

Original Article

## A mHealth intervention to promote hand-washing and cell phone cleaning in medical residents of a public hospital in Peru

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### Abstract

**Introduction:** We explore the limitations to adherence of hand-washing and evaluate the impact of a mHealth intervention for hand hygiene in residents.

**Methodology:** We explore resident's perspectives about Hospital-acquired infections (HAI) and hand washing. In baseline, participants completed socio-demographic characteristics and hand-washing habits survey. The intervention consisted of sending SMS three times a week for two months about hand hygiene and “five moments” for hand washing. The cultures of hands and cell phones were analyzed at baseline, 2 months and 4 months. We used chi-square and adjusted Generalized Estimating Equations.

**Results:** Five physicians were interviewed and 33 participants were included for quantitative analysis. Critical barriers that hinder hand washing were identified. The proportion of *Staphylococcus aureus* in hands was 54.5% at baseline and was significantly reduced at 2 months follow-up ( $p = 0.009$ ), but, benefit was lost when the intervention was discontinued; *Escherichia coli* and *Klebsiella* sp. were observed in 22.2% of hands, no changes were noted with intervention. In cell phones, there was a tendency to lower values of bacterial colonization after intervention for *Staphylococcus aureus* growth.

**Conclusions:** High prevalence of contamination in hands and phones in medical residents were found. Serious barriers to compliance with hand washing must be overcome. It is possible that prolonged or continuous interventions could be necessary to optimize hand washing and reduce hand and cell phones contamination.

**Key words:** Hand washing; barriers; mHealth intervention; physician adherence.

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### Introduction

Hospital-acquired infections (HAI) increase morbidity and mortality [1,2] in hospitalized patients. Up to 40% of HAI can be attributed to cross-infection through the hands of healthcare providers or direct contact with inanimate surfaces - bedside tables, medical equipment, among other [3–5]. Mobile phones constitute a potential large source of contamination [6,7], their role as reservoirs is poorly understood, even when these devices are used by up to 98% of the medical personnel in hospital environments [8].

Hand-washing is known to be one of the most effective measures to control HAI and cross-infection [9–11]. However; successful implementation of appropriate hand-washing practices is still a challenge worldwide [12–15].

The use of mobile technology to promote wellness (mHealth) has proven to be an effective intervention model showing positive results in healthy lifestyle promotion [16–18] and patient engagement [19,20]. Latin American countries, including Peru, have implemented diverse strategies using text messaging [20–22] as an accessible and useful low cost tool to promote compliance in patients. Studies involving mHealth reminders for health personnel hand hygiene have shown a positive impact on adherence in the short term, improving compliance and allowing the identification of barriers for implementation of recommendations [20,22–24]. However, evidence in low- and middle- income countries and related to promote hand washing are scarce [12,25]. The low adherence of health providers to hand-washing habits

persists and further intervention is required. This situation is even more critical regarding mobile phone hygiene due to the lack of standardized guidelines.

The aims of this project are i) to explore the limitations of adherence to hand-washing in residents and ii) to evaluate if an intervention based on reminders of the five moments for hand hygiene [26,27] can have an impact on bacterial colonization in the hands and mobile phones of first year residents at a teaching hospital when comparing basal and post-intervention measurements.

## Methodology

### *Study design, participant recruitment and selection criteria*

We used a mixed methods approach. First, we interviewed second and third year residents of internal medicine then, we conducted a quasi-experimental study at a public hospital, a teaching hospital of Lima, Peru. This is a public hospital with a highly crowded emergency room and scarce resources. These aspects resulting in a low frequency of hand washing.

The inclusion criteria of the quasi-experimental study were: be a resident of first year of pediatrics or internal medicine and have shifts in the emergency room of the hospital.

### *Design of messages*

Two physicians searched previous studies about knowledge, aptitudes and practice of healthcare professionals to promote hand washing and prevention of nosocomial infection.

