Onaolapo and Afolabi, J Trop Dis 2015, 4:1
DOI: 10.4172/2329-891X.1000184

Journal of Tropical Diseases

Research Article Open Access

Incidence and Antibiotic Susceptibility Profile of *Staphylococcus aureus* on Door Handles in Ahmadu Bello University, Zaria

Onaolapo JA[1*], Afolabi OE[1] and Igwe JC[2]

[1]*Department of Pharmaceutics and Pharmaceutical Microbiology, Ahmadu Bello University, Zaria*
[2]*Department of Medical Biotechnology, National Biotechnology Development Agency, Abuja*

Abstract

Pathogenic microorganisms implicated in most diseases are transferable through contact with infected persons or objects. In this study, door handles in the Faculty of Pharmaceutical Sciences and Amina female hostel in Ahmadu Bello University, Zaria, Nigeria were evaluated for the presence of *Staphylococcus aureus* and their antibiotics susceptibility profile was tested, using standard microbiological methods. The results showed that out of the 143 door handles sampled (Amina female hostel = 89, Pharmacy main block = 40, Pharmacy old block = 14), the incidence of *Staphylococcus aureus* was 50.7%(34) [with highest occurrence in Amina female hostel (35.8%), followed by Pharmacy main block (8.9%) and Pharmacy old block (6.0%)], *E. coli* was observed to be the second most common organism (9%) followed by *Shigella dysentery* 7.5%, while *Salmonella typhi*, *Seretia spp.* and *Pseudomonas aeruginosa* were both 6% respectively. The antibiotic susceptibility profile of the isolates showed that they were 100% susceptible to Ciprofloxacin, Erythromycin and Tetracycline, 97% susceptible to Mupirocin, and Cotrimoxazole, and 92% to Pefloxacin and Oxacillin. Their levels of resistance to these antibiotics were very low (3% resistance to Mupirocin and Cotrimoxazole, 8% to Pefloxacin and Oxacillin), while their resistances to Amoxicillin, Cefuroxin sodium and Cefotaxime were very high (100%). An evaluation of the pattern of resistance of the isolates showed that 76.5% of the isolates had MAR index of ≤0.4 while 70.6% of the isolates were multidrug resistant; exhibiting resistance to some commonly used Fluoroquinolone, Cephalosporine (CEP), and Betalactam/Betalactamase inhibitors (BET) groups of antibiotics (73.5%). The high incidence of *Staphylococcus aureus* in this study suggests poor hygiene among students, and the possibility of transferring pathogenic *Staphylococcus aureus* through door handles in a densely populated environ during disease outbreak is probable. To curb the spread of pathogenic and resistant *Staph. aureus*, this study suggests that door handles in A.B.U, Zaria should be replaced with silver coated surfaces with antimicrobial properties, and frequent use of disinfectant/hand sanitizer is recommended. Also proper periodic antibiotic surveillance should be encouraged to have referable documentaries in disease outbreak.

Keywords: *Staphylococcus aureus;* Door handles; Antibiotic susceptibility profile; Hygiene

Introduction

Environmental contamination with pathogenic microorganisms which are of clinical importance due to their contribution to morbidity and mortality is increasing daily. Such microorganisms especially skin associated ones like *Staphylococcus aureus* have been isolated from various sites or surfaces touched by hands both in hospitals and non-hospital environments e.g. bed sheets, bed crank, tables, buttons on the infusion pump, cotton gowns, sink handles, toilet flushes, toilet seats, cell bars, light switches, soap dishes, window handles, locker handles, radios, door handle, boxing gloves, basketballs, abdominal crunch machine, seated and upright leg presses in gymnasium and hand sanitizer dispenser [1-3]. The possibilities of isolating *Staphylococcus aureus* from these environments might be as a result of their extreme flexibility and capacity for rapid growth and reproduction [4]. This wide spread of *Staphylococcus aureus* contributes to its importance as a nosocomial and community-acquired pathogen, whose genetic plasticity could facilitate the evolution of many virulent and antibiotics resistant strains, which could present a major and constantly changing clinical problems [5]. *Staphylococcus aureus* has been implicated in diseases such as dermatitis, pneumonia, septicaemia, osteomyelitis and meningitis in both humans and swine, as well as bovine mastitis in cattle and bumble-foot disease in poultry [6]. Studies have demonstrated that, even with high compliance to hand hygiene measures, cross-transmission of *Staphylococcus aureus* could still occur, but how beneficial or harmful *Staphylococcus aureus* as environmental contaminate could depend greatly on human measure or observation [7,8]. As microbial resistance to antibiotic commonly prescribed is becoming a global challenge, this study evaluates the antibiotics susceptibility profile of *Staphylococcus aureus* isolated from door handles in the Faculty of Pharmaceutical Sciences and Amina female hostels in Ahmadu Bello University, Zaria, Nigeria in order to quantify the level of antibiotics resistance and to proffer better treatment or management options to infections associated with *Staphylococcus aureus* contacted from door handles in this area.

