Bacterial resistance in cell phone cultures of medical students

Arnold Nieto-Carhuamaca[1,2], Jhonatan Castañeda-Japan[1], Bernardo Dámaso-Mata[1,3], Vicky Panduro-Correa[1,2], Kovy Arteaga-Livias[1,3]

[1]Facultad de Medicina, Universidad Nacional Hermilio Valdizán, Huánuco, Peru;
[2]Hospital Regional Hermilio Valdizán, Huánuco, Peru;
[3]Hospital II EsSalud. Huánuco, Peru

SUMMARY

Cell phones are one of the most important and indispensable accessories for professional and social life. Cell phones used by healthcare workers are highly contaminated by microorganisms. The objective of the study was to ascertain the presence of bacterial resistance type Extended-Spectrum Beta-Lactamase [ESBL] and its related factors in cultures isolated from cell phones of medical students. A quantitative, observational, analytical and transversal study was carried out in students of the Faculty of Medicine of the Universidad Nacional Hermilio Valdizán in Huánuco, Peru. The relationship was sought between the frequency of attendance at hospital practices, cell phone disinfection and hand washing after contact with patients with the presence of ESBL-type bacterial resistance. Of the total sample, 95% of students presented positive culture to Gram-negative bacteria, 30% carried out the disinfection of their cell phone and only 5% of the students performed hand-washing in an appropriate manner. In the bivariate analysis, a statistical association was found between cell phone disinfection and the presence of ESBL-type bacterial resistance [$p<0.05$]. Cell phone disinfection is related to the reduction of ESBL-type resistance, highlighting the need for disinfection of cell phones after performing hospital practices.

Keywords: cell phone, students, microbiota, beta-lactam resistance.

INTRODUCTION

Cell phones have become one of the most important and indispensable accessories for professional and social life [1]. A large percentage of healthcare workers have admitted the use of the cell phones during contact with patients [2].
The cell phones used by health workers are highly contaminated by microorganisms, mostly pathogens, with *coagulase negative Staphylococcus, Staphylococcus aureus* and *Escherichia coli* being found more frequently [3].
The surfaces of the different hospital environments act as a source of pathogen contamination for healthcare workers [4]. The transmission of resistant bacteria is a problem that requires a lot of attention. A hospital study shows that Gram-negative bacteria resistant to multiple antibiotics were isolated from the hands of physicians [5].
The presence of Gram-positive bacteria as major contaminants on inanimate surfaces, such as cell phones, has been frequently addressed by various authors; however, the role that cell phones play in the dissemination of Gram-negative species should be discussed [6-8].
The extended-spectrum beta-lactamases [ESBL] confer resistance to penicillins, cephalosporins of first, second [except cephamycin's such as cefoxitin or cefotetan], third and fourth generation as well as aztreonam, being one of the resistance mechanisms more frequently isolated in hospital environments, reason why its potential transmission to the community has to be studied, besides that cell phones could act as a bridge for the dissemination of this type of resistance [9].

Corresponding author
Kovy Arteaga-Livias
E-mail: farteaga@unheval.edu.pe

The contact with hospital environments is one of the factors that influence the bacterial contamination of cell phones. Medical students who are going to do their practices in hospitals are exposed to bacterial contamination of their cell phones [10].
The objective of the study was to know the relationship between the frequency of attendance at hospital practices, cell phone disinfection and hand washing after contact of the patient with the presence of bacterial resistance type ESBL in Gram-negative isolated from student's cell phones of the Faculty of Medicine of the Universidad Nacional Hermilio Valdizán, in Peru.

MATERIALS AND METHODS

Research design and participants
A quantitative, observational, analytical and transversal study was carried out in the Faculty of Medicine of the Universidad Nacional Hermilio Valdizán, located in the department of Huanuco, in the central region of Peru.
The calculation of the sample size was made with the statistical program Epidat v.3.1, starting from a total population of 128 students, with certainty of 95%, an expected proportion of 95% and a minimum margin of error of 5%, requiring an amount of 60 participants after correction of Yates [11]. The sample was obtained through simple random probabilistic sampling. All the participants were enrolled between August and December of 2018, ordered by paternal surname.
Were included in the study the cell phones of the 3rd, 4th and 6th year students of the Faculty of Medicine. Fifth year students were not included because they are in another city as part of their training in surgical specialties. Those who did not accept to participate in the study, students who did not use cell phones and those who did not attend hospital practices were excluded from the study.

Questionnaire
The instrument was divided into four parts; first part composed of data such as age, sex and academic year; the second part focused on knowing how much they know about the recommendations given by the World Health Organization [WHO] to perform the correct hand washing and if they do it after contact with patients and having contact with their cell phones. The third part indicated the hospital where they performed their hospital practices, how often they go it and in what service they are doing it; the fourth part, information on cell phone disinfection by students.

