Quality Improvement Study

Medicine®

OPEN

Plastic wrap combined with alcohol wiping is an effective method of preventing bacterial colonization on mobile phones

Yen-Hung Wu, MD[a,b], Chao-Ju Chen, MD[c], Hsiu-Yueh Wu, MS[d], I Chen, MHA[e], Yi-Hsuan Chang, MBA[f], Pei-Hsuan Yang, PhD[g], Tzu-Yi Wang, MD[a], Li-Chin Chen, MHA[h], Kuan-Ting Liu, MD[a], I-Jeng Yeh, MD[a,b], Deng-Chyang Wu, MD, PhD[i,j,k], Ming-Feng Hou, MD, PhD[l], Hsin-Liang Liu, MD[a,*], Wen-Hui Su, MHA[l,*]

Abstract

Introduction: Using mobile phones for communication in emergency departments is a common practice; however, several studies have demonstrated that they may act as vectors for bacteria and viruses. This study evaluated the effectiveness of plastic wrapping in decreasing bacterial contamination on mobile phone surfaces.

Method: We used culture dishes and a luminometer to detect bacterial colonies and contamination on the phone surfaces.

Result: Our experiment showed that bacterial colonies exist on mobile phones before and after work. We found that wiping with 75% alcohol sanitizers effectively reduces the number of colonies on either a mobile phone or a temporary plastic covering. In addition, we found that bacterial colonies do not contaminate or adhere to plastic wrap any easier than to mobile phones.

Conclusion: These results demonstrated the effectiveness of plastic wrap for protecting mobile phone surfaces against bacterial colonization. In addition, applying a layer of plastic wrap protects the phone from potential damage due to the alcohol.

Abbreviation: COVID-19 = coronavirus disease 2019.

Keywords: alcohol, bacteria, infection prevention, mobile phone, plastic wrap

1. Introduction

Nosocomial infection prevention is a major challenge for emergency department. Patients in the emergency room may not only be infected while receiving treatment, but may infect other patients or hospital staff due to their own diseases. Bacteria and viruses can be transmitted by airborne droplet nuclei, large particle droplets, or direct contact with patients and their immediate environment.[1]

There are many recommendations for the control and prevention of hospital infections, including environmental hygiene, hand hygiene, antibiotic stewardship, and vaccinations, etc.[2,3] Among them, hand hygiene is the simplest method, and many studies have confirmed that frequent washing can effectively control and prevent infections.[4,5]

Using mobile phones for communication is a common practice in emergency departments; however, several studies have demonstrated that they may act as vectors for bacteria and viruses.[6–9] Therefore, some hospital staff members began wrapping their mobile phones in plastic because they thought this would decrease the chances of contamination. This study evaluated the effectiveness of plastic wrapping in decreasing bacterial contamination on mobile phone surfaces.

2. Method

We utilized the mobile phones of 6 people working in the emergency department with 2 people per group. When the first 2 people worked together, they randomly decided who would use a phone with a plastic wrap. When the next 2 people worked together for the next phase of the experiment, the mobile phone

Editor: Grant R. Campbell.

The authors have no funding and conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

[a] Department of Emergency Medicine, Kaohsiung Medical University Hospital, [b] Graduate Institute of Clinical Medicine, College of Medicine, [c] Department of Laboratory Medicine, [d] Department of Nursing, [e] Division of Financial Management, [f] Administration Center, [g] Department of Nursing, Department of Renal Care, School of Nursing, Fooyin University, [h] Department of Nursing, Kaohsiung Medical University, [i] Division of Gastroenterology, Department of Internal Medicine, [j] Cell Therapy and Research Center, Kaohsiung Medical University Hospital, [k] Regenerative Medicine and Cell Therapy Research Center, [l] Department of Superintendent office, Kaohsiung Medical University Hospital, Kaohsiung Medical University, Kaohsiung, Taiwan.

[*] Correspondence: Wen-Hui Su, Department of Superintendent office, Kaohsiung Medical University Hospital, No. 100 Shichuan 1st Rd., Kaohsiung 80708, Taiwan (e-mail: wenhui20house@gmail.com); Hsin-Liang Liu, Department of Emergency Medicine, Kaohsiung Medical University Hospital, No. 100 Shichuan 1st Rd., Kaohsiung 80708, Taiwan (e-mail: cutelpliu@gmail.com).