We based our messages in two key aspects: 1) Promote the five moments of hand washing according to other efforts of the Ministry of Health in Peru and 2) Deliver informative messages with evidence found in previous studies about methicillin-resistant *Staphylococcus aureus* in the hospital.

This information was used to design the messages (Messages in English and the original Spanish language are available in Supplementary Table 1)

### *Interview phase*

Before the intervention, we invited second and third year residents of internal medicine to be interviewed. We conducted semi-structured interviews with open ended questions to explore resident's perspectives about nosocomial infections, hand-washing practices, and interventions with short message service (SMS). We also validated our developed messages.

### *Baseline measures*

On the day of recruitment, after signed informed consent, baseline information from the participants was collected. This information included socio-demographic characteristics, self-reported hand-washing habits and availability and access to means of hand-washing including sinks, water, soap, and alcohol-based hand rubs.

The emergency room shift schedule was used to contact participants during the final hour of their shifts and take samples of the hands and cell phones.

### *Sampling and microbiological analysis*

Hands and cell phones were sampled at each evaluation point as follows. The dominant hand was sampled using the glove juice method using 10 mL of saline solution [28]. The main contact surfaces of cell phones were swabbed (touch screen or buttons, depending on the model). Aliquots (100 and 10µL) of the saline solution and cell phone swabs were inoculated in Trypticase Soy Agar (TSA) to obtain colony counts and Chocolate Agar, McConkey and Mannitol Salt agar to identify specific pathogens (*Escherichia coli*, *Klebsiella* sp. and *Staphylococcus aureus* respectively). Samples were processed by a clinical microbiology laboratory.

### *Intervention*

The SMS were delivered three times a week (Monday, Wednesday and Friday) for 2 months, SMS were sent between 7 and 8 o'clock from a cell phone. One of the researchers was responsible to send the messages.

The messages were developed and then validated with a group of residents and are available in Supplementary Table 1.

### *Follow-up assessment*

The follow up included a second and third assessment, two and four months from baseline respectively. The two-month follow-up corresponding to the end of the intervention included a new sample of the hands and cell phones. And the four-month follow-up included a third assessment of hands and cell phones samples.

### *Variables definition*

#### Exposure

Intervention.

#### Outcome

Number of bacterial colonies in hands, presence of resistant strains of *Escherichia coli*, *Klebsiella* sp. and

*Staphylococcus aureus* in hands and cell phones. Also we defined general contamination if participants had any of these bacteria.

Other variables measured include sex, age and specialty of the resident. Also, we collected self-reported information about the number of times the physicians washed their hands the day before, number of patients examined with unwashed hands, hand cleaner employed (water and soap or alcohol gel), number of times they cleaned their cell phone the last month, number of times they used their cell phone the day before, and the fieldworker verified presence of rings, long nails and particles in the nails (Yes/No).

### Sample size

We used a convenience sample of thirty three first-year residents from pediatrics and internal medicine specialties from the hospital. Most of the previous studies found 18% of change in adherence of hand-washing before and after interventions [29,30]. However, because of the characteristics of our study populations [31] and our outcome of interest we expect that our intervention can have an impact of 36%. Using STATA v. 12, we estimated the statistical power considering a change of 36% between the initial proportion of colonized hands and a final proportion post-intervention. We found a power of 78% with a confidence level of 95%.

### Statistical analysis

#### Qualitative analysis

Two authors (IBQ and MLP) read the interviews transcripts, created an initial codebook and proved the initial codes. They agreed on the final codebook and coded the remaining transcripts. Finally, authors identified patterns in the perspectives and experiences across participants and systematized the information.

#### Quantitative analysis

Demographics of the study population, potential confounding variables and frequencies of bacterial isolates were described through proportions, means and standard deviations (SD). Chi-squared was used to

address the relationship between positive cultures in colonized surfaces before intervention and socio-demographic and behavioral variables.