Methodology

Sample collection

A total of one hundred and forty three (143) samples from door handles were randomly collected using sterile swab sticks containing sterile normal saline. The samples were aseptically collected from Amina female hostel, Pharmacy main block and Pharmacy old block of Ahmadu Bello University Zaria, Samaru Campus (A.B.U).

Microbial identification, isolation and microscopy

***Corresponding author**: Onaolapo JA, Department of Pharmaceutics and Pharmaceutical Microbiology, Ahmadu Bello University, Zaria, Nigeria, Tel: 2348037033157; E-mail: jaonaolapo@gmail.com

Received October 01, 2015; **Accepted** October 26, 2015; **Published** November 02, 2015

Citation: Onaolapo JA, Afolabi OE, Igwe JC (2015) Incidence and Antibiotic Susceptibility Profile of Staphylococcus aureus on Door Handles in Ahmadu Bello University, Zaria. J Trop Dis 4: 184. doi:10.4172/2329-891X.1000184

Collected samples were suspended in sterile nutrient broth for 24hrs and then inoculated on the surface of sterile nutrient agar (NA), and incubated at 37°C for 18hrs. Gram staining and microscopy were also carried out to differentiate between Gram positive and Gram negative organisms using the method described by Chakraborty and Nishith, [9] while further morphological characterization of the colonies were carried out on Mannitol salt agar using the method described by Cheesbrough [10]. The presence of other microbial growth on MacConkey agar, Eosin methylene blue agar and Cetrimide agar were also observed.

Biochemical test

The following conventional biochemical tests; catalase, coagulase and oxidase tests described by Cheesbrough [10] were adopted to distinguish *Staphylococcus aureus* from other forms of *Staphylococcus spp*. While the Gram negatives organisms were identified by their colour on indole, methyl red, Vogue Prosker, citrate and urease described by Chakraborty and Nishith [9].

Antibiotic susceptibility test and multiple antibiotic resistance index (MARI) evaluation

The susceptibility profiles of the identified *Staphylococcus aureus* was tested against twelve (12) selected antibiotics (Tetracycline (TE), Cefuroxin sodium (CXM), Cefotaxime (CTX), Mupirocin (MUP), Ciprofloxacin (CIP), Ofloxacin (OFX), Perfloxacin (PEF), Oxacillin (OX), Cotrimoxazole (SXT), Erythromycin (E), Amoxicillin/ clavulanic acid (AMC), Amoxicillin (AML)) using disc diffusion method as described by Cheesbrough [10] and the corresponding results interpreted using CLSI [11]. The multiple antibiotic resistant (MAR) index was determined for each isolate. This is defined as the number of antibiotics to which the organism is resistant to, divided by the total number of antibiotics tested [12].

Results

Out of the 143 door handles sampled, the incidence of *Staphylococcus aureus* was 23.8% (34) with highest occurrence in Amina female hostel (16.8%), followed by Pharmacy main block (4.2%) and Pharmacy old block (2.8%) as shown in Table 1. Among the samples collected, culture identification, microscopy and biochemical tests also showed the presences of other microorganisms. The incidence of *E. coli* (9%) and *Shigella dysentery* (7.5%) were found to be the most common bacteria compared to other microorganisms isolated after *Staphylococcus aureus*. This is shown in Table 2.

Antibiotics susceptibility profile of *Staphylococcus aureus* from the sampled area

The isolates were highly susceptible to Erythromycin, Ciprofloxacin, and Tetracycline (100%), 97% susceptible to mupirocine and cotrimoxazole, 90% to Pefloxacine, and 85% to Oxacillin. But the isolates were observed to be 100% (34) resistant to Cefotaxime and Amoxicillin, 96.7% (33) resistant to Cefuroxin sodium, 76.6% and 70 % resistant to Ofloxacine and Amoxicillin clavulanic acid respectively (Figure 1).

Discussion

The dissemination of clinically significant microorganism within our environment is fast growing through cross contamination of the surfaces due to poor hygiene. Reports have pinpointed doors handle, computer surfaces, phones etc as sources of microbial transfer and could also be a route of infections in diseases outbreak [13,14].

S/N	Sample Source	No. Of Door Handles Sampled	Number of *Staph. aureus*	Percentage of *Staph. aureus* (%)
1	Amina female hostel	89	24	35.8
2	Pharmacy main block	40	6	8.9
3	Pharmacy old block	14	4	6.0
Total		**143**	**34**	**50.7**

Table 1: Distribution of *Staph. aureus* In Door Handles in Ahmadu Bello University, Zaria.