How to cite this article: Wu Y-H, Chen C-J, Wu H-Y, Chen I, Chang Y-H, Yang P-H, Wang T-Y, Chen L-C, Liu K-T, Yeh I-J, Wu D-C, Hou M-F, Liu H-L, Su W-H. Plastic wrap combined with alcohol wiping is an effective method of preventing bacterial colonization on mobile phones. Medicine 2020;99:44 (e22910).

Received: 15 May 2020 / Received in final form: 14 August 2020 / Accepted: 25 September 2020

http://dx.doi.org/10.1097/MD.0000000000022910

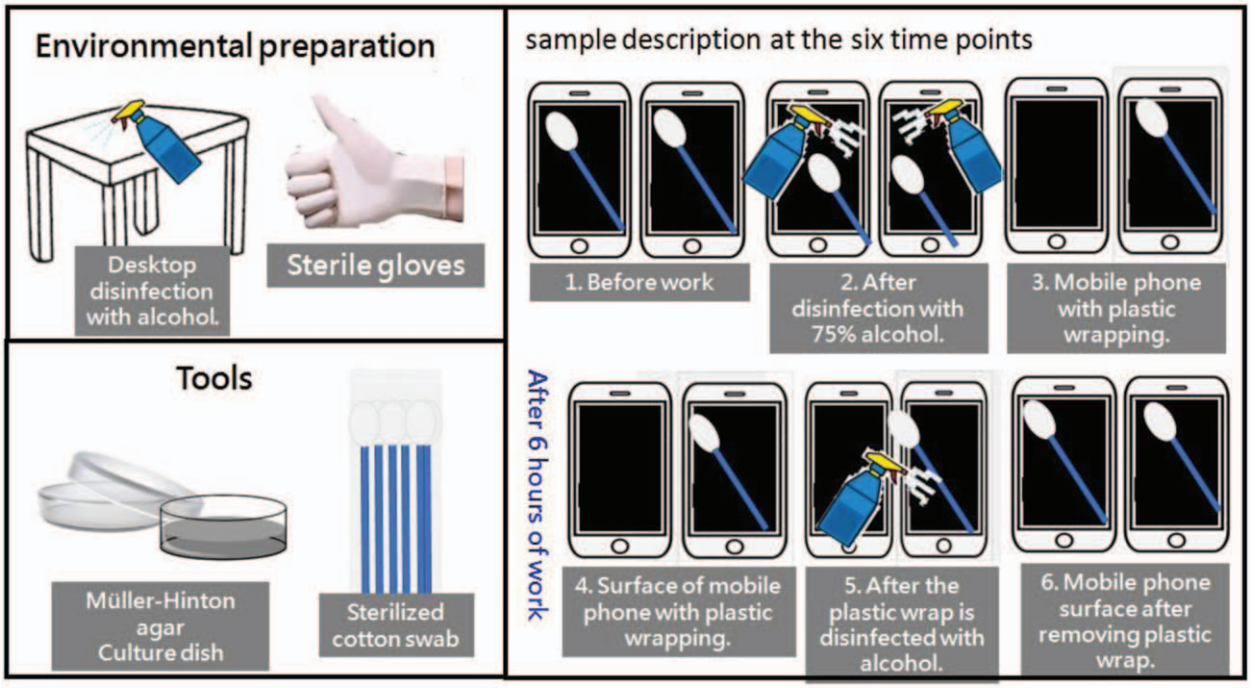

Figure 1. The experimental process and sample description at the 6 time points.

was replaced and enclosed in a new plastic wrap package. A total of 4 phases were conducted for each group, that is, twice with plastic wraps and twice without.

We recorded the bacterial colonization on the mobile phone surfaces at various time points (Fig. 1). We used cotton swabs to collect the bacteria on the phone after each 6-hour work shift. We also used sterilized cotton swabs to scratch the smart phone surfaces and used these to create agar plates. After a 48-hour incubation period in a 37°C aerobic environment, we counted the bacterial colonies growing on the surface of the Mueller-Hinton agars. To reduce the chance of bias, the same person collected the swab and wrapped the mobile phone. The practical steps for this procedure are shown in Figure 1.

