

JHI Short Report

31 July 2017

Title:

Hand-held device decontamination within healthcare environment

Running title:

How to disinfect your computer tablet device in the hospital?

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Summary

Mobile phones and tablet computers may be contaminated with microorganisms and become a potential reservoir for cross-transmission of pathogens between healthcare workers and patients. There is no generally accepted guidance how to reduce contamination on mobile devices in healthcare settings.

Our aim was to determine the efficacy of the Codonics D6000™ UV-C disinfection technology.

Daily disinfection achieved to reduce contamination on screen and on protective cases (test) significantly, but not all cases (control) could be decontaminated.

The median aerobic colony counts on the control and the test cases was 52 (IQR 33-89) cfu/25cm² and 22 (IQR 10.5-41) cfu/25cm² respectively.

Keywords

Tablet device (computer), iPad, hospital environmental surface, bacterial contamination

Introduction

The use of mobile phones and tablet computers has become widespread both in public places and in the clinical environment. Tablets are increasingly used for electronic patient and observation records, often without hand hygiene between patient and device.

These hand-held devices can be contaminated with microorganisms and be a potential source for transmission of pathogens between healthcare workers (HCW) and patients.

More than one out of seven mobile phones (13%) belong to healthcare professionals were contaminated with methicillin-resistant *Staphylococcus aureus* or vancomycin-resistant Enterococcus in a study performed in our hospital.¹

Bacteria may survive for months on inanimate surfaces.² The majority of the HCW's mobile phone is never cleaned. Ulger et al. demonstrated low rate of compliance (10.5%) with cleaning mobile phones in a healthcare setting.³

There is no generally accepted guidance how to reduce contamination on mobile devices in hospitals. Manufacturers (i.e. Apple Inc.) recommend to clean their computer, phone, display only with a soft, lint-free cloth and avoid aerosol sprays, solvents or abrasives.⁴ In a study by Albrecht et al., 47.9% of the initial bacterial contamination still remained on tablet PC (iPAD®) after following manufacturer's instructions to clean tablet devices.⁵

The use of alcohol wipes as a standard surface disinfection method on handheld electronic devices is controversial, since liquid damage is not covered under the product warranty and some common nosocomial pathogens (i.e. *Clostridium difficile* spores) cannot be inactivated by alcohol-based disinfection.

Therefore is an obvious demand for new approaches to ensure patient safety and minimize risks posed by contaminated computers and mobile phones in clinical settings.

Further research is needed on mobile electronic devices in relation to application of the modern technologies already successfully used for improving cleaning and disinfection of environmental surfaces in hospitals. "Self-disinfecting" surfaces have

been created by coating medical equipment with copper or silver.⁶ The potential of light-activated photosensitizers have been explored for application on surfaces and using light to generate reactive oxygen that can disinfect surfaces.⁷ “No-touch” single room ultraviolet-light decontamination technologies have been shown to reduce bacterial contamination of surfaces without the use of chemical compound.⁸

Our aim was to assess the efficacy of the Codonics D6000™ UV-C disinfection system to decontaminate tablet computers used and handled in a hospital setting.

Methods

Study Setting

D6000™ UV-C units were installed in two study-wards at a UK teaching hospital over five months period. Electronic hand-held tablets (Samsung Galaxy tablets and Apple iPads) used to record nursing and patient liaison activities were selected for inclusion in the trial on Ward A (Care of Elderly) and Ward B (Surgical Gastroenterology).

Trial I.

Tablet devices (without case) were either disinfected by inserting into the D6000™ UV-C disinfection unit on the “Max Defense” setting (~60s cycle) every second day [test ward], or not disinfected [control ward].

After 2 months, disinfection was terminated on the test-floor for a one-week period (washout-phase) and a cross-over performed for the remainder of the trial.

During the trial, surface sampling using blood contact plates (diameter 55 mm; Oxoid Ltd, Thermo Fisher Scientific Inc; Basingstoke, UK) were taken from adjacent points on the tablet screen before and after disinfection and also from the tablet case (pre-disinfection only).

Trial II.

Tablet devices from both study wards were disinfected daily using the D6000™ UV-C system. Tablets were separated into two groups:

Test array - Tablets with cases that fit the porthole of the D6000™

Control array - Tablets with cases that do not fit the porthole of the D6000™

Screen and cases were spot-sampled before and after disinfection. All contact plates were incubated aerobically at 37°C for 48 hours prior to reading.

