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[原著]

Survey of MRSA from Hand Dryers at University A

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Summary

The effects of hand dryers (HD) and detection of Methicillin-resistant *Staphylococcus aureus* (MRSA) in water droplets from HD have been reported. Therefore, we examined drip trays in HD at University A in order to reveal contamination with MRSA. Research was conducted in August, 2013 and 2014. Samples were collected from drip trays from a total of 15 HD that were installed in washrooms on each floor and from one part of each drip tray. Mannitol salt agar with egg yolk was used to identify SA and then the egg yolk reaction and coagulase test were performed. MRSA was not detected in 2013; however, multidrug-resistant bacteria were present. MRSA and multidrug-resistant bacteria were also detected from HD in 2014. MPIPC, CLDM, FOM, NFLX and MINO were used for drug sensitivity testing. Resistance to CLDM, FOM and NFLX was observed in both testing years. This research shows that resistant bacteria may spread through hands that touch the HD drip tray as MRSA and multidrug-resistant bacteria were detected from there. Therefore, prevention measures including those to combat the spread of COVID-19, changing HD models and the issuing of warnings are required.

Keywords: Hand dryer, Drug-resistance, Methicillin-resistant *Staphylococcus aureus* (MRSA)

Introduction

Several research results on the effects of hand dryers have been reported (1-6). Yamamoto et al. (1) reported that drying the palms and fingers with hot air after washing hands removed bacteria more effectively than paper towels. Ohno (2) stated that drying hands after washing with soap and rinsing with running water effectively removed bacterial contamination of hands. Murakami et al. (3) reported that disinfection with ethanol after drying hands with air led to more effective results than after thoroughly wiping hands with paper towels. Also, some local authorities instruct people to dry their hands completely with hand dryers after washing instead of cloth towels as part of infection control for norovirus (4). Sakai

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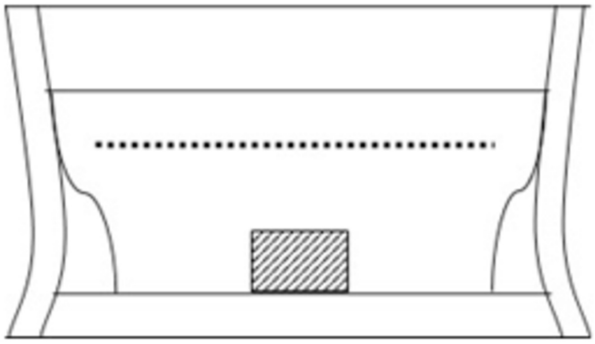

Fig. 1 Top view of hand-dryer
: The bucket part from which the specimen was collected

et al. (5) have worked toward the practical use of clean-air towels as a means of hand drying after surgical hand washing, which will make drying hands easier, quicker and more uniform than sterilized towels (6). Thus, hand dryers are considered useful for drying hands at medical facilities as well as for daily hand drying after washing hands. Using hand dryers after washing hands contributes to hand hygiene.

However, there are some concerns from the aspect of good hygiene. Resident skin bacteria such as *Staphylococcus aureus* (SA) and Coagulase negative staphylococci (CNS) were detected in hand dryer drip trays in the male washrooms at a university hospital, and enteric pathogens such as *Morganella*, *Klebsiella* and *Enterobacter* were found in the same spot in female washrooms. Furthermore, research showed that the more frequently hand dryers are used, the higher the bacterial contamination level is (7). Researchers cultured airborne bacteria from hand dryers and found CNS, *Bacillus*, *Corynebacterium* and fungus in them. They reported hand dryers are likely to cause the same hand contamination as shared towels (8, 9). Bacteria such as methicillin-resistant *Staphylococcus aureus* (MRSA), SA, and *Enterococcus* were detected from the installation location of hand dryers (10). Thus, contamination by bacteria, such as Staphylococcus and Enterobacteriaceae, in hand dryer drip trays or near hand dryers has been indicated.

In this study, we examined the drip trays of hand dryers in the Department of Nursing at University A that blow high-powered air onto the front and back sides of hands that are inserted from top to bottom, in order to reveal contamination levels with multidrug-resistant MRSA, such as resistance to beta-lactam, as a main causative bacteria of healthcare acquired infection.

