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Brief report

Use of portable electronic devices in a hospital setting and their potential for bacterial colonization

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Contamination

Portable electronic devices are increasingly being used in the hospital setting. As with other fomites, these devices represent a potential reservoir for the transmission of pathogens. We conducted a convenience sampling of devices in 2 large medical centers to identify bacterial colonization rates and potential risk factors.

The union of the electronic medical record and portable personal computer (netbooks and tablet-based personal computers, for example iPads [Apple, Cupertino, CA]) has transformed the medical landscape. In a survey sent to graduate medical education training programs, 40% reported use of portable electronic devices (PEDs) of which iPads were the most commonly used devices.[1]

Fomites (computer keyboards, clothing, stethoscopes, ties, cell phones) are well-described sources for transmission of pathogenic bacteria in hospital settings.[2-5] The touchscreen nature, portability, and high probability of coincidental use during patient encounters ensure the PEDs' place as a possible reservoir for the transmission of pathogens. The aim of our study was to evaluate the potential contamination of PEDs and associated risk factors for contamination in the hospital setting.

METHODS

We conducted a convenience sample of house officers and attending physicians carrying PEDs. The study was conducted at 2 large academic institutions in Detroit, Michigan, and was approved by the institution review boards of each institution. After verbal consent, a standardized methodology was used with moistened swabs (BBL Culture Swab, Copan for Becton, Dickinson and Company, Glencoe, MD) to sample the devices. Separate swabs were used for the screen, cover, and keyboard if applicable. A voluntary and anonymous survey tool to determine device usage, cleaning, and cleaning practices was developed and administered while devices were swabbed.

Microbiology

Sampling was conducted over a 3-day period at each institution. All swabs were obtained between 8:00 AM and 5:00 PM, kept at room temperature, and delivered within 12 hours to the research laboratory. Culture plates were incubated for 24 hours. Colonies were evaluated for organism identification using standard techniques. Susceptibility testing was performed for *Staphylococcus aureus*. Species identification and susceptibility testing was

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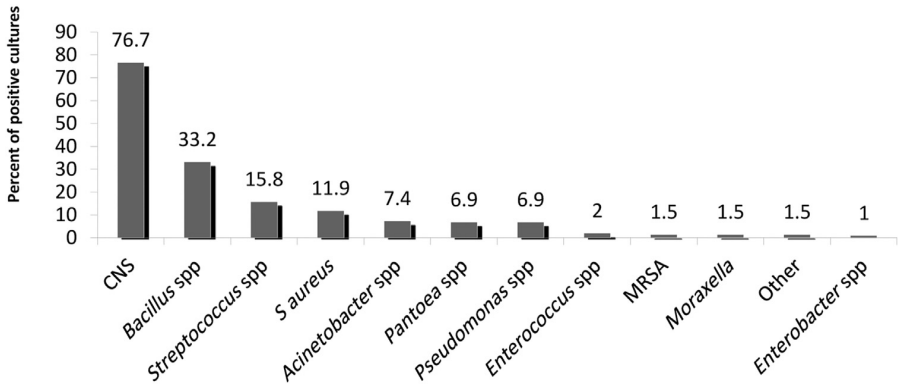

Fig 1. Organisms isolated from portable electronic device screens and covers (N = 106). *CNS*, coagulase-negative *Staphylococcus*; *MRSA*, methicillin-resistant *S aureus*.

performed on gram-negative bacilli using the VITEK 2 (bioMérieux Inc, Durham, NC). A pathogen was defined in this study as *S aureus*, *Enterococcus* spp, *Acinetobacter baumannii*, *Enterobacter spp*, and *Pantoea* spp.

Statistical analysis

Analyses were performed using IBM SPSS statistics version 22 (IBM, Armonk, NY), and a *P* value of .05 was considered to indicate statistical significance. Data were analyzed using the χ^2 test. Throughout the text, the percentages displayed are the valid percent, which indicates the percent excluding the missing data from the denominator.

