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Brief Report

Evaluation of the potential for electronic thermometers to contribute to spread of healthcare-associated pathogens

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In a point-prevalence culture survey, 24 of 300 (8%) handles of electronic thermometers in 3 hospitals were contaminated with 1 or more potential pathogens. A DNA marker inoculated onto the handles of electronic thermometers in hospital and long-term care facility settings spread to surfaces in patient rooms, to other types of portable equipment, and to patients' hands. Our findings suggest that effective strategies are needed to reduce the risk for pathogen transmission by electronic thermometers.

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Portable medical equipment that is shared among patients can serve as a vector for transmission of healthcare-associated pathogens.[1,2] For example, electronic thermometers, particularly rectal thermometers, have been implicated in the transmission of vancomycin-resistant enterococci (VRE) and *Clostridium difficile*.[3-5] In these outbreaks, it was suspected that contamination on the thermometer handles was transferred to patients via the hands of personnel. Moreover, in 2 studies, substitution of single-use disposable thermometers for shared electronic thermometers was associated with significant reductions in *C. difficile* infection (CDI) or VRE colonization.[6,7] Based on these findings, current guidelines for prevention of CDI in acute care hospitals include a recommendation that single-use disposable thermometers be used in the care of CDI patients.[8]

Many healthcare facilities continue to use shared electronic thermometers. However, the potential for transmission of pathogens by the thermometers that are currently widely used in healthcare facilities is unclear. Therefore, we used a benign DNA marker to evaluate the potential for dissemination of pathogens by shared electronic thermometers. We also conducted a culture survey to determine the frequency of contamination of electronic thermometers in 3 acute care hospitals.

METHODS

The Louis Stokes Veterans Affairs Medical Center in Cleveland, Ohio, includes a 215-bed acute care hospital and an adjacent 250-bed long-term care facility (LTCF). In the hospital, patient rooms have dedicated wall-mounted digital electronic thermometers; per facility policy, the handles of the thermometers are to be cleaned by environmental services personnel after each patient discharge. In the LTCF, portable vital signs equipment units that include digital electronic thermometers are available on each ward and shared among residents. The study protocol was approved by the Louis Stokes Veterans Affairs Medical Center's Institutional Review Board.

To evaluate the potential for dissemination of pathogens by shared electronic thermometers, we used a 222 base pair DNA marker generated from the cauliflower mosaic virus 35S promoter DNA region.[2,9] On an LTCF ward, 1 μg of the DNA marker in 1 mL was inoculated onto the thermometer handles of 6 portable vital signs units. A fluorescent marker was applied on a separate area of each thermometer handle to assess cleaning of the handle. A black light was used to assess whether the marker was removed on days 1 and 14 after application. Radiofrequency identification technology was used to monitor movement of the vital signs units. On days 1 and 14 after inoculation of the DNA marker, pre-moistened cotton-tipped swabs were used to sample high-touch surfaces (bed rails, bedside table, and call buttons) in LTCF resident rooms that had been entered by

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the vital signs units (1 swab was used per room), other portable equipment on the ward (eg, vital signs equipment and bladder scanners), and common areas on the ward, including the nursing station, staff bathroom, and lunch room. For large surfaces, a 5 × 5 cm area was sampled; for smaller surfaces such as call buttons, the entire surface area was sampled. For each day of sampling, negative control swabs opened in the patient room but not placed in contact with surfaces were processed identically. Polymerase chain reaction was used to detect the presence of the DNA marker as previously described.[2,9] LTCF personnel and residents were not aware of the study.

In the hospital, 1 μg of the DNA marker in 1 mL and fluorescent marker were inoculated onto wall-mounted thermometer handles in 6 patient rooms after a patient had been discharged but prior to cleaning by environmental services personnel. On days 1 and 2 after inoculation of the DNA marker, samples from high-touch surfaces in the rooms and from the hands of patients in the rooms were collected and processed for detection of the DNA marker as described previously. Hospital personnel were not aware of the study. The patients were aware of the study and provided consent for sampling of their hands but were not informed of the location where the DNA marker was placed.

To evaluate the frequency of contamination of electronic thermometer handles with pathogens, a point-prevalence culture survey of electronic thermometers was conducted at the Louis Stokes Veterans Affairs Medical Center and in 2 other acute care hospitals. For each facility, we cultured the handles of a convenience sample of electronic thermometers from hospital rooms; for the Louis Stokes Veterans Affairs Medical Center, electronic thermometers from portable vital signs units in the LTCF were also cultured. The thermometer handles were sampled using pre-moistened CultureSwabsTM (Becton Dickinson, Franklin Lakes, NJ). The swabs were cultured for *Staphylococcus aureus*, enterococci, streptococci, facultative gram-negative bacilli, and *C. difficile* as previously described.[10]

RESULTS

Figure 1 provides a summary of the DNA marker results on the LTCF ward. After 1 day, the DNA marker was detected on high-touch surfaces in 3 of 14 (21%) rooms sampled and on 4 of 5 (80%) items of shared portable equipment that had not been inoculated with the marker, including a bladder scanner and 3 vital signs units, but not in common areas (10 of 10 sites negative). All 6 negative control swabs were negative. There was no evidence of removal of the fluorescent marker from any of the electronic thermometer handles on days 1 or 14 after inoculation.

