ORIGINAL ARTICLE

Knowledge, Attitude and Practice of Healthcare Personnel from Sultan Ahmad Shah Medical Centre IIUM on Microorganism Transmission via Mobile Phones

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Keywords:
mobile phone; fomites; healthcare personnel

Article history:
Received: 18 November 2024
Accepted: 27 January 2025

ABSTRACT

Background: Mobile phones, widely used across all ages and occupations, are high-touch surfaces with the potential to harbour pathogenic microorganisms. Their frequent use in hospital settings enhances medical communication but raises concerns about their role as reservoirs for microbial transmission. This study assessed the knowledge, attitude, and practice (KAP) of healthcare personnel at Sultan Ahmad Shah Medical Centre (SASMEC), IIUM, regarding microorganism transmission via mobile phones. **Methods:** A cross-sectional study involving 271 healthcare personnel was conducted using standardized questionnaires. KAP scores were evaluated through true/false questions, Likert scale statements, and practice assessments. Descriptive and inferential analyses were performed to identify factors influencing KAP. **Results:** Moderate knowledge (59%), good attitude (76.3%), and moderate practices (60.7%) were observed among respondents, with factors such as age and gender influencing scores. Recommendations include implementing UV-C disinfection devices and disinfectant wipes at phone hygiene stations. **Conclusion:** Enhancing healthcare personnel's awareness of microorganism transmission via mobile phones is critical to improving hand and mobile hygiene practices, reducing infection risks, and strengthening hospital infection control measures.

INTRODUCTION

The COVID-19 pandemic heightened global concerns about virus transmission, prompting preventive measures from authorities like the WHO and CDC. A key recommendation is disinfecting high-touch surfaces, including mobile phones, which are widely recognized as potential carriers of infectious diseases. Mobile phones are essential devices used across all demographics and serve as vital communication tools in hospitals, facilitating interactions between healthcare workers and patients. Zakai et al. (2016) highlighted improved medical outcomes in asthma and diabetes patients due to mobile phone use.

However, mobile phones in hospital settings raise concerns as reservoirs for pathogenic bacteria. Wagoner et al. (2019) noted that mobile devices, often kept warm and close to the body, provide ideal conditions for bacterial growth. AlOmani et al. (2020) found mobile phones to harbour more microorganisms than toilet seats, shoelaces, or doorknobs, prompting increased research into bacterial contamination on healthcare workers' phones.

Brady et al. (2012) first linked mobile phones to hospital-acquired infections, identifying contaminants such as coagulase-negative *Staphylococcus* and *Bacillus* spp. Similarly, Missri et al. (2019) found pathogenic bacteria on nearly 40% of mobile phones in a French ICU, emphasizing their role in microorganism transmission among healthcare staff.

This study offers critical insights into healthcare workers' knowledge, attitudes, and practices, identifying behavioural gaps to guide improvements in hygiene practices and reduce transmission risks in healthcare settings.

MATERIALS AND METHODS

Study Design and Setting

The study was approved by the Kulliyyah Postgraduate and Research Committee (KPGRC) and the IIUM Research Ethics Committee (IREC), ensuring respondent confidentiality. A cross-sectional survey was conducted from March to May 2021 to assess the knowledge, attitude, and practices (KAP) of healthcare personnel regarding microorganism transmission via mobile phones at SASMEC, IIUM.

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Study Population and Sampling

The study included healthcare personnel such as doctors, nurses, lab technologists, pharmacists, and administrative staff who used mobile phones during work hours and understood English or Malay. Practical students, interns, and non-phone users were excluded. Using the Raosoft Sample Size Calculator (5% margin of error, 95% confidence interval), a sample size of 301 was determined, accounting for a 10% dropout rate. Random sampling was employed, and an online questionnaire was distributed via WhatsApp.

Questionnaire Development

A structured questionnaire was designed and validated based on Kaliyaperumal's (2004) KAP guidelines, covering demographics, knowledge, attitude (Likert scale), practices, and open-ended questions on mobile hygiene practices.