After using culture dishes to detect the cultured bacterial colonies, we used a 3 M Clean-Trace NG luminometer (Taipei, Taiwan) to detect colonies on the phone surfaces. This luminometer is used with Clean-Trace adenosine triphosphate surface tests and water tests to determine the level of contamination in a sample, and results are available in seconds. Adenosine triphosphate is a standard measurement of biological residue and an effective marker to assess the hygienic status of an environmental surface. The 3 M Clean-Trace Luminometer cell counts are measured by levels of adenosine triphosphate.[10] The steps and times of the experiment are identical to the culture dishes, as is the number of experiments.

The statistical methods employed included Wilcoxon signed rank tests and Mann–Whitney *U* tests to analyze whether there were notable differences before and after alcohol disinfection. After a work shift, the differences in the degree of bacterial colonies or contamination on the surface of the mobile phones before and after wrapping them in plastic were recorded. This research does not involve the collection of any medical records and body fluids related to the human body. It is only to detect the bacteria colony on the mobile phone. The institutional review board of the Kaohsiung Medical University Hospital waived the need for ethical approval for this study.

3. Results

The results collected from the culture dishes and luminometer recordings are shown in the appendix file. In this experiment, the initial time point represented the condition of the mobile phone prior to work. It was clearly shown that bacteria on the surface of the mobile phones were brought into the hospital from home.

When we compared the first and second time points by means of Wilcoxon signed rank tests, we found that 75% alcohol sanitizers effectively reduced the bacterial colonies on mobile phone surfaces ($P < .05$; Table 1). We compared the fourth and fifth time points and found the same result. In other words, with or without the plastic wraps, a 75% alcohol solution effectively reduced the colonies ($P < .05$; Table 1). At the third time point of the experiment, the recently placed plastic phone wraps were almost sterile, and they were made even cleaner after disinfection with the alcohol sanitizer.

We then compared the data of the mobile phones with no plastic wrap at the sixth time point to the fourth time point with

Table 1

The effect of alcohol disinfection on the surface of mobile phone and plastic wrap.

	Before alcohol	After alcohol	*P* value
Time point I and II (n = 24) (The mobile phone surface)			
Culture dish	11.46 ± 17.118	0.21 ± 0.658 (24)	**$P < .0005$**
Luminometer	828.42 ± 720.093	29.37 ± 14.331 (24)	**$P < .0005$**
Time point IV and V (n = 12) (The plastic wrap on the surface of the mobile phone)			
Culture dish	7.75 ± 7.956	0.17 ± 0.389	**$P = .003$**
Luminometer	425.25 ± 335.726	22.83 ± 8.601	**$P = .002$**

Table 2

Comparison of the number of bacterial colonies and contamination on mobile phones with and without plastic wrap.

	Experimental group with plastic wrap (n = 12)	Control group without plastic wrap (n = 12)	*P* value
Time point I (Before work)			
Culture dish	10.75 ± 14.937	12.17 ± 19.711	*P* = .817
Luminometer	827.17 ± 792.252	829.67 ± 675.679	*P* = .817
Time point II (Before work post alcohol disinfection)			
Culture dish	0.25 ± 0.866	0.17 ± 0.389	*P* = .615
Luminometer	29.25 ± 13.778	29.50 ± 15.477	*P* = .773
Time point IV and VI (After work)			
Culture dish	7.75 ± 7.956	8.42 ± 17.686	*P* = .383
Luminometer	425.25 ± 335.726	617.50 ± 472.748	*P* = .248
Time point VI (After work, remove plastic wrap)			
Culture dish	0.08 ± 0.289	8.42 ± 17.686	**$P < .0005$**
Luminometer	33.67 ± 17.778	617.50 ± 472.748	**$P < .0005$**

plastic wrap using a Mann–Whitney *U* test. After the work shift, we found that there were colonies attached to the surfaces of both the mobile phones and the plastic wraps. There were no obvious differences between the 2 groups ($P > .05$; Table 2). Finally, we compared the mobile phones with and without plastic wraps at the sixth time point. We found that the plastic wraps significantly reduced the number of bacterial colonies on the mobile phone surfaces ($P < .05$; Table 2).

