

Microbial Colonization and Multi Drug Resistance Patterns of Phones of Health Care Workers: Potential for Nosocomial Pathogens Transmission in Delta State, Nigeria

Adomi Patience Oghenechuko

Department of Microbiology, Faculty of Science, Delta State University, Abraka, Nigeria

Email address:

padomi.adomi07@gmail.com

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Abstract: Mobile phones are integral component of man's social life. Mobile phones could constitute health hazards, apart from electromagnetic radiations emitted, these devices could serve as sources of pathogenic and non pathogenic microorganisms as they come in contact with human body parts and other surfaces during usage. The study was conducted to evaluate microbial colonization and multi drug resistance patterns of phones of health care workers in Delta State. One hundred and thirty phones of health care workers were swabbed aseptically, self administered questionnaires were used to collect data from respondents to find out their hygienic attitude towards their phones. Swabs were cultured in bacteriological and mycologic media. Microbial isolates identification and sensitivity tests were done using standard methods. Most of the health care workers phones were contaminated though they admitted cleaning of phones. Bacterial and fungal contamination were 92.31% and 71.54% respectively. *Staphylococcus aureus* (33.33%), *Klebsiella pneumoniae* (18.33%) and *Escherichia coli* (25%) are potential nosocomial pathogens and were more dominant. *Geotrichum* spp (37.63%), *Aspergillus niger* (27.96%) and *Mucor* spp. (21.51%) were prevalent among the fungi species. All bacteria were resistant to ceftazidime, cefuroxime, cefixime and augmentin however sensitive to gentamycin in varied degree. Phones of health care workers carry pathogens which were multidrug resistant so could pose health risk to patients. Measures should be put in place for phones of health care workers to be cleaned always to avoid being a source of pathogenic organisms.

Keywords: Mobile Phones, Multi Drug Resistance, Health Care Workers

1. Introduction

Nosocomial infections are infections acquired by patients during their stay in the hospital excluding those present at the time of admission and those acquired transplacentally [1, 2]. The burden of nosocomial and health care associated infections is about 75% in the developing countries [3]. The implication of nosocomial infection is prolonged stay in the hospital resulting to high cost of treatment which could be difficult to both patient and hospital. More than 40% hospitalization arise from nosocomial infection in Sub-Saharan Africa, Asia and Latin America [4].

The causative agents of hospital acquired infections may spread through health care workers personal items, endoscopes, thermometer and other items used for the management of

health conditions of the patients.

Mobile phones (MP) are personal devices for communication in everyday life activities. Mobile phones are important to the health care workers (HCW) for the reason that the device serve as reference source in terms of information related to health issues. Mobile phone provide information pertaining to vaccinations [5], a hand reference for drug, laboratory medical dictionary and other matters as HCW deal with patients [6].

Mobile phones of HCW are often not disinfected and could serve as sources of infections as mobile phones get easily contaminated with hands and surfaces which get in contact with such phones. Bacterial population on Mobile Phones reflects the microbiome of the owners. Personal microbiome is a collection of microorganism associated with

personal possession of individual. Evidence exist that there are variations in human microflora including those found on the skin [7]. Exchange and sharing of MP between HCW and patients can easily lead to contamination and transmission of organisms on the surfaces of phones. Though no evidence show that bacteria reproduce on phones but studies have shown that bacteria that colonise phone are similar to those of the owner's hand [5]. The study investigated the microbial colonization and multidrug resistance patterns of phones of health workers in Delta State, Nigeria.

2. Materials and Methods

2.1. Study Design Area and Period

The research was carried out among health workers consisting of doctors, nurses, pharmacists and laboratory technicians working in different hospitals in Delta State, Nigeria within 2019 and 2020. A survey questionnaire divide into two parts was administered to them after due consent. The self administered questionnaire contained items to which the respondents were to respond to. Socio-demographic information like sex, age and occupation. while the other parts of the questionnaire contained information pertaining to awareness. if their phones can harbour infectious agents. If their phones were cleaned, how often the phones were cleaned. If phones were used when attending to patients and for what purpose.

After questionnaire completion, sterile cotton swab was rotated over the surface, both sides of the phones aseptically [8]. The swab was placed into normal saline and transported to the laboratory [6]. The samples were inoculated into blood agar, MacConkey agar, nutrient agar and Sabouraud dextrose agar. The plates were incubated at 37°C for bacteria and 25°C for fungi for 5 days. Further inoculation were done to obtain pure culture. Various biochemical tests were carried out to identify isolates.