Data Collection

Data were collected through self-administered questionnaires. Participation was voluntary, with informed consent obtained, and participants could withdraw at any time without losing benefits. Questionnaires were distributed online via Google Forms (shared through WhatsApp and email) and as hard copies to SASMEC healthcare personnel. Responses were analyzed using SPSS, with data assessed for normality prior to statistical tests. The scoring system for Knowledge, Attitude, and Practice (KAP) regarding pathogen transmission via mobile phones is detailed in Tables 1 and 2.

Table 1: Scoring system for different categories of KAP

Percentage of total score (%)	Total score of knowledge	Total score of attitude	Total score of practice	Category
≥70	19 - 26	32 – 45	19 – 27	Good
51 – 69	14 - 18	23 – 31	14 – 18	Moderate
≤50	0 – 13	10 – 23	10 – 14	Poor

Note. This scoring system was adapted from the study of Basir et al. (2020) with slight modification.

RESULTS

Sociodemographic Characteristics of Respondents

A total of 173 healthcare personnel from SASMEC@IIUM participated in the survey. Most respondents were female (69.9%) and aged between 26-33 years (53.8%). Nursing staff constituted the largest group (28.3%), while dieticians represented the smallest group (0.6%). Most respondents had 2-5 years of service (43.4%), and over half attended to patients daily (57.2%). All participants owned at least one mobile phone and brought it to work every day.

Table 2: Scoring system for each item in knowledge, attitude and practice

Response	Score
Knowledge	
Correct Statement	
True	2
Not sure	1
False	0
False statement	
True	0
Not sure	1
False	2
Attitude	
Positive statement	
Strongly agree	5
Agree	4
Neither agree nor disagree	3
Disagree	2
Strongly disagree	1
Negative statement	
Strongly agree	1
Agree	2
Neither agree nor disagree	3
Disagree	4
Strongly disagree	5
Practice	
Positive statement	
Often	3
Seldom	2
Never	1
Negative statement	
Often	1
Seldom	2
Never	3

Knowledge, Attitude, and Practice (KAP) Regarding Microorganism Transmission via Mobile Phones

Table 3 displays frequency distribution of scores (good, moderate and poor) for knowledge, attitude and practice towards microorganism transmission via mobile phones. The table shows that more than half of the staff falls in the category of moderate score for knowledge and practice with 59% and 60.7% respectively. However, the majority of the staff achieved good attitude scores with 76.3% and only 16.2% achieved moderate scores for attitude.

Most respondents (76.9%) recognized mobile phones as potential transmitters of microorganisms, but many underestimated the risks compared to other surfaces like toilet seats. While pathogen definitions and common fomites (e.g., doorknobs, mobile phones) were well understood, 17.3% were unsure about faucets as fomites (Table 4).

Attitudes towards hygiene were largely positive, with 76.3% of respondents scoring well. Most agreed microorganisms were present on mobile phones (66.5%) and supported regular cleaning (50.9%). However, 33.5% viewed indirect transmission as less severe than direct, and 36.4% were unsure about mobile phones causing healthcare-associated infections, highlighting awareness gaps (Table 5).

Mobile phone hygiene practices were moderate, with 60.7% scoring in the moderate range. Although 82.7% frequently used phones at work, only 31.8% cleaned them daily. Less than half practiced hand hygiene before (39.3%) and after (35.8%) phone use. Notably, 48.6% changed gloves before attending to patients after using phones, and 46.2% never shared their phones with others. (Table 6).

Table 3: Categories of knowledge, attitude, and practice scores concerning microorganism transmission via mobile phone (n = 173)

Category	Frequency	Percentage (%)
Knowledge		
Good (≥70%)	61	35.3
Moderate (51% – 69%)	102	59.0
Poor (≤50%)	10	5.8
Attitude		
Good (≥70%)	132	76.3
Moderate (51% – 69%)	28	16.2
Poor (≤50%)	13	7.5
Practice		
Good (≥70%)	52	30.1
Moderate (51% – 69%)	105	60.7
Poor (≤50%)	16	9.2

Table 4: Responses on knowledge concerning microorganism transmission (n = 173)

