lead to a higher risk of HAI. There is a need to study the time course of bacterial carriage in pierced earlobes as well as reciprocal transmission between the ear site and fingers. Furthermore, because bacterial carriage in pierced earlobe sites may also reflect extranasal carriage of *S aureus*, additional studies on transmission and dynamics of carriage must include earlobes, fingers, and nasal sites.

CONCLUSIONS

In this study, the frequency of *S aureus* detected in earlobes was 2-fold higher in those nurses with pierced earlobes compared with those without pierced earlobes. We have shown that the same *S aureus* PFGE type can be found in the pierced earring hole and fingers of nurses employed in a health care facility. For this reason,

pierced earlobes can be a source of HAI via cross-transmission of bacteria from earlobe holes to fingers.

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