International Journal of Scientific World, 4 (1) (2016) 15-18

International Journal of Scientific World

Website: www.sciencepubco.com/index.php/IJSW
doi: 10.14419/ijsw.v4i1.5903
Research paper

Epidemiology of oxacillin-resistant *Staphylococcus aureus* from cell phones of health-care workers in Ekiti State

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Abstract

The use of mobile phones in the clinical environment by health-care workers has become widespread. A swab of mobile phones of health-care personnel of several hospitals in Ekiti State were examined to evaluate the prevalence of Oxacillin resistant *Staphylococcus aureus* (ORSA), the resistance of ORSA to other commonly used antibiotics as well as the multiple resistant patterns of the recovered isolates. A total of 106 samples were screened yielding 100 *S. aureus* isolates. The antibiotics sensitivity profile to nine commonly used antibiotics revealed high levels of resistance amongst the isolates ranging from 47% resistance to Chloramphenicol to 100% resistance exhibited to cloxacillin with 55% of the isolates showed resistance to oxacillin while all isolates exhibited multiple resistance. Also, all 55 ORSA exhibited 100% resistance to erythromycin and cloxacillin but interestingly were very sensitive (99.9%) to gentamicin. The high recovery rate of bacteria from mobile phones revealed that cell phones may have notable roles in the transmission of multidrug resistant nosocomial pathogens, increasing the risk of cross-contamination posed to immunosuppressed patients by the heath care workers attending to them.

Keywords: *Health Care Workers; Mobile Phones; Oxacillin; S. Aureus.*

1. Introduction

Hospital acquired infections are a problem in both developed and developing countries. It significantly increases the patients' length of stay in the hospital hence higher hospital costs. The reservoir of any organism, which may be animate or inanimate objects, in the epidemiology of any bacterial disease is very important [1-2]. Sources of HAI's can include medical staffs, the patients' own flora and inanimate hospital objects [3-4] Mobile phones are being used in all aspects of health-care delivery. They are the much preferred and most used routes of communication. However, health-care workers' (HCW) mobile phones provide a reservoir of bacteria known to be responsible for hospital acquired infections [5]. Sadat-Ali *et al*. [6] reported co-contamination of oxacillin-resistant (ORSA) on HCWs' hands and their mobile phones. Also, [7] reported that previously *Staphylococcus aureus* decolonized hands of HCWs can become contaminated by bacteria from the device. Also, [8-15] investigated the role of mobile phones and also reported role of mobile phones in transmission of infection and found out that threatening infections spread by Doctor's mobile phones and that there was an increased rate of hospital infection with use of mobile phones. Despite being used on a continuous basis, these mobile phones are seldom cleaned. They can also act as fomites for transmission of pathogenic organisms like *S. aureus* amongst other nosocomial pathogens [16]. *S. aureus* is considered an opportunistic pathogen responsible for great morbidity and mortality; man is its main reservoir [17]. It can be found colonizing several sites of the human body and in health-care settings may contaminate furniture, clothes and equipment including mobile-phones of health-care workers around infected patients, which function as sources or reservoirs [18].

Oxacillin resistant *S. aureus* (ORSA) emerged during the early 60s [19], and has since caused concerns due to nosocomial infections in human health-care [20-22]. Some strains of Methicillin resistant *S. aureus* have been designated epidemic strains; these are associated with a higher prevalence and have been shown to spread within hospitals, between hospitals, and between countries [23-24].The prevalence of ORSA in post-operative infections accounts for up to 40% of nosocomial *S. aureus* infections in large hospitals in USA, [25], 50% in Portugal [26], as high as 75% in Hong Kong [27] and about 21- 30% in Nigeria as reported by [28]. The epidemiology of ORSA on the cell phones of health-care workers in Ekiti State is investigated in this study.

2. Materials and methods

Sample Collection

A total of one hundred and six non-repeat mobile phone surface swabs were collected from healthcare facilities in Ekiti State, Nigeria. Samples were cultured on Mannitol salt agar (Oxoid) and incubated at 35°C for 24 h. The discrete colonies were sub-cultured and incubated at the conditions earlier stated.

Isolation and Identification of the Organisms

Gram reaction and biochemical tests were conducted on the large and yellow colonies on Mannitol salt agar. Other tests carried on the isolates were slide coagulase (using rabbit plasma), catalase tests and growth in thioglycollate broth. Fermentation of maltose, mannose, lactose, sucrose and trehalose were also tested. The results of the identification procedures were interpreted according to Fawole and Oso [29] and Holt *et al.* [30].