Generalized Estimating Equations (GEE) analysis was used to explore potential differences between the three measurement time-points. We showed the beta coefficient and 95% confidence intervals (95% CI) to show the effect between basal and 2 months and between 2 months and 4 months. The results were adjusted for potential confounders: age, gender and specialty.

### Ethics

The Institutional Review Board of the Universidad Peruana Cayetano Heredia and the Ethics Committee of the Hospital Cayetano Heredia approved this study. Every participant signed a written informed consent.

## Results

### Results from the qualitative analysis

We interviewed five internal medicine residents from second and third year. Interviewees were aged 28 to 32, and three of them were male.

#### Hand-washing: Limitations

The main limitation reported by all participants was that less than half of the times hand-washing stations were supplied suitably with soap, paper towel, alcohol-based hand rub. Three participants complained about the large number of patients that they evaluated during their shift (around 40). One of them said physicians did not have the habit of washing their hands and another participant mentioned the lack of knowledge of physicians (Table 1).

#### Hand-washing: Knowledge

Three participants reported that most residents knew the relationship between hospital-acquired infections and hand-washing. One of them considered that less than half of residents knew the five moments of hand-washing and another participant mentioned that more than half knew the five moments (Table 1).

**Table 1.** Quotes of the qualitative analysis.

Topic	Quotes
Hand-washing: Limitations	<i>There are only two faucets for the whole emergency. Usually there are not paper towels on the floors... (Participant 5)</i> <i>Doctors do not have the custom of washing hands after examining each patient. (Participant 1)</i>
Hand-washing: Knowledge	<i>I think all residents know the relationship between nosocomial infections and hand-washing. I have to wash before seeing the patient, after examination, before a procedure. (Participant 1)</i>
Use of cell phone during shifts	<i>Residents use their cell phones a hundred times per day, calling for a consultation. We use it as a calculator, like clockwork, as a stopwatch, for everything. (Participant 2)</i>
Interventions to improve hand-washing	<i>The incentive makes people change their behavior. (Participant 4)</i> <i>Make a meeting; tell them why they have to do it. They could also coerce them. (Participant 1)</i>

### Use of Cell phone during shifts

Participants reported using their cell phone in many ways during their shifts, for example: calculate doses of drugs, make calls or seek information through Internet. Two of the participants reported that despite its high frequency of use (20 to 100 times per day), they did not clean their phones regularly (Table 1).

### Interventions to improve hand-washing

Two participants suggested interventions to improve hand-washing. The proposals were aimed to encourage hand-washing or change the behavior of non-compliant physicians. One participant pointed out that ensuring sufficient supplies for hand-washing stations would allow behavior change (Table 1).

### Results from the quantitative analysis

Out of the 33 first year medical residents in the medicine and pediatric services, 32 signed informed consent, 28 completed the baseline information and only 22 completed the follow up measurements.

### General characteristics

Physicians' mean age was 31 (SD 6.0), 66.7% of them were females, 78.8% from Internal Medicine specialty and 18.2% from Pediatrics. Other baseline characteristics of the study participants are shown in Table 2.

### Baseline colonization of hands and cell phones

In hand samples, *S. aureus* was identified in 54.5% (12 / 22) and *E. coli* / *Klebsiella* sp. growth in McConkey agar was observed in 22.2% (4 / 22) of cultures (Table 3). The association between *S. aureus* and *E. coli* / *Klebsiella* sp. and general and behavioral characteristics are available in Supplementary Tables 2 and 3.

In cell phones samples, *S. aureus* was identified in 31.8% (7 / 22) of cultures and *E. coli* / *Klebsiella* sp. growth in McConkey agar in 9.1% (2 / 22) of cultures (Table 3).

We did not find methicillin resistant *S. aureus* (MRSA) or multidrug resistant Gram-negatives in the study samples of hands or cell phones.

### Follow up: Microbiological analysis in hands

#### Number of colonies in hands

No significant differences between baseline and both follow up measurements were found. However, the number of colonies in 10 $\mu$ L of TSA was significantly higher at the second month compared to the fourth month follow-up ( $p = 0.04$ ) (Table 4).