Culture of bacteria, identification and category of sensitivity
The samples were collected with a sterile swab and a smear from the surface of the cell phones with all the necessary aseptic measures [alcohol, gloves, cottons, etc.] to avoid contamination of the sample and in the presence of an expert [biologists].
After collecting the sample in sterile swab, this was placed in a test tube with 1 mL of thioglycolate broth as a transport medium, cultured in an oven at 37° C for 24 hours and then reseeded in MacConkey agar for Gram-negative and enterobacteria, with the subsequent incubation at 37° C for 24 hours. Once the bacterial strains were cultivated, the antimicrobial susceptibility and resistance mechanisms were determined by minimum inhibitory concentration [MIC] by the broth microdilution method using an automated VITEK-2 system [bioMérieux, France], which has proved to be an effective and valuable tool in the determination of resistance in enterobacteria [12, 13].

Statistical analysis
The instrument of recollection was submitted to the judgment of 5 experts, obtaining a reliability value [Cronbach's alpha] of 0.85. A database was constructed with the information obtained with the survey and the questionnaire.
A descriptive analysis of the information was carried out through frequencies, percentages, measures of central tendency [mean, median]. Fisher's exact test was used for the association between variables and bacterial sensitivity. A p value <0.05 was considered for a significant difference and its 95% confidence interval.

Ethical aspects
The study was reviewed and approved by the Ethics Committee of the Universidad Nacional Hermilio Valdizán and all the participants signed the informed consent. Confidentiality of the data obtained from the Data Collection Sheets was maintained.

RESULTS

Between August and December 2018, data and cell phone cultures of 60 medical students were collected. Of the sample studied, 61.7% correspond to the female sex, with a range of age ranging from 18 years to 43 years, average of 25.25 years, with the highest frequency of attending hospital practices 5 days a week and at least 4 hours a day; 5% of the students perform the appropriate hand washing and 30% [18 students] perform the disinfection of their cell phone, the rest of the characteristics are shown in Table 1.

Table 2 shows the inferential analysis between the strains with the extended-spectrum beta-lactamase [ESBL] resistance mechanism and the variables studied, finding that the lack of disinfection of the cell phone is related to the presence of this resistance mechanism in cell phone cultures of medical students. It is important to highlight that the rest of the variables studied did not reach statistically significant for the presence of ESBL-type resistance.

Table 1 - Clinical and demographic characteristics of cell phones of medical students.

Variable	*Frequency*	*Percentage*
Sex		
Female	37	61.7
Male	23	38.3
Age		
[X + SD]	25.25 + 3.69	
Academic year		
Third	27	45
Sixth	19	31.7
Fourth	14	23.3
Hand washing		
Adequate	3	5
Regular	11	18.3
Not adequate	46	76.7
Type of hospital		
EsSalud II Huánuco	36	60
Hospital Regional Hermilio Valdizán Medrano	24	40
Hospital area		
Emergency room	40	66.7
Hospitalization	14	23.3
Intensive care unit	2	3.3
Outpatient Clinics	4	6.7
Hospital practices assistance		
One day a week	1	1.7
Three days a week	4	6.7
Four days a week	7	11.7
Five days a week	48	80
Practice hours per day		
2	1	1.7
3	17	28.3
4	31	51.7
5	11	18.3
Cell phone disinfection		
Yes	18	30
No	42	70
ESBL Type Resistance		
Yes	34	72.3
No	13	27.7

DISCUSSION

Inanimate objects that are used by healthcare workers act as an important source of nosocomial infections; the popularity of mobile phones and the lack of antiseptic technique allow the potential risk of transmission of pathogenic bacteria [6]. In our study we found that hand washing after having contact with the patient and after using the cell phone does not have a causal relationship with the presence of ESBL type resistance in cell phones. In their study, Foong et al. don't find resistant bacteria and only 5% had potentially pathogenic bacteria [14]. Tselebonis, contrary to us, showed that the inadequate hand washing process increased bacteria with intermediate resistance to antimicrobials. However, unfortunately this study was not done with cell phones. Banawas, in a study on resistance in Gram-positives, finds that there are multiple resistances to benzylpenicillins, erythromycin and fusidic acid; even some strains were resistant to oxacillin [6, 15]. Debnath found high resistance in *E. coli*, even resistance to carbapenems [16].