Antibiotic Sensitivity Testing

Each of the isolates of *S. aureus* was grown at 37 °C in Mueller-Hinton broth (Oxoid) for 18 h and adjusted to an optical density of 0.5 McFarland Standard. The disc diffusion method was used for susceptibility testing as described by Clinical and Laboratory Standard Institute [31]. The isolates were tested against eight commercial antibiotic disks (Abtek Biological Limited) their concentrations in microgram in the discs were as follows: Oxacillin (5), augmentin (30), chloramphenicol (30, cotrimoxazole (25), gentamicin (10µg), erythromycin (15), amoxycillin (100) and tetracycline (30), cloxacillin (5).

3. Results

One hundred and six mobile phones of health-care workers (58 from nurses, 18 from doctors and 30 from laboratory scientists) from tertiary (3°), secondary (2°) and primary (1°) health-care institutions were sampled yielding 100 *S. aureus* isolates. 26 isolates were recovered from the 3° institutions with 86% and 93% recovery from A and B respectively while 31 and 43 isolates were recovered from 2° and 1° respectively. 100% recovery was observed in all of the 2° institution workers' phones sampled while all of the 1° institution workers' phones except two (86% and 89% for institution A and C respectively) showed 100% recovery rate (Table 1).

Antimicrobial susceptibility testing on the recovered isolates showed high levels of resistance in all the isolates ranging from 47% resistance to Chloramphenicol to 100% resistance exhibited to cloxacillin. Fifty-five isolates (55%) showed resistance to oxacillin (Table 2). ORSA highest occurrence was observed in isolates recovered from laboratory scientists (60%), while the least occurrence was recorded amongst isolates from nurses (48.3%).

Multiple resistance was observed in all the isolates, 20% showing resistance to all the drugs used while only 8% resisted just 3 classes of antibiotics. The multiple resistance pattern is shown in Table 3.

Table 1: Occurrence of *Staphylococcus aureus* Isolates on Mobile Phones of Health-Care Workers in Ekiti State.

Hospital	Doctors	Nurses	Lab scientist	Total	Growth	Percentage occurrence (%)
3° A	3	7	4	14	12	85.7
3° B	3	9	3	15	14	93.3
2° A	2	5	3	10	10	100
2° B	2	5	3	10	10	100
2° C	2	6	3	11	11	100
1° A	2	7	5	14	12	85.7
1° B	1	5	2	8	8	100
1° C	1	6	2	9	8	88.9
1° D	1	4	3	8	8	100
1° E	1	4	2	7	7	100
Total	18	58	30	106	100	94.3

(Legend: 3° = tertiary health care institution; 2° = secondary health care institution; 1°= primary health care institution)

Table 2: Antibiotic Susceptibility Pattern of *Staphylococcus aureus* Isolates

Antibiotics	Sensitivity Resistance	Intermediate	Sensitive
Oxacillin (5µg)	55	3	42
Augmentin (30µg)	73	9	18
Amoxycillin	76	7	17
Chloramphenicol (30µg)	47	12	41
Cotrimoxazole (25µg)	94	3	3
Gentamicin	17	10	73
Erythromycin (5µg)	94	2	4
Tetracycline (10µg)	73	6	21
Cloxacillin (5µg)	100	0	0

Table 3: The Multiple Antibiotic Resistant Phenotypes for *Staphylococcus aureus* Isolated From Cell Phones of Health Care Workers in Ekiti State