4. Discussion

Bacteria and viruses can be spread in three main ways: droplets, contact exposure and airborne. The common pathogens transmitted by droplets include *Hemophilus influenzae*, Group A *Streptococcus*, *Bordetella pertussis,* respiratory viruses, seasonal influenza and meningococcal disease. As part of standard precautions, wearing a surgical mask can provide adequate droplet protection for the health care professional.[11]

As for contact exposure-related transmission, according to previous studies, patients infected or colonized with multidrug-resistant organisms can be found in the emergency department. The pathogens transmitted in this manner include methicillin-resistant *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Enterobacteriaceae*, vancomycin-resistant *Enterococcus*, vancomycin-resistant *Enterococcus*, *Acinetobacter baumannii* and other enteric pathogens. Contact prevention measures require the use of protective clothing and gloves during patient care to prevent healthcare personnel from being infected by these pathogens and spreading them to other patients.

As for airborne transmission, the pathogens which can potentially be transmitted in the emergency department such as tuberculosis, measles, varicella, influenza, and even severe acute respiratory distress syndrome. Appropriate protection to prevent droplet being infected by nuclei in the air requires the use of N95 or electric purifying air respirators. After the coronavirus disease 2019 (COVID-19) broke out in Wuhan, China, in December 2019, it quickly spread worldwide.[12] The first COVID-19 case in Taiwan was confirmed on January 21, 2020.[13] Several strategies for infection prevention in hospitals were suggested, such as limiting the number of simultaneous visitors, drive-through pharmacies for long-term medication control patients, new equipment and methods for testing patients suspected of being infected with COVID-19, and denying hospital admission when a patient had either previous contact or travel history and was presenting signs of fever or upper respiratory infection. Hand hygiene using alcohol-based hand sanitizers is practiced worldwide to prevent COVID-19 cross-transmission, and it has been one of the most effective, simplest and cheapest procedures.[14]

In today's world, electronic devices like mobile phones, laptops, and desktop computers are essential parts of daily life. Although people are taught to wash their hands frequently and to maintain good overall hygiene, they may not clean these devices (e.g., touch screens, keyboards) as often as they should. According to previous research, bacteria may not only collect and live on keyboards[6] but also on the surfaces of mobile phones.[7] The most common pathogens found on mobile phones include Coagulase-negative *Staphylococcus*, *S. aureus*, *Micrococcus* species, *Enterobacter* species, *Escherichia coli*, *Klebsiella* species and *Enterococcus* species. This includes not only pathogens but also bacteria that are resistant to many drugs such as methicillin-resistant *S. aureus*.[8] In addition, viruses may also be present on mobile phones. Viruses previously found on mobile phones include influenza viruses, noroviruses, rotaviruses, and respiratory syncytial viruses.[15,16] The transmission of infections via mobile phones is not limited to medical care institutions because phones are ubiquitous in every community and have proven to be a possible vehicle for transmission.[17]

Although previous research has found that 70% alcohol wipes can effectively reduce the amount of colonies and further reduce the risk of nosocomial infections,[18] alcohol can cause damage to their phones, which may account for people being reluctant to adopt this method.

Based on the results of our experiment, bacterial colonies may be present on mobile phones before and after medical personnel use them at work. Wiping with 75% alcohol sanitizers can effectively reduce the number of colonies on either a mobile phone or its temporary plastic covering. Plastic wrap is cheap and easy to replace. A mobile phone wrapped with plastic can be fully disinfected with alcohol while avoiding having the alcohol contact the phone itself. In addition, we found that bacterial colonies do not contaminate or adhere to plastic wrap any easier than to mobile phones.

The results of the 2 experimental methods (luminometer and culture dish) demonstrated the effectiveness of plastic wrap for protecting mobile phones. The 2 methods have advantages and disadvantages. Culture dishes are very cost effective, but they require incubation and take a long time to produce results. Luminometers produce results much faster but are more expensive.

5. Limitations

Our research has several limitations, such as the small sample, the difference in personal hygiene habits between participants, the differences in workload and the amount of contact with patients, and the size of mobile phone brands among other possible factors that may affect results. To mitigate potential bias, the sampling, plastic wrapping and calculation of the number of colonies on wraps and phones were all conducted by the same person.

6. Conclusion

To summarize the results of our experiment, we believe that encasing mobile phones in plastic wrap is an effective method of preventing them from becoming vectors for bacterial transmission.