Materials and Methods

1. Sample collection

Samples were collected before cleaning from one drip tray of each hand dryer (TOTO CLEAN DRY). On each floor of the five-story University A, three hand dryers were installed in washrooms. Therefore, samples were collected from a total of 15 drip trays (Fig. 1). Examiners whose techniques had been confirmed to unify in advance wiped approximately 10cm² of the surface of each testing site once with saline pre-wet SEED® swabs (ELMEX Limited). Samples were collected on Aug 30, 2013 and Aug 15, 2014.

2. Count of total bacterial and identification of MRSA

Each SEED® swab was placed in 10 mL of phosphate buffer solution (PBS) after sample collection to suspend bacteria. One mL of the suspension was dropped onto heart infusion agar (HI agar, Eiken Chemical Co., Ltd.) and the total viable bacteria count was conducted. Colonies of SA surrounded by a pearly luster were obtained on the Mannitol salt agar with egg yolk (Eiken Chemical Co., Ltd.) and grown in axenic culture at 35°C for 48 hours under aerobic incubation. Gram stain was used

Table 1. Number of living bacteria according to year and place of collection

	2013	2014
Floor		
1F	46	54
2F	28	20
3F	30	2
4F	40	6
5F	30	17

Table 2. Drug-resistant pattern for various antibiotics according to the hierarchy of the detected bacteria

2013	MPIPC	CLDM	FOM	MINO	NFLX
1F	S	R	S	S	S
2F	S	R	R	S	R
4F	S	S	R	S	S
2014					
4F	R	R	S	S	S
〃	R	S	S	S	S
5F	R	R	S	S	S
〃	R	S	S	S	S
〃	R	S	R	S	S
〃	R	S	R	S	R

for independent colonies. Only gram-positive cocci were identified with the coagulase test. MRSA was identified by the oxacillin resistance.

3. Drug sensitivity test

BD Sensi-Disc (Becton, Dickinson and Company) was used in a single disc method. Five agents, including Fosfomycin (FOM), Clindamycin 2 (CLDM), Norfloxacin 10 (NFLX), Minocycline 30 (MINO) and Oxacillin 1 (MPIPC) were used. They were then checked for resistance (R) or sensitivity (S).

Results

1. Viable bacteria count by year and sampling floor (Table 1)

More than 20 colony forming unit/ 10cm² were detected on each floor in 2013. The highest number of viable bacteria was detected on the first floor compared to the other floors. In contrast, the number of viable bacteria was low on the second floor. Fifteen and six times as many viable bacteria were detected on the third and fourth floor in 2014 and 2013, respectively. In 2014, the detected numbers of bacteria differed among the testing floors. More viable bacteria were detected on the first floor than on the other floors, the same as in 2013. However, less viable bacteria were detected in 2014 from the second to fifth floors than the previous year.

2. Drug sensitivity test and Ddrug resistance pattern for each antimicrobial agent (Table 2)

In 2013, drug-resistant bacteria were not detected on the third and fifth floors and MRSA was not detected from any hand dryers. Multidrug-resistant bacteria that were resistant to CLDM, FOM and NFLX were detected on the second floor; however, bacteria detected on the other floors showed resistance only to CLDM and FOM.

Whereas, in 2014, no resistant bacteria were detected on the first, second and third floors. However, MRSA with four multidrug-resistant patterns, such as resistant only to MPIPC, to MPIPC and CLDM, to MPIPC and FOM, and to MPIPC, FOM and NFLX was detected. On the fourth and fifth floors, bacteria with two of the four drug-resistant patterns were detected (only to MPIPC and to MPIPC and CLDM). Bacteria resistant to three agents were detected similar to that in 2013; however, bacteria with the same drug-resistant patterns as those in 2013 were not detected. Staphylococcus detected in this study was sensitive to MINO both in

2013 and 2014.

Discussion

Hand washing after using the toilet is required to remove bacteria that adheres to hands. Hand dryers are categorized into two types, one that blows droplets with jet air for drying hands, the other that dries hands with hot air. They are installed to facilitate hand drying not only in washrooms in restaurants, amusement facilities and offices, but also recently in washrooms in medical facilities. Presumably, this is because hand dryers are cost effective as they do not produce any waste unlike paper towels.

