

Risk Factors of Bacterial Contamination on Healthcare Workers' Smartphone

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Abstract:

Smartphone is a rapidly growing communication and information technology. Smartphone has many advantages for healthcare workers in terms of communication and information access. Smartphones that are contaminated by bacteria carry significant risk for patients in hospital. Smartphone users' behavior is considered a factor that predisposes contamination of bacteria on the smartphones. The reasearch need to be done to investigate factors affecting bacterial contamination on healthcare workers' smartphones. This was an observational analytic study conducted using cross-sectional design. This study was conducted at PKU Muhammadiyah Gamping Hospital on April until June 2018. Study participants included 94 healthcare workers at PKU Muhammadiyah Gamping Hospital who met inclusion criteria, namely those who had and brought their smartphones. Each participant was asked to fill a questionnaire. Each smartphone was swabbed to obtain sample for culture with TSA medium, subsequently incubated at 37oC for 24 hours followed by gram staining. Data analysis was conducted using Chi Square or Fisher test. The results showed that 86.2% of healthcare workers used smartphone more than three times during work hours at hospital, 85.1% did not use smartphone during physical examination or therapeutic intervention, 73.4% did not clean their smartphone everyday, and 87.2% smartphone were contaminated by bacteria showing the morphology of gram negative bacilli and gram positive cocci. There was no significant influence of frequency of smartphone use at hospital ($p=1.000$), using smartphone during physical examination or therapeutic intervention ($p=0.686$), and cleaning smartphone everyday ($p=1.000$) on bacterial contamination on healthcare workers' smartphones. In conclusion, 87.2% of healthcare workers' smartphones were contaminated by bacteria. Frequency of smartphone use at hospital, smartphone use during physical examination or therapeutic intervention, and cleaning smartphone everyday did not affect bacterial contamination over healthcare workers' smartphones.

Keywords: risk factors; bacterial contamination; smartphone

Introduction

A total of 1.59 billion people in the world used smartphones, an increase of up to 2.48 billion in 2018. Indonesia ranks third with the highest smartphone users in Asia Pacific.¹

Smartphones are portable, flexible, multimedia access, and fast information, making it easier for health workers.² However, smartphones are considered dangerous for patients in hospitals. As many as 28.6% of the smartphones of health workers in South Korean teaching hospitals are contaminated with bacteria.³

There are several factors that cause bacterial contamination of smartphones. With a wider surface, more bacteria isolated from smartphones than non-smartphones.^{3,4} Pockets of clothes become a place for bacteria to grow on cell phones. Bacterial growth occurs in the cellphones of health workers who have never been cleaned with alcohol, do not wash their hands after using a cell phone, do not wash their hands before visiting patients, and cell phones that are used when visiting patients.⁵

Cell phones contain bacteria that cause nosocomial infections.⁶ The prevalence of nosocomial infections in Indonesia reaches 7.1%.⁷ In 2015, phlebitis infections occurred at 8.7 per mile, operating area infections (3.74%), and there was no incidence of infection caused by central vein insertion at PKU Muhammadiyah Gamping Hospital.⁸

This study aims to determine the factors that influence the contamination of germs on the smartphone of health workers. This research is expected to provide information related to the hand hygiene behavior of health workers.

Research Method

This was observational analytic research with a cross-sectional research design conducted at PKU Muhammadiyah Gamping Hospital from April to June 2018.

The population was health workers at PKU Muhammadiyah Gamping Hospital. Samples were taken using a purposive sampling technique who met the inclusion criteria including groups of health workers who own and carry smartphones. Health workers who were not willing to become respondents were excluded from the study. Determination of the sample size using the Lameshow formula with the minimum required sample size of 84 subjects.

The independent variables of this study were the factors that influence the contamination of germs, namely the frequency of smartphone use in the hospital, the use of smartphones when conducting examinations or maintenance actions, and cleaning smartphones every day.

The implementation of the research began with filling out an informed consent form and a questionnaire to obtain data on the behavior of health workers. Sampling using a sterile cotton swab moistened with physiological NaCl was rubbed on a smartphone screen with an area of 2x2 cm, then cultured onto TSA media. TSA media was incubated at 37°C for 24 hours in an inverted position. Colonies growing on TSA media were followed by gram staining. Data analysis used Chi square test or Fisher's test and calculated the Odds Ratio value to find out which group had a greater risk than other groups.