No.	Statements	True N (%)	False N (%)	Not Sure N (%)
1.	Pathogen can be defined as an organism that can cause disease to its host	**143 (82.7)**	1 (0.6)	29 (16.8)
2.	Microorganism may be transmitted via mobile phone.	**133 (76.9)**	14 (8.1)	26 (15)
3.	Mobile phones have lower risk to harbour microorganism as compared to toilet surfaces (e.g. door handles, toilet seat, and toilet flush handle).	84 (48.6)	51 (**29.5**)	38 (22)
4.	Cross-contamination (transfer of bacteria or other microorganisms from one substance to another) highly occurs on surfaces of healthcare related building (e.g. hospital) than public settings (e.g. supermarket).	116 (67.1)	**26 (15)**	31 (17.9)
5.	Most species of bacteria can only survive for two weeks on dry inanimate surfaces.	60 (34.7)	**18 (10.4)**	95 (54.9)
6.	Most viruses from the respiratory tract, such as *corona*virus, *influenza, SARS,* or *rhino*virus, can survive on dry inanimate surfaces for one to seven days.	**99 (57.2)**	21 (12.1)	53 (30.6)
7.	Major phones manufacturer (e.g. Samsung, Apple and Google) has published proper disinfections guide for mobile phone	**40 (23.1)**	87 (50.3)	46 (26.6)
8.	Hand sanitizer has the same effectiveness on reducing the number of microorganisms on hand as compared to soap and water.	111 (64.2)	**36 (20.8)**	26 (15)
9.	Below listed item(s) can be potentially categorized as fomite (Fomite: inanimate object that serves as a mechanism of transfer for infectious agents between hosts.)			
	(a) Doorknob	**160 (92.5)**	0	13 (7.5)
	(b) Mobile Phone	**155 (89.6)**	2 (1.2)	16 (9.2)
	(c) Stethoscope	**134 (77.5)**	7 (4.0)	32 (18.5)
	(d) Lift Button	**163 (94.2)**	0	10 (5.8)
	(e) Faucet/water tap	**138 (79.8)**	30 (17.3)	5 (2.9)

Note. Correct answers are in bold.

Table 5: Responses on attitude statements concerning microorganism transmission (n = 173)

No	Statement	Strongly Disagree n (%)	Disagree n (%)	Neither Agree nor Disagree n (%)	Agree n (%)	Strongly Agree n (%)
1.	I am aware that microorganisms are present on mobile phones.	9 (5.2)	4 (2.3)	13 (7.5)	32(18.5)	**115 (66.5)**
2.	I believe that microorganisms on mobile phones surface cannot be transmitted to human.	**67 (38.7)**	47 (27.2)	35 (20.2)	13 (7.5)	11 (6.4)
3.	I believe that indirect transmission of pathogens by touching mobile phones is not as severe as direct transmission such as person-to-person contact.	24 (13.9)	28 (16.2)	38 (22)	58 (33.5)	**25 (14.5)**
4.	I believe that touching a mobile phone using gloves is an improper action.	20 (11.6)	22 (12.7)	31 (17.9)	42 (24.3)	**58 (33.5)**
5.	I should only clean my hands after touching public surfaces (e.g. shopping cart handle).	**67 (38.7)**	25 (14.5)	21 (12.1)	33 (19.1)	27 (15.6)
6.	I believe that I would clean my phone more often if there was a readily accessible disinfection tool at the workplace	8 (4.6)	8 (4.6)	18 (10.4)	39 (22.5)	**100 (57.8)**
7.	I believe that frequent hand cleaning before and/or after touching mobile phones will reduce the presence of microorganisms on mobile phones.	9 (5.2)	8 (4.6)	16 (9.2)	44 (25.4)	**96 (55.5)**
8.	I believe that mobile phones are a source of healthcare associated infection.	10 (5.8)	15 (8.7)	63 (36.4)	40 (23.1)	**45 (26)**
9.	I believe that mobile phone should be cleaned on a regular basis.	10 (5.8)	3 (1.7)	28 (16.2)	44 (25.4)	**88 (50.9)**

Note. Correct answers are in bold.

