

Ear canal carriage of *Staphylococcus aureus* associated with earphone usage in healthcare workers

Akiko Kanayama Katsuse, Masahiro Morita, Seiko Ono, Misato Enomoto, Izumo Kanesaka, Intetsu Kobayashi

Toho Univ., Faculty of Nursing, Dept. of Infection Control and Prevention, Tokyo, JAPAN

Background

Remote work increased in healthcare workers during and after the COVID-19 pandemic. As earphones adhere closely to the ear canal, there is concern that increased humidity and temperature increases bacterial growth. Ear canal carriage of *Staphylococcus aureus* in healthcare workers using earphones was studied to determine the association between *S. aureus* carriage and duration of earphone use.

Methods

Between August 2022 to August 2024, ear canals and earphones of healthcare workers were swabbed. Samples were cultured on mannitol salt agar to determine the presence of *S. aureus*. Colonies with typical *S. aureus* morphology were gram stained. Gram-positive cocci were tested by the coagulase test for identification of *S. aureus*.

*S. aureus* isolates were screened for the presence of MRSA using the CLSI cefoxitin disk diffusion method. MICs of cefoxitin (FOX), cefazolin (CEZ), imipenem(IPM), clarithromycin(CAM), minocycline(MINO), gentamicin (GM), clindamycin (CLDM), levofloxacin (LVFX) and vancomycin (VCM) were determined by the CLSI agar dilution method (CLSI M100-Ed31, 2021).

Pulse-field gel electrophoresis (PFGE) was performed after restriction enzyme digestion with *Sma* I . PCR assays were used for SCC*mec* typing and detection of the PVL gene, as described previously (D.C. Oliveira et al, Antimicrob Agents Chemother, 2002, K. Boye et al. Clin Microbiol Infect, 2007).

Duration of earphone usage per day over the past 7 days was recorded.

Table 1

Ear canal and earphone cultures yielding *S. aureus*.

Positive for <i>S. aureus</i>	No. of <i>S. aureus</i> positive(%)	no.(%)		
Ear canals	15(25.4)	Ear canal only	10(16.9)	} 20(33.9)
		Ear canal and earphone	5(8.5)	
Earphones only	5(8.5)			
Not detected	39			
Total	59			

Table 2

MIC distribution of antimicrobials in 25 isolates of *S. aureus* recovered from ear canals(E) and earphones(P).

Antimicrobials	Sites	MIC : $\mu\text{g/mL}$												
		$\leq 0.06$	0.12	0.25	0.5	1	2	4	8	16	32	64	128	$>128$
FOX	E						12	1	2					
	P						8	2						
CEZ	E			1	12	2								
	P			1	9									
IPM	E	13	1	1										
	P	10												
CAM	E		10						1	2				2
	P		10											
MINO	E		15											
	P		10											
GM	E		11	2			1			1				
	P		6	1			1		1	1				
CLDM	E	15												
	P	10												
LVFX	E	1	11					2	1					
	P		8	1				1						
VCM	E				15									
	P				10									

E, *S. aureus* isolated from ear canals(*n*=15)

Susceptible, Intermediate, Resistant

P, *S. aureus* isolated from earphones(*n*=10)

Table 3

Antimicrobial susceptibility, *Scm* type and PVL gene presence of MRSA isolates

Sample no.	MIC : $\mu\text{g/mL}$									Scm	PVL
	FOX	CEZ	IPM	CAM	MINO	GM	CLDM	LVFX	VCM	type	gene
15 E	16	2	0.25	8	0.12	0.12	$\leq 0.06$	8	0.5	IV	–
40 E	8	2	0.12	>128	0.12	0.12	$\leq 0.06$	0.12	0.5	IV	–

E, *S. aureus* isolated from ear canals

Susceptible, Intermediate, Resistant

Table 4

Antimicrobial susceptibility for *S. aureus* recovered from both ear canals(E) and earphones(P) of each subject.