Further research is required because this survey into contamination with MRSA in jet hand dryers was conducted over several days only during summer. However, the results show that MRSA may be transmitted through hands when the hands touch the hand dryer drip tray that is contaminated with MRSA. Other reports showed that jet hand dryers had scattered more bacteria than paper towels (10, 11). Thus, further survey and examination on the use of paper towels, change of models, cleaning time and method, as well as the installation position of the dryer on walls are required.

MRSA has been classified into hospital-acquired MRSA (HA-MRSA) and community-acquired MRSA (CA-MRSA) since the latter part of the 20th century (12). HA-MRSA is resistant to beta-lactams, fluoroquinolones and fosfomycins (12, 13). CA-MRSA is frequently resistant only to beta-lactams (13); however, an increasing number of fluoroquinolone resistance in CA-MRSA has been found, i.e., CA-MRSA has become similar to HA-MRSA (13).

The examination of bacteria found in hand dryers shows clear differences between the testing years. The possible reasons for this include low contact frequency between the medical facility and university in 2013 as it had been 4 years since University A was established and only one year since on-site nursing practice began at the time of the examination. In contrast, two drug resistance patterns of MRSA were observed in 2014, i.e., bacteria resistant only to MPIPC, which is the resistance pattern of CA-MRSA, and bacteria resistant to MPIPC, FOM and NFLX, which is the resistance pattern of HA-MRSA. This may have been caused by the more frequent travel of students of on-site practice between the medical facility and university and those students having more contact with people in the city in 2014 with the further passing of time since the school opened. Therefore, bacteria are considered to be increasingly transported from downtown to the university by bacteria carriers such as students due to their increasing use of public transportations and other facilities. Thus, some bacteria was scattered onto hand dryer drip trays when bacteria carriers used the washrooms in the university.

Awareness programs may need to be launched to ensure that people pay careful attention to bacterial contamination on hands, e.g., warning posters at visually recognizable places so that people who use hand dryers will not touch hand dryer drip trays. Some facilities have stopped using hand dryers in order to prevent the spread of COVID-19. However, as the effectiveness and usefulness of hand dryers have already been confirmed (1, 2), we will conduct further research on improvements in hand dryers to fully exploit their

potential, such as inserting hands from different angles to prevent bacteria from spreading, setting filters or acrylic plates to block bacteria, or using hand dryers with other functions that prevent bacteria from spreading, as and when required.

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Conflicts of interest

None.

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A 大学のハンドドライヤーにおける MRSA の実態調査

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要 旨

ハンドドライヤー（HD）の効果についてはこれまでにいくつかの研究結果が報告されている。また、HD は医療関連施設などのトイレ内に設置が普及している。一方、HD 内に付着している水滴などからはメチシリン耐性黄色ブドウ球菌（MRSA）が検出されているという報告もある。そこで A 大学に設置されている HD 内の MRSA についての細菌汚染の実態を明らかにするため、HD の水受け部分を調査し検討した。調査日は 2013 年、2014 年の各々 8 月に行い採取箇所は 5 階建ての各階のトイレに設置された全 15 台の HD の水受け部分の 1 箇所から採取した。総菌数の計数は HI 培地、黄色ブドウ球菌の同定には卵黄加マンニット食塩寒天培地を用いて卵黄反応およびグラム染色による形態の確認、コアグラーゼ試験を実施した。薬剤感受性試験は同定された菌株について MPIPC、CLDM、FOM、NFLX、MINO を用いた。結果として 2013 年では MRSA は検出されなかったが多剤耐性菌は検出された。また 2014 年は HD から MRSA が検出され多剤耐性菌も検出された。各年に共通して検出されたブドウ球菌の耐性薬剤は CLDM、FOM、NFLX であった。調査から MRSA や多剤耐性菌の存在が認められ、HD の水受け部分へ接触することにより手指を介した耐性菌が伝播する可能性が推測された。しかし検討した機種は紫外線殺菌灯がなく今後は機種の変更や機種による留意点などの注意勧告の掲示を含め新型コロナウイルス(COVID-19)飛散防止機能を備えた対策の検討を行い安全・安心して使用することの方策が必要と思われる。

キーワード：ハンドドライヤー、薬剤耐性菌、メチシリン耐性黄色ブドウ球菌（MRSA）