Number of classes	Phenotype	Organism(*S. aureus*)
3	ERY/CXC/COT	2
	AMX/ERY/CXC	2
	TET/CXC/COT	2
	AUG/CXC/COT	2
		8
4	AMX/ERY/CXC/COT	3
	AUG/TET/CXC/COT	1
	ERY/TET/CXC/COT	2
		6
5	AMX/ERY/TET/CXC/COT	2
	OXA/ERY/CXC/COT/CHL	1
	OXA/AUG/AMX/ERY/CXC	1
	OXA/AMX/ERY/TET/CXC	1
	OXA/AUG/ERY/CXC/COT	2
	AUG/AMX/ERY/CXC/COT	4
	AUG/ERY/TET/CXC/COT	2
	ERY/TET/CXC/COT/CHL	1
		14
6	OXA/AMX/ERY/TET/CXC/COT	1
	OXA/AUG/AMX/ERY/CXC/COT	2
	AUG/AMX/ERY/CXC/COT/CHL	1
	AUG/AMX/ERY/TET/CXC/COT	6
	AUG/ERY/TET/CXC/COT/CHL	2
	OXA/AMX/ERY/CXC/COT/CHL	1
	AUG/AMX/TET/CXC/COT/CHL	1
		14
7	AUG/AMX/ERY/TET/CXC/COT/CHL	6
	OXA/AUG/AMX/ERY/TET/CXC/COT	7
	OXA/AMX/ERY/TET/CXC/COT/CHL	2
	OXA/AUG/AMX/ERY/CXC/COT/CHL	1
	AUG/AMX/ERY/TET/CXC/GEN/COT	1
	OXA/AUG/AMX/ERY/CXC/GEN/COT	1
	OXA/AUG/ERY/TET/CXC/COT/CHL	1
		19
8	OXA/AUG/AMX/ERY/TET/CXC/COT/CHL	14
	AUG/AMX/ERY/TET/CXC/GEN/COT/CHL	5
		19
9	OXA/AUG/AMX/ERY/TET/CXC/GEN/COT/CHL	20
		20

4. Discussion

Nosocomial infections continue to pose significant risk of increased mortality and morbidity among the patients and the various etiological agents responsible for such infections vary from hospital to hospital and also in different geographical regions [32]. Isolation of bacterial agents from electronic devices such as handheld computers and personal digital assistants has shown these devices to be possible modes of transmission of nosocomial pathogens [33]. Unlike fixed phones, mobile phones are often used in these areas close to the patients and these patients are more vulnerable to hospital acquired infections [34]. In this study, 100 *S. aureus* were recovered from 106 mobile phones sampled showing that they are important reservoir in hospital settings and thus put immunocompromised patients as well as those in intensive care at risks of cross infections.

Famurewa and David [2] examined 150 cell phones of volunteers in the university premises, commercial centres, hospital personnel (Doctors and Nurses) and hospitalized patients and recovered 124 bacteria identified as *Escherichia coli, Pseudomonas aeruginosa*, *Klebsiella* sp, *Serratia* sp, *S. aureus* and *Proteus vulgaris*. Tambe and Pai [16] recovered 65 *S. aureus* from 120 mobile phones of health-care providers as the most prevalent bacteria species from the cell phones, and this agrees with the findings of [35] who observed that *S. aureus* is one of the most frequently isolated bacteria in hospital infections after recovering 39 isolates which was second only to *P. aeruginosa* with 43 isolates. In another study, [36] also recovered only *S. aureus* isolates from 30 mobile phones sampled. The antibiotics resistance testing showed high levels of

resistance to commonly used antibiotics with the resistance ranging from 17% to gentamicin to 100% resistance observed to cloxacillin. These antibiotics are extensively used in Nigeria and often prescribed over the counter [37]. Resistant strains especially Oxacillin resistant *S. aureus* (ORSA) has become the most common cause of nosocomial infections worldwide [38] with this study finding 55% ORSA isolates. This finding agrees with that reported by [39] who observed 52.5% ORSA amongst health-care workers of University of Ilorin Teaching Hospital. Also, [40] recovered 20% *S. aureus* from 250 phones sampled and observed that they showed high resistance to oxacillin. However, the reports of [41], [42] showed lower recoveries of ORSA with only 4.0% and 1.8% in New-Zealand and India respectively. Also, some local studies have reported ≤ 45.0% ORSA prevalence on patient's isolates [43], [44], and [45]. The differences in the design of these studies may be responsible for the disparity in carriage rates of ORSA as well as the likelihood of poor infection control policies in health-care settings [46].

Multiple resistance was observed in all ORSA isolates similar to the report of the study by [47] who observed 91.6% multiple drug resistant isolates from cell phones of clinical workers. Although the development of resistance to antibiotics is a factor of exposure to the antimicrobials [48], other factors may also be responsible [46]. Such multi drug- resistance has serious implications in the treatment of infections caused by these pathogens and for the possible co-selection of antimicrobial resistance mediated by multi-drug resistance plasmids [49].

5. Conclusion

Although cell phones are important devices for in health care settings, the high prevalence of multiple resistant organisms especially ORSA calls for a review of its use by health workers. Hence, the training of health-care personnel about strict infection control procedure, hand hygiene, environmental disinfection, and eventually, optimum disinfection methods are of great importance. To prevent the emergence of drug resistant forms, indiscriminate use of higher antibiotics needs to be stopped and antibiotic policy to be strictly followed.

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