2.2. Antimicrobial Susceptibility Testing

Standard disc including ceftazidime (30µg), cefuroxime (30µg), gentamycin (10µg), cefixime (5µg), ofloxacin (5µg), augmentin (30µg), nitrofurantoin (300µg) and ciprofloxacin (5µg) (Abtek Biological Ltd) were tested against the microbial isolates using standard methods 100µl of Macfarland suspension of isolates were inoculated into the surface of Mueller-Hinton agar and the disc were introduced and incubated at 37°C for 18hrs. The inhibition zones were measured using a calibrated ruler and then interpreted according to standard guidelines [9].

3. Results

Table 1 indicated the survey results obtained from respondents. Eight males (29.63%) and nineteen (19) females (70.37%) filled the administered questions. Others refused to fill their questionnaires. Most of the respondents were within the age range of 26 and 35 and nurses were the most

responsive to request among the respondents that agreed to the swabbing of mobile phones. Again, majority of the respondents attend to at least 30 patients a week. As for awareness of pathogen transmission by phones, 17 (62.96%) were very much aware that phones surfaces could carry pathogens which may be transmitted to patients. Health workers who clean their phones use handkerchieves 10 (37.04%) and majority of others use methylated spirits. Occasionally, 12 (44.44%) use phones when attending to patients and 15 (55.56%) use phones once a day. Those that use phones while attending to patients use it as device for information and consultation 13 (48.15%), and others as hand reference for drug 6 (22.22%) and lastly for observation of patients 10 (37.04%).

Table 1. Demographic Data and Information on Health Care Workers phone Use.

Sex	NO	%
Males	8	29.63
Females	19	70.37
Age		
21-25	0	0
26-30	16	59.26
31-35	7	25.93
36-40	4	14.81
Occupation		
Nurse	21	77.75
Doctors	3	11.11
Laboratory Technology	1	3.70
Pharmacy	2	7.40
Number of Patients attended to a week		
20	1	3.70
30	8	29.63
50	7	25.93
100	0	0
More than 100	0	0
No response	11	40.75
Awareness of pathogens transmission by phones		
NUMBER	%	
Yes	17	62.96
No	10	37.04
Do you disinfect your cell phone?		
Number	%	
Yes	10	37.04
No	17	62.96
What do you use to disinfect your phones		
Methylated spirit	17	62.9
Handkerchief	10	37.04
Others specify		
How often do your use phone while attending to patients		
Once a day	15	55.56
Occasionally	12	44.44
No time	0	0
Do you use phone as a device for information and consulting when atten to patients		
Yes	13	48.15
No	6	22.22
No response	8	29.65
If yes what kind of information/service do you use your cell phone for?		
Mobile phone provide information pertaining to vaccination	1	3.70
A hand reference for drugs	6	22.22
Others please specify	1	3.70
Observation of patients	10	
Do you have any comment.		

Table 2. Towns and health workers sampled.

Towns in Delta State.	NURSES	DOCTORS	PHARMACISTS	TECHNOLOGISTS LABORATORY	Total (%)
Abraka	20	5	5	5	36 (27.69)
Warri	5	5	0	0	10 (7.69)
Agbor	17	7	4	11	39 (30)
Eku	22	1	0	1	24 (18.46)
Obiaruko	13	3	4	1	21 (16.15)
TOTAL	66	19	15	6	130 (100)

Table 3. Bacterial contamination of health workers in Delta State.

Bacteria	Nurses	Doctors	Pharmacists	Laboratory Technologists	Total (%)
Staphylococcus aureus	19	8	7	6	40 (33.33)
Streptococcus spp	7	2	2	1	12 (10)
Escherichia coli	10	7	7	5	30 (25)
Klebsiella pneumonia	14	2	4	3	22 (18.33)
Proteus spp	5	0	0	0	5 (4.17)
Bacillus spp	1	0	0	0	1 (0.83)
Pseudomonas aeruginosa	4	1	2	1	8 (6.67)
Corynebacterium spp	2	0	0	0	2 (1.67)
Total	62	20	20	15	120 (100)

Samples collected as stipulated in table 2 above were Abraka 36 (27.69%), Warri 10 (7.69%), Agbor 39 (30%), Eku 24 (18.46%) and Obiaruko 21 (16.15%).