S/N	ORGANISMS	Number of Isolates (n = 67)	Percentage (%)
1	Staphylococcus aureus	34	50.7
2	Eschericheria coli	6	9
3	Shigella dysentery	5	7.5
4	Salmonella typhi	4	6
5	Pseudomonas aeruginosa	4	6
6	Serretia spp.	4	6
7	Klebsiella spp.	3	4.4
8	Citrobacter spp.	2	3
9	Proteus mirabilis	2	3
10	Salmonella paratyphi A	2	3
11	Enterobacter spp.	1	1.4
		67	100

This result showed the microbial contaminate on door handles in the areas sampled

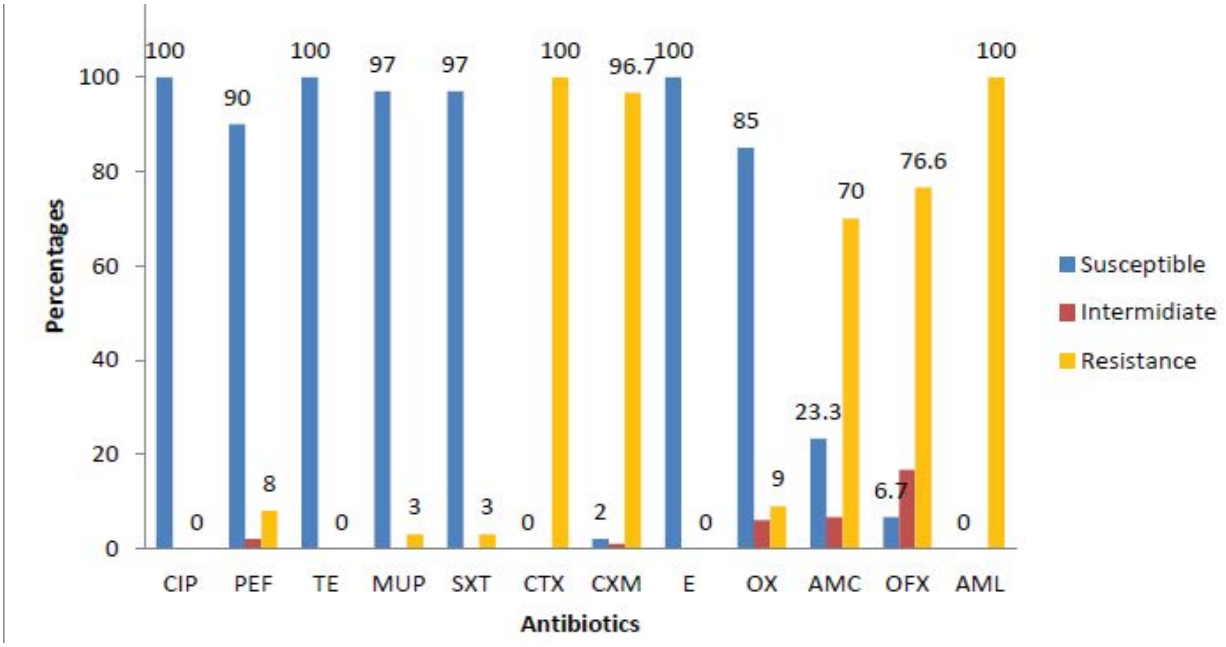
Table 2: Percentage of Bacteria Isolated from the Door Handles Sampled.

This study evaluates the incidence and antibiotics susceptibility profile of *Staphylococcus aureus* from door handles in the Faculty of Pharmaceutical Sciences and Amina female hostels in Ahmadu Bello University, Zaria. Out of the 143 door handles sampled, the incidence of *Staphylococcus aureus* was 50.7% (34) with highest occurrence in Amina female hostel (35.8%), followed by Pharmacy main block (8.9%) and Pharmacy old block (6.0%) (Table 1).The result showed that a total of eleven (11) different microorganisms were isolated. *Staphylococcus aureus* was observed to be present in all the samples evaluated (50.7) (Table 3) followed by *E. coli* (9%), *Shigella dysentery* (7.5%), *Salmonella typhi, P. aeruginosa*, and *Seretia spp.* (6%), *Klebsiella spp.* (4.4%), *Citrobacter spp., Proteus mirabilis and Salmonella paratyhi A* (3%) and *Enterobacter spp.* (1.4%) (Table 3). These findings concurred with the report of Ajayi and Ekozien [15] in Ekpoma, Kawo et al., [16] in Kano and Itah and Ben [17] in Akwa Ibom, Nigeria, who reported that *Staphylococcus aureus* and *E. coli* are the most predominate surface microbe from door handles, tables, hand of students and computers. These surfaces especially the door handle are indeed a breeding ground for microbes as reported by Barker and Jones [18], who noted that contamination of the environment via the surface-to-hand-to-mouth could be an avenue of contacting diseases and encourages disease wide spread. This calls for good hygienic practices as these microbes are signal of unhygienic environment [19]. The antibiotic susceptibility profile of the *Staphylococcus aureus* isolated from the sampled door handles showed that the isolates were highly resistant (100% (34)) to Cefotaxime and Amoxicillin, 96.7% (33) resistance to Cefuroxin sodium, 76.6% and 70% resistance to Ofloxacine and Amoxicillin clavulanic acid respectively (Figure 1). This result concurs with other studies that *Staphylococcus aureus* from surfaces have high percentages of antibiotic resistance even to methicillin (60.4%) [2]; Gentamicin, Amoxicillin-clavulanic acid and Cotrimoxazole [15]. This suggests that