### Staphylococcus aureus in hands

The proportion of subjects who had *Staphylococcus aureus* in their hands decreased significantly after two months of intervention from baseline ( $p = 0.009$ ), and reached to basal values, after having suspended the intervention, when we compare the 2-month vs. 4-month follow up ( $p = 0.003$ ) (Tables 3 and 4).

### Escherichia Coli / Klebsiella in hands

No differences were found between time points for proportion of subjects who showed *E. coli* / *Klebsiella* growth when grown directly in McConkey (Tables 3 and 4). Additionally, none of isolates obtained produced Extended-Spectrum  $\beta$ -Lactamases (ESBL).

### General contamination in hands

There was a significant difference between baseline values and 2-month follow-up (54.6% vs. 36.4%,  $p = 0.004$ ) of general contamination in hands. However, general contamination increased significantly between the last two time points (36.4% vs. 68.2%,  $p = 0.005$ ) (Table 3). All comparisons were adjusted for age, gender and specialty.

**Table 2.** General characteristics of study participants at baseline.

Characteristic	N (%)
<b>Sex</b>	
Female	18 (64.3)
Male	10 (35.7)
<b>Age (years)*</b>	31 $\pm$ 6.0
<b>Specialty</b>	
Internal Medicine	24 (78.8)
Pediatrics	4 (18.2)
Times hands were washed the day before*	6.8 $\pm$ 3.3
<b>Hand cleanser employed</b>	
Water and soap	26 (78.8)
Alcohol based hand gel	2 (6.1)
Number of patients examined without washing your hands	4.4 $\pm$ 3.0
Times cellular phone was cleaned in the last month*	2.6 $\pm$ 3.7
Times cellular phone was used the day before*	9.1 $\pm$ 4.0
<b>Presence of rings</b>	
No	23 (69.7)
Yes	5 (15.2)
<b>Presence of long sleeves</b>	
No	27 (81.8)
Yes	1 (3.0)
<b>Presence of long nails</b>	
No	19 (57.6)
Yes	9 (27.3)
<b>Presence of dirty nails</b>	
No	25 (75.8)
Yes	3 (9.1)

\*Mean  $\pm$  SD.

**Table 3.** Frequency of positive cultures at different time points.

	Basal		2 months		4 months	
	n (%)	CI95%	n (%)	CI95%	n (%)	CI95%
<b>Hands</b>						
<i>Staphylococcus aureus</i>	12 (54.5%)	32.5% - 74.9%	4 (18.2%)	6.4% - 41.9%	13 (59.1%)	(36.5% - 78.4%)
<i>Escherichia Coli</i> / <i>Klebsiella</i> sp.	5 (18.2%)	(6.4% - 41.9%)	5 (22.7%)	(9.1% - 46.5%)	4 (22.7%)	(9.1% - 46.5%)
General contamination	12 (54.6%)	(32.5% - 74.9%)	8 (36.4%)	(18.2% - 59.5%)	15 (68.2%)	(44.7% - 85.0%)
<b>Cell phones</b>						
<i>Staphylococcus aureus</i>	7 (31.8%)	(14.9% - 55.3%)	6 (27.3%)	(11.9% - 50.9%)	5 (22.7%)	(9.1% - 46.5%)
<i>Escherichia Coli</i> / <i>Klebsiella</i> sp.	2 (9.1%)	(2.0% - 32.7%)	1 (4.5%)	(0.5% - 29.6%)	1(4.5%)	(0.5% - 29.6%)
General contamination	8 (36.4%)	(18.2% - 59.5%)	6 (27.3%)	(11.9% - 50.9%)	5 (22.7%)	(9.1% - 46.5%)

CI95%: Confidence Interval 95%.

*Follow up: Microbiological analysis in cell phones*

*Staphylococcus aureus*, *E. coli* / *Klebsiella* growth and general contamination did not show significant differences (Table 3).