Bacterial and fungal contaminations were 92.31% and 71.54% respectively. The bacteria included *Staphylococcus aureus* (33.33%), *Streptococcus* spp. (10%), *Escherichia coli* 24.17%,

Klebsiella pneumoniae (18.33%), *Proteus* spp (4.17%), *Pseudomonas aeruginosa* (6.67%) *Corynebacterium* spp. (1.67%) and *Bacillus* spp. (0.89). Fungal isolated were *Aspergillus niger* (27.96%), *Rhodotorula* spp. (5.38%), *Geotrichum* spp. (37.63%), *Mucor* spp. (21.51%) and *Penicillium* spp. (7.53%) (Tables 2 and 3).

Table 4. Fungal Contamination of Health workers in Delta State.

FUNGI	NURSES	DOCTORS	PHARMACISTS	TECHNOLOGISTS LABORATORY	Total (%)
Aspergillus niger	18	5	3	0	26 (27.96)
Rhodotorula spp	5	0	0	0	5 (5.38)
Geotrichum spp	27	5	3	0	35 (37.63)
Mucor	16	2	2	0	20 (21.51)
Penicillium spp.	3	2	2	0	7 (7.53)
TOTAL	69	14	10	0	93 (100)

Table 4 shows the antibiogram of bacteria from mobile phones of health workers in Delta State. All the bacterial isolates were resistant to ceftazidime, cefixime, augmentin and cefixime. However, showed varied susceptibility to gentamycin, ofloxacin, nitrofurantoin and ciprofloxacin.

Staphylococcus aureus were more sensitive to ciprofloxacin (67.5%), ofloxacin 52.50%, gentamycin 45% and nitrofurantoin 40%. *Streptococcus* spp. were 75% sensitive to ciprofloxacin, nitrofurantoin and 66.67% sensitive to ofloxacin and gentamycin. *Escherichia coli* were

66.67% sensitive to gentamycin, ofloxacin nitrofurantoin and 23.33% to ciprofloxacin. *Klebsiella pneumoniae* were susceptible to ciprofloxacin. *Pseudomonas aeruginosa* were sensitive to ofloxacin and gentamycin 62.5%).

Klebsiella pneumonia were very sensitive to antibiotics as only 1 (20%) of 5 isolates was resistant to gentamycin and ciprofloxacin. Equally, *Pseudomonas aeruginosa* showed low resistance as 3 (37.5%) of 8 isolates were resistant to gentamycin, ciprofloxacin and 25% resistant to ofloxacin.

Table 5. Antibiogram of bacteria from mobile phones.

Antibiotics	Sensitivity pattern	<i>Staphylococcus aureus</i> N=40 (%)	<i>Streptococcus</i> spp. N=12 (%)	<i>Escherichia coli</i> N=30 (%)	<i>Klebsiella pneumoniae</i> N=22 (%)	<i>Proteus</i> spp N=5 (%)	<i>Bacillus</i> spp. N=1 (%)	<i>Pseudomonas aeruginosa</i> N=8 (%)
Ceftazidim	Resistant	0	0	0	0	0	0	0
	Intermediate	0	0	0	0	0	0	0
	Sensitive	0	0	0	0	0	0	0
Cefuroxime	Resistant	0	0	0	0	0	0	0
	Intermediate	0	0	0	0	0	0	0
	Sensitive	0	0	0	0	0	0	0
Gentamycin	Resistant	22 (55)	4 (33.33)	20 (66.67)	12 (54.54)	1 (20)	-	3 (37.5)
	Intermediate	0	0	0	0	0	0	0
	Sensitive	18 (45)	8 (66.67)	10 (33.33)	10 (45.45)	4 (80)	1 (100)	5 (62.5)