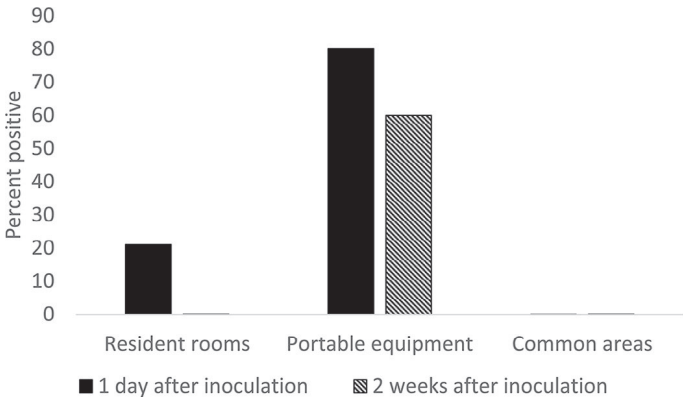

Fig 1. Percentage of detection of a DNA marker on high-touch surfaces in rooms of long-term care facility (LTCF) residents (n = 14 rooms), on portable equipment that was not inoculated with the marker (n = 5), and in common areas on the LTCF ward (n = 10). The DNA marker was inoculated onto the handles of 6 shared electronic thermometers on portable vital signs units on the LTCF ward. For LTCF rooms, 1 swab was used to sample the bed rails, bedside table, and call button.

Table 1
Frequency of recovery of microorganisms from electronic thermometers in 3 Cleveland-area hospitals

Microorganisms	Hospital 1	Hospital 2	Hospital 3	All cultures
Total aerobic and facultative bacteria, mean (range)	16.5 (0-300)	5 (0-300)	15 (0-100)	12 (0-300)
Coagulase-negative staphylococci	8/100 (58)	10/100 (10)	55/100 (55)	123/300 (41)
MRSA	5/100 (5)	0/100 (0)	0/100 (0)	5/300 (2)
Enterococci	1/100 (1)	0/100 (0)	1/100 (1)	2/300 (0.6)
Streptococci *	2/100 (2)	2/100 (2)	8/100 (8)	12/300 (4)
Gram-negative bacilli †	4/100 (4)	0/100 (0)	3/100 (3)	7/300 (2)
Clostridium difficile	1/100 (1)	0/100 (0)	0/100 (0)	1/300 (0.3)
1 or more pathogens ‡	10/100 (10)	2/100 (2)	12/100 (12)	24/300 (8)

NOTE. Values are no. positive samples/no. sampled (%) unless otherwise specified. For total aerobic and facultative bacteria, plates with more than 300 colonies were counted as 300.
MRSA, Methicillin-resistant *Staphylococcus aureus*.
*Streptococci included 6 *Streptococcus agalactiae*, 5 Viridans group *Streptococcus*, and 1 *Streptococcus pyogenes*.
†Gram-negative bacilli included 2 *Pseudomonas aeruginosa*, 3 *Klebsiella* spp., and 2 *Enterobacter* spp.
‡Pathogens included MRSA, enterococci, gram-negative bacilli, and *C. difficile*.

In the hospital assessment of dissemination from wall-mounted thermometer handles, the DNA marker was detected on high-touch surfaces in 2 of 6 (33%) rooms and on the hands of 1 of 6 (17%) patients. All 6 negative control swabs were negative. There was no evidence of removal of the fluorescent marker from the wall-mounted thermometer handles in any of the rooms on days 1 or 2.

Table 1 shows the results of cultures collected from electronic thermometer handles in the 3 hospitals (300 total). Of the 300 thermometers, 155 (52%) were portable digital electronic, 87 (29%) were wall-mounted digital electronic, 13 (4%) were small handheld digital electronic, and 45 (15%) were temporal. Coagulase-negative staphylococci were frequently recovered from thermometer handles. Excluding coagulase-negative staphylococci, 8% of thermometers had contamination with 1 or more pathogenic microorganisms.

DISCUSSION

Our findings were consistent with multiple previous reports suggesting that shared electronic thermometers can be a source of pathogen transmission.[3-7] A DNA marker inoculated onto electronic thermometer handles of portable vital signs equipment on an LTCF ward was transferred to surfaces in rooms of LTCF residents and to portable equipment on the unit. In hospital rooms, the DNA marker was similarly transferred from handles of wall-mounted electronic thermometers to surfaces in the rooms and, on 1 occasion, to the hands of a patient. It is likely that the hands of healthcare personnel played a major role in transferring the DNA marker from the contaminated thermometer handles to other sites. Based on fluorescent marker monitoring, the handles of both wall-mounted and portable thermometers were not being cleaned between patients. Finally, we found that the handles of electronic thermometers were often contaminated with potential pathogens.

Our findings have important implications for infection control. First, if electronic thermometers are used, effective protocols need to be developed to ensure that the handles are cleaned between patients. Although our infection control policies require cleaning of thermometers between patients, the lack of fluorescent marker

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removal demonstrated that the handles were not being cleaned. Such use of fluorescent markers may provide a useful approach to monitor cleaning of thermometers. Second, hand hygiene after contact with thermometer handles may be beneficial to reduce the risk for transmission of pathogens. Finally, use of disposable thermometers may provide an alternative approach to reduce the risk for pathogen transmission.

Our study had some limitations. The concentration of the DNA marker applied to the thermometer handles was high, so our results are likely to reflect a worst-case scenario. The marker is rendered nondetectable by bleach but not by quaternary ammonium disinfectants or alcohol hand sanitizer.[9] Thus, our findings may not correlate well with dissemination of pathogens that are killed by these agents.

In summary, our findings are consistent with previous studies in demonstrating the potential for shared electronic thermometers to contribute to pathogen transmission. These results highlight the need for effective strategies to decontaminate electronic thermometers and to educate healthcare and environmental services personnel of the risk for pathogen transmission. In addition, our findings provide support for the recommendation that single-use disposable thermometers should be used in care of CDI patients.[8]

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