**Discussion***Main Findings*

We found a worrisome frequency of bacterial colonization and presence of *S. aureus* and *E. coli* / *Klebsiella*. However, none of the isolates were resistant strains associated with hospital-acquired infections. After two months of intervention, the results only showed reduction in the proportion of *S. aureus* and general contamination, and a return to the basal level at the 4-month follow-up. These results were not found with number of colonies (bacterial concentration) and *E. coli* / *Klebsiella*, neither in hands nor cell phones samples.

It is possible that the positive effect of the intervention was not observed because hand measurements could have been taken immediately after having them washed or hours after, increasing variability greatly. Or it is also possible that the effect of the intervention can not materialize due to the severe difficulties and barriers described for hand washing.

*Comparison to other interventions*

Studies in other contexts show diverse results in comparison to our findings. A study that evaluated the colonization on hands of health workers by polymerase chain reaction assay found that 45% of 20 participants were positive for *S. aureus* during 10 days [32]. In

India, a study found 13% of *S. aureus* in hand of health workers and 6.5% were methicillin-resistant *Staphylococcus aureus* (MRSA) [33]. A study in a Portuguese hospital found MRSA on hands of 8.9% health workers [34]. Finally, a study evaluated different pathogens and found in hands of 132 physicians, 46.1% of *S. aureus*, 15% of *E. coli* and 1.5% of *Klebsiella* sp. [35].

These findings are difficult to compare to our context because of the differences in the sample technique, time of evaluation and hospital department evaluated. However, we found in the baseline evaluation higher rates of colonization by *S. aureus* (54.5%) and lower rates of MRSA in comparison to other studies. Whereas, our rates of *E. coli* / *Klebsiella* sp. (22.2%) were similar to other studies.

The presence of barriers like irritation of the hands, time spent for hand wash, lack of monitoring, absence of hospital guidelines and absence of facilities are often described as challenging [36]. Some of these barriers were described by participants in our qualitative results.

A study from a teaching hospital in Geneva evaluated the compliance of hand-washing before and during a campaign with posters in strategic areas showing the importance of hand disinfection and appropriate provision of soap, water and alcohol solution. After three years the compliance of hand-washing improved from 48% to 66%, additionally a decrease in nosocomial infections and MRSA transmission was found [29]. We have to mention that

**Table 4.** Effect of the intervention over time in the number of colonies and positive cultures.

	Number of colonies		<i>Staphylococcus aureus</i>		<i>Escherichia Coli</i> / <i>Klebsiella</i> sp.	
	Beta (CI95%)*	p	Beta (CI95%)*	p	Beta (CI95%)*	p
Basal	Ref		Ref		Ref	
2 months	235 (-13.6 - 483.6)	0.064	-1.61 (-2.83 - -0.41)	0.009	0.36 (-1.40 - 2.13)	0.687
4 months	-23.9 (-272.4 - 224.7)	0.04**	0.20 (-0.86 - 1.27)	0.003**	0.67 (-1.04 - 2.38)	0.713**

\*Adjusted by age, gender and specialist; \*\* p value of comparison between 2 months and 4 months.

the study site has posters in different areas; however, an appropriate compliance rate is not achieved [37].

A multifaceted educational program in the neonatal unit at a Children's Hospital also implemented an intervention during three years that was conducted to improve hand-washing compliance. Compliance increased from 42% to 55% after intervention and was maintained at 54% after 9 months [38]. The post-intervention evaluation of this study is similar to ours, however the time of their intervention was completely different, probably a longer intervention time could be necessary to achieved better compliance.

A clustered randomized trial evaluated 11 intensive care units from general hospitals in Argentina. They introduced a multimodal intervention including administrative participation. Physician compliance rose from 54.5% to 72% and they achieve a sustained effect after 5 months. Feedback and participation of the hospital authorities were important for the strategy of change [30].