Author contributions

Conceptualization: Deng-Chyang Wu, Ming-Feng Hou.
Data curation: Chao-Ju Chen, Li-Chin Chen.
Investigation: Yen-Hung Wu, Hsiu-Yueh Wu, Pei-Hsuan Yang, Tzu-Yi Wang, Hsin-Liang Liu.
Methodology: Yen-Hung Wu, Chao-Ju Chen, Tzu-Yi Wang, Hsin-Liang Liu, Wen-Hui Su.
Project administration: Wen-Hui Su.
Resources: I Chen, Yi-Hsuan Chang, Pei-Hsuan Yang, Li-Chin Chen, Hsin-Liang Liu, Wen-Hui Su.
Software: I Chen.
Supervision: I-Jeng Yeh.
Visualization: Hsiu-Yueh Wu, Yi-Hsuan Chang, Kuan-Ting Liu, I-Jeng Yeh, Deng-Chyang Wu, Ming-Feng Hou, Hsin-Liang Liu, Wen-Hui Su.
Writing – original draft: Yen-Hung Wu, Wen-Hui Su.
Writing – review & editing: Kuan-Ting Liu, Hsin-Liang Liu.

References

[1] Liang SY, Theodoro DL, Schuur JD, et al. Infection prevention in the emergency department. Ann Emerg Med 2014;64:299–313.
[2] Mehta Y, Gupta A, Todi S, et al. Guidelines for prevention of hospital acquired infections. Indian J Crit Care Med 2014;18:149–63.
[3] Fernando SA, Gray TJ, Gottlieb T. Healthcare-acquired infections: prevention strategies. Intern Med J 2017;47:1341–51.
[4] Kingston L, O'Connell NH, Dunne CP. Hand hygiene-related clinical trials reported since 2010: a systematic review. J Hosp Infect 2016;92:309–20.
[5] Bolon MK. Hand hygiene: an update. Infect Dis Clin North Am 2016;30:591–607.
[6] Koscova J, Hurnikova Z, Pistl J. Degree of bacterial contamination of mobile phone and computer keyboard surfaces and efficacy of disinfection with chlorhexidine digluconate and triclosan to its reduction. Int J Environ Res Public Health 2018;15:2238.
[7] Karkee P, Madhup SK, Humagain P, et al. Mobile phone: a possible vector of bacterial transmission in hospital setting. Kathmandu Univ Med J (KUMJ) 2017;15:217–21.
[8] Rozario SR, Rahman H, Fakhruddin ANM, et al. Prevalence of multidrug-resistant bacteria on mobile phone surface. J Microsc Ultrastruct 2019;8:14–9.
[9] Chao Foong Y, Green M, Zargari A, et al. Mobile phones as a potential vehicle of infection in a hospital setting. J Occup Environ Hyg 2015;12: D232–5.
[10] Clean-Trace™ NGi Luminometer available at: https://multimedia.3m.com/mws/media/919873O/3mclean-trace-ngi-luminometer-and-docking-station-user-manual.pdf. Accessed April 1, 2020.
[11] Siegel JD, Rhinehart E, Jackson M, et al. Health care infection control practices advisory commitee. 2007 guideline for isolation precautions: preventing transmission of infectious agents in health care settings. Am J Infect Control 2007;35(Suppl 2):S65–164.
[12] Guan WJ, Ni ZY, Hu Y, et al. China medical treatment expert group for COVID-19: clinical characteristics of coronavirus disease 2019 in china. N Engl J Med 2020;382:1708–20.
[13] Liu YC, Liao CH, Chang CF, et al. A locally transmitted case of SARS-CoV-2 infection in Taiwan. N Engl J Med 2020;382:1070–2.
[14] Lotfinejad N, Peters A, Pittet D. Hand hygiene and the novel coronavirus pandemic: the role of healthcare workers. J Hosp Infect 2020;105:776–7.
[15] Pillet S, Berthelot P, Gagneux-Brunon A, et al. Contamination of healthcare workers' mobile phones by epidemic viruses. Clin Microbiol Infect 2016;22: 456.e1–6.
[16] Raoult D. The mobile phone as a vector for virus RNA: a link with Ebola outbreaks? Clin Microbiol Infect 2016;22:401.
[17] Bhoonderowa A, Gookool S, Biranjia-Hurdoyal SD. The importance of mobile phones in the possible transmission of bacterial infections in the community. J Community Health 2014;39:965–7.
[18] Schabrun S, Chipchase L. Healthcare equipment as a source of nosocomial infection: a systematic review. J Hosp Infect 2006;63: 239–45.