Table 6: Responses on practice concerning microorganism transmission (n = 173)

No	Statement	Never N (%)	Seldom N (%)	Often N(%)
1.	I use my mobile phone at work	**1 (0.6)**	29 (16.8)	143 (82.7)
2.	I use my phone at least once every hour	**5 (2.9)**	45 (26)	123 (71.1)
3.	I clean my mobile phone with disinfection wipes/alcohol swabs every day.	26 (15)	92 (53.2)	**55 (31.8)**
4.	If I'm using my mobile phone with gloves on, I change the gloves before attending to the patient.	51 (29.5)	38 (22)	**84 (48.6)**
5.	I bring my mobile phone to the restroom/toilet.	**38 (22)**	71 (41)	64 (37)
6.	I use my mobile phone while eating during break time.	**18 (10.4)**	55 (31.8)	100 (57.8)
7.	I share my mobile phone with workmates or family members	**80 (46.2)**	57 (32.9)	36 (20.8)
8.	I clean my hands using alcohol wipes/hand sanitizers/soap and water before touching the mobile phone	17 (9.8)	80 (50.9)	**68 (39.3)**
9.	I clean my hands using alcohol wipes/hand sanitizers/soap and water after touching the mobile phone	29 (16.8)	82 (47.4)	**62 (35.8)**

Note. Expected answers are in bold.

Association of Sociodemographic Factors with KAP on Microorganism Transmission

As can be seen in Table 7, one-way ANOVA was used to analyze knowledge differences on microorganism transmission based on sociodemographic factors. Age group was found to significantly affect knowledge (p=0.018), with the group above 33 years old (M=16.50) scoring significantly lower than the group under 26 years old (M=17.89) and 26-33 years old (M=18.06) group.

Table 7: Comparison of total mean knowledge scores on microorganism transmission between different age group using one-way ANOVA test (n = 173)

Age Group	*n*	Knowledge score (%)		*F*-statistic *(df)*	*p*-value
		Mean	*SD*		
Under 26 years old	56	17.89	2.229	4.128	0.018*
26-33 years old	93	18.06	2.536	(2, 170)	
Above 33 years old	24	16.50	2.226		

**p* <0 .05 shows a significant difference.

Table 8 shows a significant difference in attitude scores based on age group (χ^2 = 8.842, p=0.012). The 26-33 years old group had the highest attitude score (mean rank = 92.42), with significant differences between under 26

years old and above 33 years old groups (p=0.008) and 26-33 years old vs above 33 years old (p=0.004).

Table 8: Comparison of attitude scores on microorganism transmission between age groups using Kruskal-Wallis test (n = 173)

Age Group	*n*	Mean rank	df	*χ 2*	*p*-value
Under 26 years old	56	89.89	2	8.842	0.012*
26-33 years old	93	92.42			
Above 33 years old	24	59.23			

**p<0.05* shows a significant difference.

Table 9: Comparison of practice scores concerning microorganism transmission between different genders and involvement in attending patient using Mann-Whitney U test (n = 173)

Gender	*n*	Mean rank	U	*z*	*p*-value
Female	121	93.70	2335.5	-2.699	0.007*
Male	53	71.41			

**p* < 0.05 shows a significant difference.

There were significant differences in practice scores between genders (p=0.007), with females having higher practice scores (mean rank = 93.70) (Table 9). There were also significant differences in practice scores between the age groups (χ^2 = 10.378, p=0.006), with the under 26 years old group showing the highest practice score (mean rank = 100.97). Post-hoc analysis revealed significant differences between under 26 years old and above 33 years old groups (p=0.005).

Suggestions for Reducing Microorganism Transmission via Mobile Phones in Hospitals

The respondents provided various suggestions to minimize microorganism transmission through mobile phones in hospitals. The most common recommendation (42 respondents, 50.6%) was to place UV phone sanitizers at designated hygiene stations. Other proposals included disinfection wipes (23 respondents, 27.7%), alcohol swabs (8 respondents, 9.6%), and plastic phone covers (10 respondents, 12.0%).

Additionally, respondents emphasised the importance of regular phone disinfection (37 respondents, 37.4%) and proper hand hygiene (32 respondents, 32.3%) before and after phone use. Other suggestions included reducing phone usage during work hours (19 respondents, 19.2%), increasing awareness through campaigns and training (9 respondents, 9.1%), and avoiding sharing personal phones (2 respondents, 2.0%).