#### *Importance to public health*

Previous studies implemented campaigns, multifaceted intervention programs and organizational hand-washing cultures; however, this process is high cost and need continuous monitoring. We proposed an intervention with SMS to promote hand-washing and cell phone cleaning that is low cost and easy to implement, nevertheless we could not find positive results.

Studies about innovative and cost-saving ways to implement hand-washing are always valuable but probably longer interventions and/or reinforcement of strategies are needed. Also, involvement of administrative staff, stakeholders and decision makers is essential.

Low- and middle- income countries have precarious health system and even the principal referral hospitals have high rates of HAI that generate a huge economic impact. For this reason, the use of mHealth or social media to promote hand-washing appear to be a pathway to solve the problem, and involvement of administrative staff, stakeholders and decision makers is essential.

#### *Strengths and Limitations*

Our study has some limitations, the first was insufficient power due to small sample size to find the expected results. Even when our power calculation was estimated in 78%, we only have follow-up information of 22 participants and that decreased our power to find the expected differences. However, the advantages are that we have a homogenous sample of first year

residents with similar shifts working in the study hospital.

Another limitation is our outcome measure. The culture results from the hands could have been affected by the last time the participants washed their hands, unlike cell phones which are seldom cleaned.

Additionally, we did not include a process evaluation study to explore how the intervention was deliver and explore if the participants read the completed message, if they understood the messages and if they agreed with the provided information.

Finally, an important and possible explanation for the unexpected results of our study, regardless of the awareness of health personnel in hand-washing, are the barriers of infrastructure, availability of cleaning supplies and work overload of healthcare workers that contributes and perpetuates a high frequency of colonization. These findings should be a warning to decision-makers and stakeholders to prioritize hospital security and take suitable measures to address this problem holistically.

## **Conclusions**

High prevalence of contamination in hands and cell phones in medical residents was found. We identified critical barriers for hand-washing among the residents of internal medicine and comparisons with other contexts suggest this is a global problem that requires attention. Even though, we couldn't demonstrate sustainability of the efficacy of our intervention, we consider our results a starting point for further larger-scale intervention initiatives.

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## **Authors' Contributions**

Study Design: MLP, JR, GM; protocol writing: MLP, JR, GM; laboratory procedures: KC, JR; data analysis: TDLC, MC; manuscript writing and final approval: MLP, MC, TDLC, IB, JR, GM. MC, TDLC, IB, KC, JR: contributed equally to this work

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**Annex – Supplementary Items****Supplementary Table 1.** Text of sent SMS messages.

<b>Messages in English</b>	
a)	One of every two or three residents carries MRSA in their hands. Take care of your patients. Take care of your family. Wash your hands.
b)	One of four cell phones carries MRSA. Take care of your patients and your family. Clean your phone.
c)	Remember that there are five moments for hand-washing. Reduce nosocomial infections.
d)	Time 1: Wash your hands before patient contact. Reduce nosocomial infections.
e)	Time 2: Wash your hands before performing an aseptic task. Reduce nosocomial infections.
f)	Time 3: Wash your hands after you were exposed to body fluids. Reduce nosocomial infections.
g)	Time 4: Wash your hands after patient contact. Reduce nosocomial infections.
h)	Time 5: Wash your hands after handling the patient's environment. Reduce nosocomial infections.
<b>Messages in Spanish</b>	
a)	Uno de cada dos o tres residentes porta MRSA en las manos. Cuida tus pacientes. Cuida tu familia. Lávate las manos.
b)	Un cuarto de los celulares porta MRSA en las manos. Cuida tus pacientes y tu familia. Limpia tu celular.
c)	Recuerda que hay cinco momentos para el lavado de manos. Reduce las infecciones intrahospitalarias.
d)	Momento 1: Lávate las manos antes de contactar al paciente. Reduce las infecciones intrahospitalarias.
e)	Momento 2: Lávate las manos antes de realizar una tarea aséptica. Reduce las infecciones intrahospitalarias.
f)	Momento 3: Lávate las manos después de exponerte a fluidos corporales. Reduce las infecciones intrahospitalarias.
g)	Momento 4: Lávate las manos después de contactar al paciente. Reduce las infecciones intrahospitalarias.
h)	Momento 5: Lávate las manos después de contactar el entorno del paciente. Reduce las infecciones intrahospitalarias.

