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RESEARCH LETTER

How Dirty Is Your Phone? Evaluating Restroom Behavior and Cell Phone Surface Contamination

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TO THE EDITOR

Health-care–acquired infections (HAIs) cost $28.4–$33.8 billion and thousands of patient lives annually.[1] Current monitoring efforts focus on device-associated infections. Cell phones improve care delivery by providing rapid access to resources but are easily contaminated and rarely disinfected. One potential area accounting for their contamination is restrooms. There is little empirical research, but one non–peer reviewed survey of 408 Americans showed that 61% use their phone in the restroom.[2] Given the diverse microbial biogeography found in public restrooms, this is an alarming health concern. Accordingly, we surveyed restroom cell phone use by health professional students and measured cell phone surface contamination levels.

METHODS

We surveyed 169 students using restrooms in the Medical Education and Training Building at the University of North Texas Health Science Center between 11:00 A.M. and 1:00 P.M. Monday–Friday. The survey consisted of nine self-reported items on a Likert-type scale, ranging from 0 ("Extremely Unlikely") to 10 ("Extremely Likely"). Participants answered questions regarding their restroom phone use, hygiene, and handwashing. Contamination levels were assessed using ATP luminometry, an established test for surface cleanliness. Residual surface adenosine triphosphate (ATP) suggests the presence of pathogens but may be confounded by other ATP–containing sources. This was assessed from only 101 participants due to availability of the EnSURE ATP luminometer (Hygiena, LLC, Camarillo, California). Levels were then compared to established health care cleanliness benchmarks.[3] We used *t*-tests to compare contamination levels between sexes and Spearman ranked correlation to associate levels with survey responses.

RESULTS

Overall, students were likely to use phones in the restroom (Table 1), with males using them more when defecating ($p < 0.01$), and females more so when urinating ($p = 0.001$) (Table 2). Students also reported a very high likelihood of handwashing after using the restroom (Table 1), with higher likelihoods in females ($p < 0.05$) (Table 2). Overall, students cleaned their phone less than once weekly and were somewhat unlikely to remove the case (Table 1). When asked about their most common method of cleaning, students used alcohol swabs (66.7%), soap & water (10.0%), water alone (5.5%), UV light (2.2%), and other (15.6%). Although the average phone contamination level was 1,702.09 ± 165.90 RLU [relative light unit]/100 cm^2, lower levels were associated with higher likelihoods of handwashing and phone cleaning ($p < 0.05$). Upon comparing cleaning methods, "soap & water" was associated with the lowest levels of contamination (Table 3).

DISCUSSION

Health professional students report using phones and handwashing while in the restroom, but not regularly cleaning their phones. Overall phone surface contamination levels exceeded established health care benchmarks by 3-to 17-fold.[3] Students carrying these habits into their health care careers may increase the risk of HAIs.

These results must be taken in the context of luminometry's inherent limitations. Previous work has established 100–500 RLU as an upper limit for health care surface cleanliness[3] and shown strong linear predictability among pure cells and organic contaminants,[4] but there is limited research directly linking luminometry with HAI spread. This study is also limited by the recall bias associated with all survey data. Future studies should replicate this paradigm while also including additional forms of measurement, such as colony-forming units.

Monitoring surface contamination is critically important to prevent HAIs. In 2018 The Joint Commission identified high noncompliance rates on reducing infection risks associated with medical equipment, devices, and sup-

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Table 1. Descriptive Statistics for Survey Responses and Cell Phone Contamination Levels

	N	Mean ± SD
On a scale from 0–10, how likely are you to use your phone while in the restroom?	169	6.85 ± 3.071
On a scale from 0–10, how likely are you to use your phone when defecating?	168	6.30 ± 3.544
On a scale from 0–10, how likely are you to use your phone when urinating?	169	3.59 ± 3.394
On a scale from 0–10, how likely are you to check social media while using the restroom?	169	6.14 ± 3.450
On a scale from 0–10, how likely are you to wash your hands after using the restroom?	168	9.47 ± 1.203
On a scale from 0–10, how likely are you to wash your hands after defecating?	169	9.88 ± 0.674
On a scale from 0–10, how likely are you to wash your hands after urinating?	169	9.25 ± 1.654
How many times per week do you clean your cell phone (1–5)?	169	1.53 ± 0.747
On a scale from 0–10, if you clean your cell phone, how likely are you to remove the case when doing so?	126	4.15 ± 3.625
Cell phone surface contamination (RLU/100 cm^2)†	101	1,702.09 ± 1,667.252

SD, standard deviation; RLU, relative light unit.

* Question scaled 1–5, where 1 = "Never"; 2 = "1–3 times per week"; 3 = "4–6 times per week"; 4 = "7–9 times per week"; 5 = More than 10 times per week."

† Range = 0–8,082 RLU/100 cm^2).

Table 2. Descriptive Statistics for Survey Responses and Cell Phone Contamination Levels Between Sexes.

	n	Males (Mean ± SD)	*n*	Females (Mean ± SD)
On a scale from 0–10, how likely are you to use your phone while in the restroom?	86	7.03 ± 3.070	83	6.65 ± 3.078
On a scale from 0–10, how likely are you to use your phone when defecating?	85	7.06 ± 3.304	83	5.52 ± 3.630
On a scale from 0–10, how likely are you to use your phone when urinating?	86	2.76 ± 3.098	83	4.46 ± 3.486
On a scale from 0–10, how likely are you to check social media while using the restroom?	86	6.08 ± 3.555	83	6.19 ± 3.358
On a scale from 0–10, how likely are you to wash your hands after using the restroom?	85	9.26 ± 1.407	83	9.69 ± 0.910
On a scale from 0–10, how likely are you to wash your hands after defecating?	86	9.80 ± 0.905	83	9.95 ± 0.266
On a scale from 0–10, how likely are you to wash your hands after urinating?	86	8.88 ± 2.055	83	9.63 ± 0.972
How many times per week do you clean your cell phone?*	86	1.53 ± 0.762	83	1.53 ± 0.738
On a scale from 0–10, if you clean your cell phone, how likely are you to remove the case when doing so?	66	4.27 ± 3.707	60	4.02 ± 3.558
Cell phone surface contamination (RLU/100 cm^2)†	57	1,911.30 ± 1,809.552	44	1,431.07 ± 1,437.661

SD, standard deviation; RLU, relative light unit.

* Question scaled 1–5, where 1 = "Never"; 2 = "1–3 times per week"; 3 = "4–6 times per week"; 4 = "7–9 times per week"; 5 = More than 10 times per week."

† Range = 0–8,082 RLU/100 cm^2).

Table 3. Descriptive Statistics for Survey Cell Phone Contamination Levels by Cleaning Method

	n	Mean ± SD (RLU/100 cm^2)
Does not clean	39	1,988.10 ± 1,845.978
Alcohol swab	41	1,672.29 ± 1,601.232
Other	10	1,619.60 ± 1,821.827
Water	3	1,062.00 ± 803.105
Ultraviolet light	1	1,019.00 ± 0.000
Soap & water	7	772.86 ± 788.321

SD, standard deviation; RLU, relative light unit.

plies in hospitals (70.85%), office-based surgery practices (63.55%), and ambulatory health care practices (60.65%).[5] One previous hospital-based study found 74% of staff members' phones contaminated by bacteria, with 5% contaminated by potentially pathogenic bacteria (methicillin-sensitive *Staphylococcus aureus* and coliforms).[6] However, cell phone–related pathogen transmission can be lowered in health care settings with effective hand hygiene policies.[7] Despite the rising utility of cell phones, more work is needed to ensure their safe use in health care.

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