Antibiotics	Sensitivity pattern	<i>Staphylococcus aureus</i> N=40 (%)	<i>Streptococcus</i> spp. N=12 (%)	<i>Escherichia coli</i> N=30 (%)	<i>Klebsiella pneumoniae</i> N=22 (%)	<i>Proteus</i> spp N=5 (%)	<i>Bacillus</i> spp. N=1 (%)	<i>Pseudomonas aeruginosa</i> N=8 (%)
Cefixime	Resistant	0	0	0	0	0	0	0
	Intermediate	0	0	0	0	0	0	0
	Sensitive	0	0	0	0	0	0	0
Ofloxacin	Resistant	19 (47.5)	4 (33.33)	20 (66.67)	12 (54.54)	-	-	2 (25)
	Intermediate	0	0	0	0	0	0	0
	Sensitive	21 (52.50)	8 (66.67)	10 (33.33)	10 (45.45)	5 (100)	1 (100)	6 (75)
Augmentin	Resistant	0	0	0	0	0	0	0
	Intermediate	0	0	0	0	0	0	0
	Sensitive	0	0	0	0	0	0	0
Nitrofurantoin	Resistant	19 (22.5)	3 (25)	20 (66.67)	12 (54.54)	0	0	0
	Intermediate	5 (12.5)	0	3 (10)	5 (22.73)	1 (20)	0	0
	Sensitive	16 (40)	9 (75)	7 (23.33)	5 (22.73)	4 (80)	1 (100)	0
Ciprofloxacin	Resistant	13 (32.5)	3 (25)	17 (56.67)	9 (40.91)	1 (20)	0	3 (37.5)
	Intermediate	0	0	0	0	0	0	0
	Sensitive	27 (67.5)	9 (75)	13 (43.33)	13 (59.09)	4 (80)	1 (100)	5 (62.5)

Key, S=sensitive, R=resistance; < 13 =R, >14mm =S.

Table 6. Resistance patterns of mobile phones isolates of Health care workers in Delta State.

Antibiotics	<i>Staphylococcus aureus</i> N=40 (%)	<i>Streptococcus</i> spp. N=12 (%)	<i>Escherichia coli</i> N=30 (%)	<i>Klebsiella pneumoniae</i> N=22 (%)	<i>Proteus</i> spp N=5 (%)	<i>Bacillus</i> spp. N=1 (%)	<i>Pseudomonas aeruginosa</i> N=8 (%)
Ceftazidime	40 (100)	12 (100)	30 (100)	22 (100)	5 (100)	1 (100)	8 (100)
Cefuroxime	40 (100)	12 (100)	30 (100)	22 (100)	5 (100)	1 (100)	8 (100)
Gentamycin	22 (55)	4 (33.33)	20 (66.67)	12 (54.54)	0 (0)	0 (R)	3 (37.5)
Cefixime	40 (100)	12 (100)	30 (100)	22 (100)	5 (100)	1 (100)	8 (100)
Ofloxacin	19 (47.5)	4 (33.33)	20 (66.67)	12 (54.54)	0 (0)	0 (R)	2 (25)
Augmentin	40 (100)	12 (100)	30 (100)	22 (100)	5 (100)	1 (100)	8 (100)
Nitrofurantoin	24 (60)	3 (25)	20 (66.67)	19 (86.36)	1 (20)	0 (R)	8 (100)
Ciprofloxacin	13 (32.5)	3 (25)	17 (56.67)	9 (40.91)	1 (20)	0 (R)	8 (100)

4. Discussion

Nosocomial infections are hospital based infections which are caused by pathogens present in hospital and their facilities. Source of infectious agents in hospital settings could be from a contaminated person, health care facilities, health worker, food and water, environment, shared items and other facilities. 27/130 (20.78%) of respondents filled the questionnaires presented to them however, all submitted their phones to be swabbed. Out of the 130 phones swabbed, 120 of them were contaminated with microorganisms with bacterial contamination of 92.31% and fungi 71.54%. This findings conforms to other findings conducted on health workers, bacterial contamination were high as 98.15%, 94.2%, 93% and 69% reported by previous researchers [6, 10-12] but differ from 24% obtained by Balapriya et al., [13] in India which was quite low.

Bacterial isolated from the phones of health worker in this study are potentials nosocomial pathogens. *Staphylococcus aureus* cause superficial and deep seated skin infections [2] and also a commensal that colonises 20% individuals nasal passages. Long stay in the hospital reduces the immunity of patients and therefore make them prone to infections caused by this organism. In this study, 33.3 of isolates were *S. aureus*, which was the most predominant organism. Apart from health care worker, *S. aureus* have been isolated from student and others [5].

Escherichia coli as a nosocomial pathogen cause diseases in hospitals and health institutions [14].