**Supplementary Table 2.** Association between positive *S. aureus* from hand's basal samples and general characteristics and behaviour variables.

<b>Characteristics</b>	<b><i>S. aureus</i></b>		<b><i>p</i> value†</b>
	<b>Positive (n = 12)</b>	<b>Negative (n = 10)</b>	
<b>Sex</b>			0.454
Female	7 (58.3)	7 (70.0)	
Male	5 (41.67)	3 (30.0)	
<b>Age (years) *</b>			0.722
<b>Specialty</b>			0.029
Internal/General Medicine	12 (100.0)	6 (60.0)	
Pediatrics	0 (0.0)	4 (40.0)	
<b>Behaviour variables</b>			
Times hands were washed the day before*	7.0 ± 3.0	6.7 ± 4.2	0.502
Patients examined with unwashed hands*	4.3 ± 2.3	3.8 ± 2.7	0.659
<b>Hand cleaner employed</b>			0.714
Water and soap	11.0 (91.7)	9.0 (90.0)	
Alcohol gel	1.0 (8.3)	1.0 (10.0)	
Times cellular phone was cleaned in the last month*	3.0 ± 5.6	2.7 ± 1.1	0.121
Times cellular phone was used the day before*	7.9 ± 3.0	10.5 ± 5.0	0.263
<b>Presence of rings</b>			0.714
No	11 (91.7)	9 (90.0)	
Yes	1 (8.3)	1 (10.0)	
<b>Presence of long nails</b>			0.221
No	9 (75.0)	5 (50.0)	
Yes	3 (25.0)	5 (50.0)	
<b>Presence of dirty nails</b>			0.571
No	10 (83.3)	9 (90.0)	
Yes	2 (16.7)	1 (10.0)	

†Fisher exact test; \*Mean ± SD, Wilcoxon rank sum.

**Supplementary Table 3.** Association between *E. coli*/Klebsiella growth from hand's basal samples and general characteristics and behaviour variables.

Characteristics	<i>E. coli</i> / <i>Klebsiella</i> sp.		<i>p</i> value†
	Positive (n = 4)	Negative (n = 18)	
<b>Sex</b>			0.465
Female	2 (50.0)	12 (66.7)	
Male	2 (50.0)	6 (33.3)	
<b>Age (years) *</b>	27.7 ± 1.5	31.7 ± 7.1	0.243
<b>Specialty</b>			0.418
Internal/General Medicine	4 (100.0)	14 (77.8)	
Pediatrics	0 (0.0)	4 (22.2)	
<b>Behaviour variables</b>			
Times hands were washed the day before*	6.3 ± 3.0	7.0 ± 3.7	0.795
Patients examined with unwashed hands*	2.5 ± 1.7	4.4 ± 2.5	0.189
<b>Hand cleaner employed</b>			0.662
Water and soap	4 (100.0)	16 (88.9)	
Alcohol gel	0 (0.0)	2 (11.1)	
Times cellular phone was cleaned in the last month*	6.5 ± 9.1	2.1 ± 1.4	0.403
Times cellular phone was used the day before*	8.3 ± 2.9	9.3 ± 4.4	0.837
<b>Presence of rings</b>			0.662
No	4 (100.0)	16 (88.9)	
Yes	0 (0.0)	2 (11.1)	
<b>Presence of long nails</b>			0.535
No	3 (75.0)	11 (61.1)	
Yes	1 (25.0)	7 (38.9)	
<b>Presence of dirty nails</b>			0.470
No	3 (75.0)	16 (88.9)	
Yes	1 (25.0)	2 (11.1)	

†Fisher exact test; \*Mean ± SD, Wilcoxon rank sum.