Sample no.	MIC ; $\mu\text{g/mL}$								
	FOX	CEZ	IPM	CAM	MINO	GM	CLDM	LVFX	VCM
20 E	2	0.5	$\leq 0.06$	0.12	0.12	0.12	$\leq 0.06$	0.12	0.5
20 P	4	0.5	$\leq 0.06$	0.12	0.12	0.12	$\leq 0.06$	0.25	0.5
36 E	2	0.5	$\leq 0.06$	0.12	0.12	0.12	$\leq 0.06$	0.12	0.5
36 P	2	0.5	$\leq 0.06$	0.12	0.12	0.12	$\leq 0.06$	0.12	0.5
37 E	2	0.5	$\leq 0.06$	0.12	0.12	0.12	$\leq 0.06$	0.12	0.5
37 P	2	0.5	$\leq 0.06$	0.12	0.12	0.12	$\leq 0.06$	0.12	0.5
47 E	2	0.5	$\leq 0.06$	0.12	0.12	16	$\leq 0.06$	4	0.5
47 P	2	0.5	$\leq 0.06$	0.12	0.12	16	$\leq 0.06$	4	0.5
52 E	2	0.5	$\leq 0.06$	0.12	0.12	0.12	$\leq 0.06$	0.12	0.5
52 P	2	0.5	$\leq 0.06$	0.12	0.12	0.12	$\leq 0.06$	0.12	0.5

E, *S. aureus* isolated from ear canals

Susceptible, Intermediate, Resistant

P, *S. aureus* isolated from earphones

Table 5

Duration of earphone usage per day over the past 7days, and prior to sample collection on the day(*n*=59).

Site where <i>S. aureus</i> was detected		median(range)		
		Over the past 7days		Sample collection day
		Days of use	Hours per day	
Ear canal only	<i>n</i> =10	5.0(3-7)days	1.3(0.2-2.6)	1.3(0-3.0)
Ear canal and earphone	<i>n</i> =5	7.0(2-7)days	1.3(0.3-2.3)	1.0(0.5-2.0)
Earphone only	<i>n</i> =5	4.0(1-7)days	0.7(0.1-3.8)	1.0(0.5-2.0)
Not detected	<i>n</i> =39	4.0(0-7)days	0.6(0-3.1)	0.5(0-4.0)
Total	<i>n</i> =59	4.0(0-7)days	0.7(0-3.8)	0.5(0-4.0)

Table 6

Detection of *S. aureus* through earphone use on the day of sample collection.

Positive for <i>S. aureus</i>	Use of earphones on the sample collection day			
	Used case( <i>n</i> =43)		Unused case( <i>n</i> =16)	
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
Ear canals	14* (32.6)	Ear canal only 9 (20.9)	1* (6.3)	Ear canal only 1 (6.3)
		Ear canal and earphone 5 (11.6)		Ear canal and earphone 0
Earphones	5 (11.6)		0	
Total	19 (44.1)		1 (6.3)	

\**p*<0.05

Results

- S. aureus* was detected in 20 (33.9%) of 59 subjects, of which 10 isolates were detected only in the ear canal, 5 in the earphone only, and 5 in both the ear canal and earphone(Table 1).
- Scm* type IV MRSA was isolated from 2 ear canal samples. The remaining isolates were MSSA(Table 2, 3).
- In each of the five cases, *S. aureus* with identical characteristics was detected from the ear canal and earphones(Table 4, Fig.).
- The average duration of earphones usage was 1.3 hours per day in the 15 *S. aureus* positive subjects compared to 0.6 hours per day in the 39 *S. aureus* negative subjects(Table 5).
- Of the 59 samples collected from earphone users, *S. aureus* was detected in 19 of 43 (44%) subjects using earphones prior to sample collection, but only in 1(6%) of the 16 subjects not using earphones(Table 6).

Conclusion

Earphone usage duration was longer when *S. aureus* was detected in the ear canal. Prolonged use of earphones can increase ear canal carriage leading to potential spread to the healthcare environment.

Therefore identical *S. aureus* adhere to earphones, the necessity for hand hygiene after handling was suggested, particularly when used in healthcare settings.

Acknowledgment

This work was supported by JSPS KAKENHI Grant Numbers JP22K10514.

Fig.

PFGE results of *S. aureus* isolates detected from both sites of each subject.