The data was analyzed using Chi square test or Fisher's test and calculates the Odds Ratio value to find out which group has the greater risk.

Result

Characteristics of respondents for this research listed in table 1.

Table 1. Characteristics of Respondents

Characteristics of respondents	Total	Percentage (%)
Gender		
Male	32	34.0
Female	62	66.0
Occupation		
Doctor	7	7.4
Nurse	71	75.5
Midwife	3	3.2
Pharmacist	1	1.1
Pharmaceutical technical personnel	2	2.1
Physiotherapist	4	4.3
Medical recorder and information	2	2.1
Radiographer	3	3.2
Medical laboratory technologist	1	1.1
Unit		
Surgery room	10	10.6
Inpatient room	52	55.3
Intensive care	11	11.7
Emergency room	7	7.4
Obstetric room	4	4.3
Laboratory	1	1.1
Radio diagnostic room	3	3.2
Medical rehabilitation room	4	4.3
Pharmacy room	2	2.1
Total	94	100,0

Table 1 showed that most of respondents are female health workers (66.0%), work as nurses (75.5%), and work in inpatient rooms (55.3%).

Table 2. Smartphone Use by Health Workers at PKU Muhammadiyah Gamping Hospital

Smartphone use	Total	Percentage (%)
Frequency		
1-3x	13	13.8
>3x	81	86.2
Use of Smartphone during patients check up		
Yes	14	14.9
No	80	85.1
The purpose of smartphone use		
Looking for information or case literature	69	73.4
Discussion with other health workers	79	84.0
Take case photos	70	74.5
Other	82	87.2

In Table 2. It can be seen that most of the respondents used smartphones more than three times while in hospital (86.2%), did not use smartphones when carrying out examinations or treatment actions (85.1%), used smartphones for other unrelated activities. with patient care (87.2%), not cleaning the smartphone every day (73.4%) and using tissue and alcohol as a cleaning tool (54.3%).

Table 3. Germ Contamination on Smartphones of Health Workers at PKU Muhammadiyah Gamping Hospital

Germ contamination	Total	Percentage (%)
Yes	82	87.2
No	12	12.8
	94	100

In Table 3. It is known that most of the smartphones of health workers are contaminated with germs (87.2%). Gram stain results show gram-negative rods and gram-positive cocci.

Table 4. Analysis of Risk Factors for Germ Contamination on Smartphones

Variable	Germ's contamination		Total	OR (95%)	P value
	Yes	No			
Frequency					
1-3x	1	12	13	0.530	1.000
>3x	11	70	81	(0.06-4.49)	
Smartphone Use					
No	11	69	80	2.072	0.686
Yes	1	13	14	(0.25-17.46)	
Smartphone cleanse					
Yes	3	22	25	0.909	1.000
No	9	60	69	(0.23-3.67)	

In Table 4. It can be seen that there is no significant effect of the frequency of smartphone use on the contamination of germs on the smartphones of health workers ($p=1,000$). Table 4 shows that there is no significant effect of smartphone use during examination or action on germ contamination on health workers' smartphones ($p=0.686$), and there is no significant effect of daily smartphone cleaning on health worker's smartphone contamination ($p=1,000$)

Discussion

It was reported that as many as 87.2% of health workers' smartphones were contaminated with germs. The prevalence of germ contamination on mobile phones belonging to health workers varies from 43% to 97.8%.^{9,10} The prevalence of different germ contamination from a number of studies can be influenced by differences in the screen area of the cell phones studied, differences in sample culture methods, and characteristics of health workers.

Smartphones have a large screen surface, increasing the risk of microorganism contamination. The streak plate method produced a statistically higher number of organisms than the pour plate method. The streak plate method is considered easier to use in bacterial detection research than the pour plate method¹¹.

Bacterial contamination on the mobile phones of female health workers is high due

to the habit of lending mobile phones to others.¹² Meanwhile, bacterial contamination on the cellphones of male health workers is also high because they rarely clean their cellphones, and personal hygiene is low.^{13,14} Bacterial contamination on mobile phones of doctors and nurses is high.¹⁵ Bacterial contamination on mobile phones of health workers who work in inpatient rooms is high because health workers examine several patients with varied personal hygiene and lower hand washing compliance than health workers in the operating room.^{16,17}