Statistics

Medians for test and control group(s) were calculated and differences between sample populations determined using a t-distribution test. Level of significance was set at $\alpha=0.05$ and the test statistic (p) deemed significant where $p<0.05$.

Results

Trial I.

Bacterial contamination on the flat screen of hand held devices was low. The median aerobic colony count (ACC) on both wards was 9 [interquartile range (IQR) 5-18] cfu/25cm² (n=481 in total).

The contamination on the protective cases (Faux leather; ethylene-vinyl foam) was higher, than on the screen, median ACC was 42 (IQR 21-77.5) cfu/25cm² (n=479).

Codonics D6000™ UV-C disinfection technology effectively decontaminated tablets on the test wards to below the detection limit (median ACC was 0cfu/25cm²) but they were recontaminated to the baseline level within 48 hours (Figure 1).

Trial II.

Contamination on screen was further reduced by disinfecting the devices daily compared to 48 hourly disinfection, the median ACC was 2.5 (IQR 1-6.75) cfu/25cm² (n=102 in total).

The median ACC on the screens of the tablet devices in the control and the test arrays was 4 (IQR 2-9) cfu/25cm² and 2 (IQR 1-4.5) cfu/25cm² respectively (p=0.0504) (Figure 2).

Control cases - too bulky or wider to fit into the portal on the D6000™ - were significantly more contaminated (p<0.0001) with bacteria than test cases which could be disinfected with this technology. The median ACC on the control and the test cases was 52 (IQR 33-89) cfu/25cm² (n=51) and 22 (IQR 10.5-41) cfu/25cm² respectively (n=51).

Discussion

A completely flat profile of computer keyboards is one of the most important features in achieving low bacterial counts.^{1; 9}

Bacterial contamination on the flat screen of hand held devices was low in our study; the median ACC was 10 (IQR 6-14.5) cfu/25cm² during the pre-intervention period on both wards (n=39).

Codonics D6000™ UV-C disinfection technology effectively decontaminated tablets on the test wards to below the detection limit (median ACC was 0cfu/25cm²) but they were recontaminated to the baseline level within 48 hours, therefore significant difference between control and test keyboard screen contamination could not be achieved.

Followed the company (Codonics Incl, Middleburg Heights, Ohio, USA) protocol; screen and the protective cases of tablet computers were disinfected daily on two hospital wards.¹⁰ The median ACC was reduced to 2.5 (IQR 1-6.75) cfu/25cm² (samples were taken before UV disinfection). Very low level surface contamination was assured by daily disinfection of tablet devices with D6000™.

The surface of the protective cases was significantly more contaminated with bacteria than the flat screen surface. Some cases could not be disinfected by this technology because these cases were too bulky or wide to fit into the portal on the D6000™. These cases (control) were significantly more contaminated ($p < 0.5$) with bacteria than test cases which could be disinfected with this technology.

Our results suggest that UV-based decontamination technology would provide a quick and efficient method for the disinfection of mobile devices such as tablet computers and mobile phones in healthcare settings.

Conclusion

Codonics D6000™ effectively reduced contamination on tablets used in healthcare environment, but not all protective cases could be decontaminated by this method. There is no generally accepted guidance how to reduce contamination on mobile

devices in healthcare settings hence there is an obvious demand for novel approaches to ensure patient-safety and minimize risks posed by contaminated computers and mobile phones in clinical settings and/or standardize protective cases to ones than can easily be decontaminated.

Acknowledgements

The project was presented as a poster at the Federation of Infection Societies (FIS) Annual Conference and the 10th Healthcare Infection Society (HIS) International Conference; Edinburgh, United Kingdom, Nov 2016. M. Muzslay, S. Yui, S. Ali, A.P.R. Wilson. Hand-held device decontamination within healthcare environment.

Conflict of interest

None

Funding Sources

This study was funded by unrestricted grant from Codonics Inc. (USA). Equipment (D6000™) was provided free-of-charge by Codonics. Financial support was provided to subsidise microbiological media costs. However, Codonics was not involved in the study design, outcome or writing and editing of the article.

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Figure 1. Aerobic bacterial contamination on hand-held device screen and case in hospital setting in Trial I. Error bars indicate interquartile range.