Our study finds that cellular disinfection is inversely associated with the presence of ESBL type germs. Bodena and Heyba found, in their respective studies, both in the univariate analysis and

in the multivariate analysis that the lack of cell phones cleaning is associated with the bacterial load; Egert found that cleaning with dry clothes or disinfectants reduces the presence of microorganisms in cell phones. Likewise, Foong found that those who cleaned their cell phones daily had no bacterial growth, so this procedure should always be considered in all circumstances of cell phone use in hospital and health areas [11, 17-19].

Table 2 - Bivariate analysis of ESBL type resistance in cell phones of medical students.

Characteristic / Variable	*Type of bacterial resistance*				*p**
	ESBL n=47				
	Negative n [%]		*Positive n [%]*		
Sex					
Female	6	21.4	22	78.6	0.32
Male	7	36.8	12	63.2	
Academic year					
Third	6	30	14	70	1.00
Fourth	2	22.2	7	77.8	
Sixth	5	27.8	13	72.2	
Type of hospital					
Hospital Regional Hermilio Valdizán Medrano	6	33.3	12	66.7	0.52
ESSALUD II Huánuco	7	24.1	22	75.9	
Hospital area					
Emergency room	9	29	22	71	1.00
Hospitalization	3	27.3	8	72.7	
Intensive care unit	0	0	1	100	
Outpatient Clinics	1	25	3	75	
Hand washing					
Adequate	1	50	1	50	0.83
Regular	2	25	6	75	
Not adequate	10	27	27	73	
Hospital practices assistance					
One day a week	0	0	1	100	1.00
Three days a week	1	25	3	75	
Four days a week	2	33.3	4	66.7	
Five days a week	10	27.8	26	72.2	
Cell phone disinfection					
Yes	0	0	13	100	<0,01
No	13	38.2	21	61.8	
Hand washing after using the cell phone					
Yes	0	0	2	100	0.37
No	13	28.9	32	71.1	

*Fisher's exact test

Another important finding is that the type of hospital is not associated with ESBL type resistance, as mentioned in several studies, where there are low frequencies of bacterial contamination, as well as those with a high level of contamination in cell phones [1, 6, 7, 14, 16, 17, 19, 21].

The high frequency of Gram-negative bacterial found is striking, since most studies indicate a predominance of Gram-positive [which were not studied in the present work], which could correspond to poor cleaning habits, as mentioned by Akinyemi, who found that the highest cellular contamination occurred in food vendors and students [1]. In the same way, Foong suggests that being a student was a risk factor for high bacterial load; in addition, in a Peruvian study, it was found that 50% of cell phones had contamination with enterobacteria and ESBL-type resistance corresponded to 33% of the entire population. This coincides with the literature review, since many studies have shown that the frequency of cell contamination, as well as the microorganisms involved, depend on the geographical area of study, suggesting that in our region there may be a greater frequency of Gram-negative organisms [11, 18, 22].

In Peru, multiple studies have shown a high percentage of prevalence of resistant ESBL strains in fecal, blood and inanimate samples, which could explain the high frequency of resistant bacteria found in our study [23-25].

It is necessary to consider that, although automated methods, such as the VITEK-2 system used in our study, have proven to be useful tools for

We found that the frequency of attendance at hospital practices is not associated with ESBL type resistance. Kotris concludes that there are no differences between the isolated bacteria in the cell phones of medical students and healthcare workers [20]. Kalpana, on the other hand, finds that there is a greater frequency of cellular contamination in healthcare workers, when compared to family visitors [90% vs 66%], in a hospital in India [7]. Galazzi, in his study designed to assess bacterial contamination before and after hospital work, found that there was no difference in the load of bacteria at the start and end of work [21].

identifying and classifying bacterial strains, conventional methods are still a reliable technique in determining bacterial sensitivity [12, 13, 26]. Therefore, not having performed the conventional method additionally could be a weakness in our study.

Another factor that could have influenced the high frequency of cell phone positive culture for Gram-negative bacteria is the use of pre-incubation for 24 hours before placement in the automated system, so we suggest that in future studies direct sowing in the culture medium be used and the results obtained are compared.

The main limitation of our study lies in the difficulty to extrapolate results to the student population in all health sciences, requiring more studies that include other professions responsible for patient care.

CONCLUSION

We found that cellular disinfection is related to the reduction of ESBL-type resistance, highlighting the importance of disinfecting cell phones after performing hospital practices as a measure to avoid contamination by resistant germs.

Contributions of the authors

A.N.C., J.C.J. and K.A.L. participated in the conception of the study, A.N.C. and J.C.J. performed the data collection, K.A.L., B.D.M. and V.P.C. prepared the manuscript, reviewed the statistical analysis and made the critical revision of the manuscript. All the authors approved the final version.

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Conflicts of interest

The authors declare no conflicts of interest.

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