The morphology of the bacteria isolated from the smartphone of health workers at PKU Muhammadiyah Gamping Hospital were gram-negative rods and gram-positive cocci. Coagulase negative *Staphylococcus* and *Staphylococcus aureus* were the most commonly isolated bacteria from cell phones.¹⁸ The most common gram-negative bacteria isolated from cell phones include *Escherichia coli*, *Acinetobacter* sp, *Pseudomonas* sp, and *Klebsiella* sp.^{19,20,21}

There is no significant effect of the frequency of smartphone use in hospitals on the contamination of germs on the smartphones of health workers. A similar result was reported by a study that the higher the frequency of using mobile phones during working hours, the more mobile phones of health workers were contaminated with bacteria although there was no statistically

significant effect ($p=0.384$).¹⁰ It is different from other studies that the frequency of cell phone use has a significant relationship with *Staphylococcus aureus* colonization on nurses' cell phones with OR = 0.18322.²²

Differences in research results can be caused by the time of data collection, shared use, and contamination of germs from the community. In this study, data were collected on the morning shift, afternoon shift, and night shift as well as at the beginning, middle, and end of each work shift without classifying time differences. retrieval of the data. There was a significant decrease in germ contamination on the cellphones of health workers at the end of working hours because health workers cleaned cellphones during work shifts. The night shift has the potential to have a higher prevalence of germ contamination on mobile phones than the day shift and morning shift.²³ This study did not investigate further whether health workers lend their personal smartphones to others and whether these smartphones are also used outside the hospital because germ contamination can be obtained from other users and the environment outside the hospital and cross-contamination does not only occur inside the hospital. but also in the community.^{5,9,12,20}

There is no significant effect of using a smartphone when conducting an examination or action against germ contamination on the smartphone of health workers. The results of this study are supported by previous studies that there is no significant relationship between the use of mobile phones when visiting patients with germ contamination on mobile phones ($p = 0.139$).¹⁰

The number of germs on the hands of health workers has increased after using mobile phones. Microorganisms isolated from mobile phones are the same as

microorganisms isolated from the hands of health workers.²⁴ Few doctors wash their hands before or after using their mobile phones, especially if a call comes in while examining a patient.²⁵ If hand hygiene is inadequate and the organism is able to survive for several minutes in the hands of the health care provider, transmission of the pathogen through the hands of the health worker to other patients and inanimate objects can occur.²⁶

There was no significant effect of daily smartphone cleaning on germ contamination on the smartphones of health workers. Cell phones that are cleaned regularly contain lower germ numbers than cellphones that are not cleaned regularly, although not statistically significant.²⁷ The results of this study contradict a study that cell phones that are cleaned every day show 10% lower bacterial growth than cell phones that are not cleaned every day with p value = 0.049.¹⁰

The difference between the results of this study and previous studies can be influenced by cleaning tools and smartphone storage areas. The prevalence of mobile phones contaminated with pathogenic bacteria decreased from 83% to 8% after cleaning with a 32% isopropyl alcohol cloth. Lower alcohol concentrations are considered safe for Apple products, so they can be used by all mobile phones.²⁸ The germ number of smartphones cleaned with a microfiber cloth was 0.22 ± 0.10 CFU/cm², while a lower germ number was found in smartphones that were cleaned with an alcohol lens cloth of 0.06 ± 0.02 CFU/cm², but there was no difference. a statistically significant reduction in the number of germs.²⁹ Currently there is no specific guide for cleaning smartphones in hospitals, although a number of studies of smartphone cleaning tools have been carried out. Disinfectants should be able to reduce the number of germs without damaging the

cellphone because cell phone manufacturers prohibit the use of solutions on the cellphone screen.³⁰

Smartphone storage can also affect the contamination of germs. Cell phones stored in bags have the potential to be contaminated with germs due to transmission of germs from the bag. Meanwhile, mobile phones stored in clothes pockets are potentially contaminated because clothes that tend to be warm are breeding grounds for microorganisms that are resistant to dry environments such as *Staphylococcus sp* and *Acinobacter sp*.¹²

Conclusions

As many as 87.2% of health workers' smartphones are contaminated with germs. The factors in this study did not have a significant effect on germ contamination on the smartphone of health workers

Health institutions can consider limiting the use of smartphones in high-risk units, making Standard Operating Procedures for using smartphones in hospitals and increasing hand hygiene compliance controls for health workers.

Further research should improve and refine the limitations of this study and examine other factors. Health institutions should implement smartphone cleaning routines for health workers, improve hand hygiene compliance control, and consider limiting smartphone use in high-risk units

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