Tablet devices (without case) were either disinfected by D6000™ UV-C unit every second day [test ward], or not disinfected [control ward].

Preliminary phase: Pre-intervention. Baseline bacterial contamination on hand-held devices. Disinfection by Codonics D6000™ UV-C units was not performed.

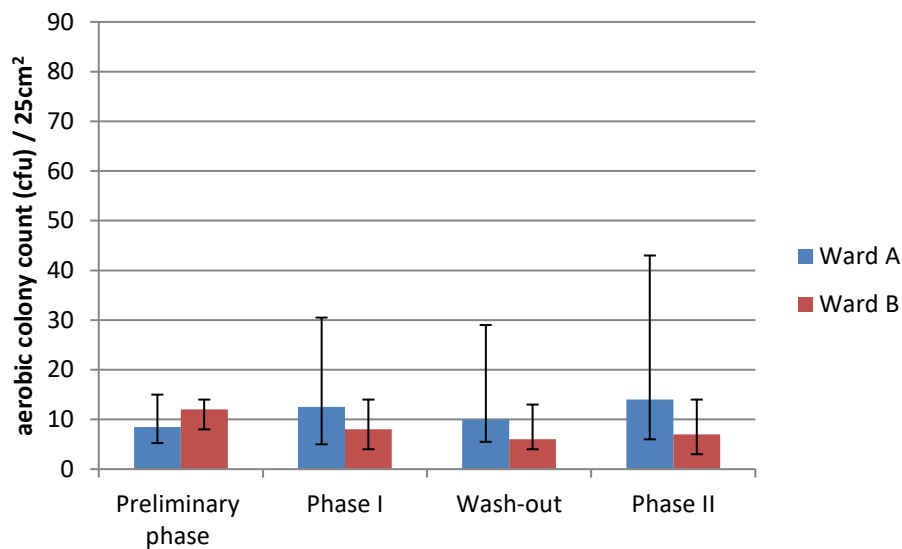
Phase I: Tablet devices were disinfected on the test floor (Ward B) every second day.

Wash-out period: No disinfection.

Phase II. Tablet devices were disinfected on the test floor (Ward A) every second day.

Ward A: Care of Elderly and Ward B: Surgical Gastroenterology.

A) Aerobic bacterial contamination on hand-held device screen.



B) Aerobic bacterial contamination on the protective cases of the tablet devices.

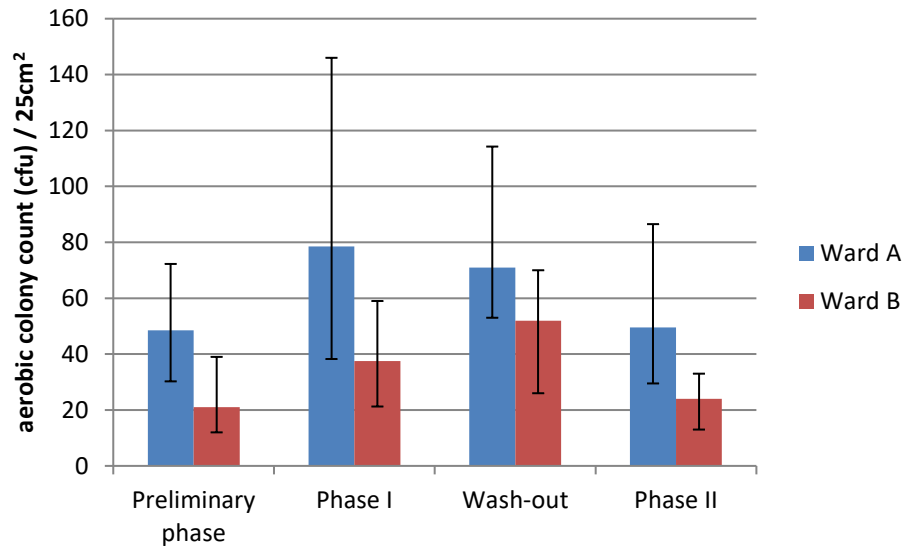


Figure 2. Aerobic bacterial contamination on hand-held device screen and case in hospital setting in Trial II. Error bars indicate interquartile range.

All tablet devices were disinfected daily using the D6000™ UV-C system.