DISCUSSION

KAP Concerning Microorganism Transmission via Mobile Phones

The webpage "How are COVID-19 key indicators trending in Pahang?" (2025) from the KKMNOW platform by the Ministry of Health Malaysia highlights a significant surge in COVID-19 cases in Pahang between March and May 2021. Cases increased sharply from 912 on 1 April 2021 to 4,399 on 1 May 2021, emphasizing the timeliness and relevance of conducting the study during this critical period.

During the study period, students were instructed to adhere to the Movement Control Order (MCO) implemented by the campus. While clinical postings at SASMEC were permitted, they were conducted under strict Standard Operating Procedures (SOPs) established by SASMEC. Students were strongly encouraged to minimise physical contact and avoid crowded areas within the hospital. To distribute the survey, hardcopies were provided to healthcare personnel who were accessible to the author. Additionally, online platforms were utilised to enhance data collection and ensure a more representative dataset.

Most respondents (59%) demonstrated moderate knowledge about microorganism transmission via mobile phones, influenced by their educational backgrounds (e.g., administrative staff, engineers, radiologists, doctors, and science officers) and increased awareness during the COVID-19 pandemic. As shown in Table 4, 67.1% of respondents agreed with Statement 4, believing that cross-contamination occurs more frequently in healthcare settings, reinforcing the perception of hospitals as high-risk environments during the outbreak. Meanwhile, 15% disagreed, and 17.9% were unsure, highlighting gaps in understanding microbial risks. Similarly, for Statement 5, more than half (54.9%) were uncertain about bacterial survival on dry surfaces, possibly due to limited microbiological knowledge among non-science professionals.

Misconceptions were also evident regarding microbial contamination levels on mobile phones compared to toilet surfaces and the survival of bacteria on dry surfaces. Although many respondents recognised the importance of hand washing, fewer understood the effectiveness of hand sanitizers, and awareness of mobile phone disinfection guidelines, such as those from manufacturers like Apple, was limited. These findings emphasise the need for targeted education to correct misconceptions and improve awareness of microbial transmission, especially during public health crises.

The majority (76.3%) exhibited good attitudes toward preventing microorganism transmission. Most acknowledged the potential contamination of mobile phones and agreed on the importance of regular disinfection. Studies, including those by Ulger et al. (2015) and Jalalmanesh et al. (2017), emphasise mobile phones as fomites for nosocomial infections. Respondents also agreed on the benefits of combining hand hygiene with surface cleaning to reduce contamination.

While 60.7% demonstrated moderate practices, nearly one-third showed good practices. Hence, inconsistencies in proper disinfection remain evident. Regular mobile phone cleaning and adherence to hygiene practices, such as hand washing, were the most reported actions, aligning with Malhotra et al. (2020), who emphasised the importance of workplace disinfection tools.

The vital role of mobile phones for healthcare personnel is evident, with 82.7% reporting frequent use at work. Despite high knowledge levels, a gap between awareness, attitude, and practice persists. For instance, while 67.1% of respondents recognized the risk of cross-contamination in healthcare settings (Statement 4), only 31.8% cleaned their phones daily, and 48.6% changed gloves after phone use before patient care. Furthermore, 37% admitted to bringing phones into restrooms, a known high-contamination area.

For Statement 5, uncertainty regarding bacterial survival on dry surfaces (54.9% Not Sure) likely contributes to these inconsistent practices. While respondents understand the risks of microbial transmission, translating this knowledge into reliable infection control practices remains a challenge. The anonymous nature of the survey encouraged honest responses, providing valuable insights into real-world behaviours. These findings underscore the need for targeted interventions to bridge the gap between knowledge and practice, ensuring consistent and effective infection control among healthcare professionals.

Factors Associated with KAP Concerning Microorganism Transmission via Mobile Phones

Age significantly influenced knowledge scores, with the 26–33 age group scoring highest and those above 33 scoring lowest. This contrasts with Desta et al. (2018), who found higher knowledge among older healthcare personnel. Younger personnel's higher scores may be linked to their active social media use, as highlighted by Hj Ahmad, Ismail, & Nasir (n.d.), where 18–34-year-olds are the largest social media users in Malaysia. Social media's role in sharing COVID-19 awareness likely enhanced their knowledge. Other factors, such as gender, staff category, and years of service, showed no significant impact on knowledge scores.