Klebsiella pneumoniae has been noted as eight significant bacterial pathogen in health care settings [2]. The gastro intestinal tract, skin and pharynx are colonized by *K. pneumoniae*, which are normally transmitted through person to person contact, when hands are not washed after attending to a patient. Exposed wounds, respiratory machines are other sources of its transmission. Similar findings was obtained by Bodena et al. [6] *Klebsiella pneumoniae* like this study was the third predominant organism. Their study also showed that *Klebsiella* spp. was 6.9% but in this study, it was 19.17% which was higher than theirs however, lower than 39.8% as reported by Pipliya and Jain [12].

Pseudomonas aeruginosa cause 11% of all nosocomial infections and common reservoir for its contamination are breast pumps, incubations, sinks and hands of hospital staff and hand soaps [15,16].

Other bacterial isolated from health workers in Delta State were *Proteus* spp, *Bacillus* spp and *Corynebacterium* spp.

Ibtesam et al. [17] reported that health care workers phones were contaminated with enteric bacteria. Fungal isolated included *Aspergillus niger*, *Mucor* spp, *Geotrichum* spp and *Rhodotorula* spp. Anibijuwon et al. [18] isolated *A. niger* (90%) and *Rhizopus* spp (50%) from mobile phones.

Antibiotic sensitivity

All isolates were resistant to ceftazidime, cefuroxime, cefixime and augmentin in this research. However showed

varied sensitivity to gentamycin, ofloxacin, nitrofurantoin and ciprofloxacin. This study showed that all the isolates were multidrug resistant as all showed resistance to more than three antibiotics in this study. Multidrug resistant isolates were also identified from health workers and from health care settings from previous studies. Ceftazidime and ceftaxime resistant *E. coli* was isolated from health care setting [19]. Olu-taiwo et al. [3] reported multi drug resistant isolates from phone and keyboards of health care university students. Likewise, bacterial isolated from phones of health care workers showed various level of resistance to ceftazidime, gentamycin and ciprofloxacin *Staphylococcus aureus*, *P. aeruginosa*, *E. coli* were multidrug resistant to these drugs [11]. Multidrug isolates were also reported from studies on students and others [20, 21].

5. Conclusion

Mobile phones of health workers in Delta State were contaminated with pathogenic bacteria and fungi; which could pose potential health risk to patients who seek medical assistance. *Klebsiella pneumoniae*, *Escherichia coli*, *Streptococcus* spp, *Proteus* spp were among bacterial isolated. *Aspergillus niger*, *Geotrichum* spp, *Mucor* spp, and *Rhizotorula* spp. were fungal isolated. All bacteria isolated were multi drug resistant. Health care workers could be a source of inoculation of multidrug resistant isolates to patients. Measures for deliberate cleaning of phones of health workers should be set up. As phones are essential commodities of humans and also some health workers use it as tool for their services.