RESULTS

There were 106 physicians who agreed to have their devices sampled; 64.2% (n = 68) were men, and 27.4% (n = 29) were from the medicine and pediatric departments. Tablet-based devices were the most common devices sampled (86.8%; n = 92). Thirty-three percent (n = 35) of devices were used by first-year trainees. There was equal distribution of samples from both institutions.

All devices yielded at least 1 positive culture from the screen or cover (Fig 1). There was no difference in the proportion of positive cultures by sex, level of training, or institution. Gram-positive organisms were cultured from nearly all devices (93.4%; 99/106) and the covers (94.3%; 100/106). Gram-negative organisms were found on 21.7% (23/106) of devices and 20.8% (22/106) of screens (Table 1). At one of the institutions, differences between specialties were assessed, and 66.7% (4/6) of devices used by surgeons were colonized compared with 17.9% (7/39) of devices by nonsurgical physicians ($P = .01$).

Seventeen percent (n = 4/24) of respondents never cleaned their devices. Forty-six percent (13/33) reported cleaning their devices monthly to once per year and had higher pathogen colonization rates than the 34.8% (16/33) who cleaned them daily to weekly and the 17.4% (4/33) that never cleaned them. The most commonly reported methods of cleaning included a dry cloth (33%), alcohol wipes (33%), chlorhexidine (18%), or other (20%). Combinations of cleaning methods were also reported. There was no impact on device colonization based on cleaning methods (data not shown).

Practices that did not impact colonization rates included carrying devices into patient rooms, self-reported hand hygiene use, and glove use.

Table 1
Microbiology results

Characteristic	Screens (n = 106) (%)	Covers (n = 106) (%)
Gram-positive organisms	99 (93.4)	100 (94.3)
Gram-positive pathogens	14 (13.2)	15 (14.2)
Staphylococcus aureus	11 (78.6)*	14 (93.3)*
Enterococcus spp	3 (21.4)*	1 (6.7)*
Gram-negative organisms	23 (21.7)	22 (20.8)
Gram-negative pathogens	11 (10.4)	12 (11.3)
Acinetobacter baumannii	3 (27.3)†	4 (33.3)†
Enterobacter spp	1 (9.1)†	1 (8.3)†
Pantoea spp	7 (63.6)†	7 (58.3)†

*Percentage of gram - positive pathogens.
†Percentage of gram - negative pathogens.

DISCUSSION

The expanded use of PEDs has provided clinicians with ready access to electronic medical records. The convenience of carrying these devices into patient rooms for point-of-care, real-time application cannot be ignored or underestimated, but we can also not ignore their potential as fomites. Just as infection control focuses on hand hygiene, a question remains whether equal attention should be applied to handheld devices that come into close proximity to patients.

In our study, 53 out of 204 (25.9%) swabs yielded at least 1 pathogen. The bacteria found on device covers did not always match the bacteria on the screens, and we can only speculate as to the rationale for this finding.

Brady et al[6] demonstrated that the combination of constant handling and heat generated by cell phones and the fact that they are kept warm and easy to store in pockets, handbags, and brief cases creates a prime breeding ground for microorganisms that are normally found on skin. Our study demonstrates that PEDs are contaminated with pathogens and are a potential source of transmission.

Kiedrowski et al[7] found that using a soft, microfiber cloth moistened with sterile water, alcohol wipes, and bleach wipes removed 100% of the methicillin-resistant *S aureus* that were experimentally placed onto iPad screens. We did not identify any difference in colonization rates of PEDs when self-reported cleaning methods were assessed.

Our work has limitations. The Midwest location of our institution may not reflect colonization rates at other institutions and different climates. This study had a disproportionate number of

trainees and may not reflect colonization rates of PEDs used by other providers.

Nevertheless, we have shown that PEDs can be colonized with a variety of pathogenic organisms. The significance of colonization and implications for patient care remains unclear. Larger, prospective, and continuous sampling studies are needed to resolve these limitations. Additional studies are necessary to determine the safety risks to patients and identify best practices and infection control policies as this technology expands in the health care arena.

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