Attitude scores mirrored knowledge trends, with the 26–33 age group scoring highest. Post hoc tests revealed a significant difference between those above 33 and younger groups. These findings suggest that younger healthcare personnel's exposure to social media has positively influenced their attitudes, aligning with Ul Haq et al.'s (2012) definition of attitude as a predisposition shaped by knowledge.

Gender significantly influenced practice scores, with females scoring higher, which is consistent with findings from Jalalmanesh et al. (2017) and Mon et al. (2020), both of whom observed better phone hygiene practices among females. This study supports these findings, demonstrating a significant difference in practice scores between male and female respondents. Jalalmanesh et al. (2017) found that female medical students cleaned their phones more frequently than their male counterparts, resulting in lower levels of microbial contamination on their devices. Similarly, Mon et al. (2020) reported that females exhibited higher levels of mobile phone hygiene compared to males. These studies collectively highlight the gender-related differences in hygiene practices, particularly in healthcare settings, and underscore the importance of targeted interventions to improve phone hygiene among all healthcare personnel. Age also influenced practice scores, with significant differences between those above 33 and under 26, aligning with trends in knowledge and attitude.

Suggestions for Phone Hygiene Stations in Hospitals and Reducing Microorganism Transmission via Mobile Phones

Participants suggested various measures to improve phone hygiene in hospitals. The most recommended solution was the use of UV-C light technology, which has proven effectiveness in reducing bacterial contamination. Malhotra et al. (2020) demonstrated that a UV-C disinfection device reduced bacterial colonies by 99.9% after two cycles. This method is already widely used in hospitals to disinfect patient rooms, pharmacy clean-rooms, and operating rooms, proving effective against pathogens such as MRSA, *Clostridioides difficile*, and norovirus.

Another suggestion was the provision of disinfectant wipes or alcohol swabs at hygiene stations, as these are cost-effective, easy to implement, and effective. Studies, such

as Brady et al. (2012), showed a 79% reduction in bacteria after using 70% isopropyl alcohol wipes. Similarly, Leong et al. (2020) found that hygiene stations equipped with disinfectant wipes and educational materials increased daily phone cleaning among users. Plastic covers for phones were also proposed as a practical solution. Wu et al. (2020) found that temporary plastic wraps combined with alcohol wipes effectively prevent microbial colonization, with no additional contamination compared to uncovered phones.

To minimise microorganism transmission via mobile phones, respondents emphasised the importance of promoting frequent hand hygiene. Proper hand washing before and after phone use aligns with CDC (2020) guidelines, which highlight hand hygiene as one of the most effective measures against pathogen transmission, especially during the COVID-19 pandemic. Regular phone disinfection was another widely supported suggestion, with CDC guidelines recommending daily cleaning of high-touch surfaces like phones to reduce the risk of contamination and infection from virus-laden surfaces.

While some respondents suggested reducing phone use in healthcare settings, this approach is impractical due to the integral role of mobile phones in patient care (Ulger et al., 2015). Instead, implementing usage restrictions in high-risk areas, such as ICUs and operating theatres, was seen as a more feasible alternative. Increasing awareness among healthcare personnel was also proposed, with strategies such as regular announcements, posters, and signage emphasising phone hygiene and its role in pathogen transmission. Lastly, respondents highlighted the importance of avoiding phone sharing, as it significantly reduces the risk of cross-contamination.

CONCLUSION

This study found that healthcare personnel had moderate knowledge (60%) and practice (61%) but a good attitude (77%) regarding microorganism transmission via mobile phones. Age influenced KAP levels, with older personnel performing better. Implementing UV-C disinfection devices and providing disinfectant wipes at phone hygiene stations were the top recommendations. These findings can raise awareness, encourage regular hygiene practices, and guide SASMEC management in adopting preventive measures to reduce transmission risks.

ACKNOWLEDGEMENT

This research was funded by the Ministry of Higher Education, Malaysia through the Fundamental Research Grant Scheme (FRGS) for Research Acculturation of Early Career Researchers (Project ID: RACER 19-027-0027).

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