References

- [1] AL Laham, N. Mevivilla, J. R. Chan, L. Abdelateef, N. Elamren, F. A. Ginocchio, C. C et al., (2008). MRSA clonal complex 22 strains harbouring toxic shock syndrome toxin (TSST-1) are endemic in primary hospital in Gaza, Palestine Plos one, 10 (3). e0120008.
- [2] Khan, H. A., Ahmad A. and Mehboob (2015) Nosocomial Infections and their control strategies. Asian Pacific Journal of Tropical Biomedicine 5 (7): 509-514.
- [3] Olu- Taiwo, M, Laryee, C. A, Mykels D. K, and Forson, A. O. (2021). Multi drug resistant bacteria on the mobile phones and computer keyboards of Health-care university students in Ghana Canadian Journal of infectious diseases and medical microbiology <https://doi.org/10.1155/2021/1647959>
- [4] World health Organization. Prevention of hospital acquired infection: a practical guide, Geneva: World Health Organization: 2002 (online <https://www.yumpu.com/en/document/view/5820954/prevention-of-hospital-acquired-infections-world-health-organization>, accessed 26-11-2020.
- [5] Ulger, F., Dilek, A., Esen, S. Subul, M. Leblebicioky. H. (2018). Are health Workers' mobile phones a potential source of nosocomial infections?. Review of Infectivity. The Journal of infection in developing countries 9 (10) 1046-1053.
- [6] Bodene, D, Teklamerinyz, balkrichung, S. and Tesfa 920190. Bacterial contamination of mobile phones of health professionals in Eastern Ethiopia. Antimicrobial susceptibility and associated factors tropical medicine and health, 47: 15, 1-10.
- [7] Grace, E. A and Segre, F. A (2011). The skin Microbiome Nature reviews, microbiology, 9 (4): 244-253.
- [8] Madhuri, J. R., Saraswathi, M., Mahitha, G., Bhargavi, M., Deepika, S. and Lakshmi, V. G. (2015). Bacterial contamination of mobile phones and computers in microbiological laboratories. European Journal of Biotechnology and Bioscience, 3 (9), 51-55.
- [9] CLSI (2012). Methods for Dilution Antimicrobial Susceptibility Tests for Bacteria that Grow Aerobically, Approved Standard, 9th ed., CLSI document M07-A9. Clinical and Laboratory Standards Institute, 950 West Valley Road, Suite 2500, Wayne, Pennsylvania 19087, USA.
- [10] Chih Hsiang, C., Szu-yuan, C., Jang-hil, L., Chu-Jan, C., YUHAN, C. AND Pang-Hsin, H. (2017). Nasal colonization and bacterial contamination of mobile phones carried by medical staff in operating room.
- [11] Debnath, T., Bhowmik, S., Islam, I., Choudhury, (2018). Presence of multi-drug resistant bacteria on mobile phones of health workers accelerates the spread of nosocomial infections and regarded as a threat to public health in Bangladesh. Journal of microbiology and ultrastructure 6 (3): 165-169.
- [12] Phipps, S. and Jain, S. K (2015). Bacterial contamination of mobile phones of Health Care Worker in a tertiary care hospital. Indian Journal of Applied research 5 (8): 732-735.
- [13] Balapriya, P. Padmakumari, J. Vijayalakshmi, J. (2016) A screening for nosocomial pathogens in stethoscopes sphygmomanometers and mobile phones of health care providers in a tertiary care hospital Int. J. Curr. Microbial Appl Sci 5 (10); 91-8.
- [14] Lausch, K. R., Fuusted, K, Larsen, C. S, Storgaard, M. (2013) Colonisation with multiresistant Enterobacteriaceae in hospitalized Danish patients with a history of recent travel. A cross-sectional study. Travel Med. Infect. Diseases 11 (5): 320-3.
- [15] Jones, B. L, German, L. J. Simpson, J. Curran, E. T, McNamee, S, Lucas C, et al., An outbreak of *Serratia marcescens* in two neonatal intensive care units J. Hosp. Infect 46 (4): 314: 9.
- [16] Rabier, V., bateillon, S, Jolivet-Gougeon, Chaplain, J. M. (2008). Beuchee, A. Betremieux, P. Handwashing soap as a source of neonatal *Serratia marcescens* outbreak Acta Paediatr 97 (10): 38: 1-5.
- [17] Ibtasam, O. A., Mohamed, E. El fedaa, M. F and Morad, A. S (2016). Microbial contamination of mobile phones of health care workers in teaching hospitals, West Libya LJMRCOM 10 (1): 140-147.
- [18] Anibijuwon, I. I. Odaibo, D. O. Omojasola, D. F and Ibrahim, F. R. (2015) isolation of microorganism on the surfaces of mobile. Nigerian Society for Microbiology 28: 2821-2828.
- [19] Oteo, J' Nwarro, C' Cercenads, E. Delgado-Iribarren, A., Wilhelmi, I., Orden, B. Garaa-cobos, S., Araal, B., bautista, V. And Campos, J. (2006). Spread of *E. coli* strain with high-level cefotaxime and ceftazidime resistance between community, long term care facilities and hospital institutions Journal of Clinical Microbiology. 44 (70): 2359-2366.

- [20] Enass, G. S. (201) Isolation, identification, and determination of antimicrobial susceptibility of bacteria isolated from mobile phones of students J. of chemistry of Anbar for pure science 9 (3): 7-9.
- [21] Shiluli, C. Achok, C. Nyaswa, P., Ogwai, S. Aroko, A., Obila, J, Koigi, G, Ridhwana, M. Okwayo, B., Warijiru, D, Lukeha, L. Ryckaert, E., Durme, A. V, Walschaerts, V and De Preter, V. (2021) Antimicrobial sensitivity patterns of Staphylococcus species isolated from mobile phones and implications in the health sector BM Research Notes 14: 1 <https://doi.org/10.1186/s13104-020-05413-7>