S/no	Isolates	Gram Positive	Mannitol	Catalase	Coagulase	Oxidase	Probable organism
1	A2a	+	Golden yellow	+	+	_	*Staph. aureus*
2	A2b	+	Golden yellow	+	+	_	*Staph. aureus*
3	B1a	+	Golden yellow	+	+	_	*Staph. aureus*
4	D1b	+	Golden yellow	+	+	_	*Staph. aureus*
5	D2b	+	Golden yellow	+	+	_	*Staph. aureus*
6	E2a	+	Golden yellow	+	+	_	*Staph. aureus*
7	F1a	+	Golden yellow	+	+	_	*Staph. aureus*
8	F1b	+	Golden yellow	+	+	_	*Staph. aureus*
9	F2a	+	Golden yellow	+	+	_	*Staph. aureus*
10	F2b	+	Golden yellow	+	+	_	*Staph. aureus*
11	G2a	+	Golden yellow	+	+	_	*Staph. aureus*
12	H1a	+	Golden yellow	+	+	_	*Staph. aureus*
13	H1b	+	Golden yellow	+	+	_	*Staph. aureus*
14	H1c	+	Golden yellow	+	+	_	*Staph. aureus*
15	H2a	+	Golden yellow	+	+	_	*Staph. aureus*
16	H2b	+	Golden yellow	+	+	_	*Staph. aureus*
17	H2c	+	Golden yellow	+	+	_	*Staph. aureus*
18	I1a	+	Golden yellow	+	+	_	*Staph. aureus*
19	I1b	+	Golden yellow	+	+	_	*Staph. aureus*
20	I2	+	Golden yellow	+	+	_	*Staph. aureus*
21	J2a	+	Golden yellow	+	+	_	*Staph. aureus*
22	K1a	+	Golden yellow	+	+	_	*Staph. aureus*
23	K2b	+	Golden yellow	+	+	_	*Staph. aureus*
24	L1a	+	Golden yellow	+	+	_	*Staph. aureus*
25	L1b	+	Golden yellow	+	+	_	*Staph. aureus*
26	M1a	+	Golden yellow	+	+	_	*Staph. aureus*
27	M1b	+	Golden yellow	+	+	_	*Staph. aureus*
28	N2a	+	Golden yellow	+	+	_	*Staph. aureus*
29	N2b	+	Golden yellow	+	+	_	*Staph. aureus*
30	D2c	+	Golden yellow	+	+	_	*Staph. aureus*
31	M2p	+	Golden yellow	+	+	_	*Staph. aureus*
32	N2c	+	Golden yellow	+	+	_	*Staph. aureus*
33	N2g	+	Golden yellow	+	+	_	*Staph. aureus*
34	D2h	+	Golden yellow	+	+	_	*Staph. aureus*

Table 3: Isolation and Characterization of *Staphylococcus aureus* from Door handles in A.B.U.

in situation of such infections from door handle, these antibiotics should not be hoped on as the last resort for treatment. However, promising for therapeutics are Erythromycin, Ciprofloxacin, and Tetracycline as the isolates from this study showed 100%, 97% susceptibility to Mupirocine and Cotrimoxazole respectively, 90% to Pefloxacine, and 85% to Oxacillin. This result is supported by the study of Ajayi and Ekozien, [15]. Also in the areas sampled the antibiotic susceptibility pattern of the isolated *Staphylococcus aureus* showed that 96.7% of the isolates were simultaneously resistant to Amoxicillin, Cefuroxin sodium (CXM) and Cefotaxime (CTX); while 73.5% were resistant to Fluoroquinolone, Cephalosporine (CEP), and Betalactam/Betalactamase inhibitors (BET) groups of antibiotics. The result also showed that 76.5% of the isolates had MAR index of ≤0.4 while 70.6% of the isolates were multidrug resistant (Table 4). The high resistance observed in this study concur with the observation of Daniel and Kenneth [20], in whose study 50% (6) of the total antibiotics tested (12) (Ampicillin, Penicillin, Cefuroxime and Cloxacillin, and Amikacin) were inactive against both Gram-positive and Gram-negative bacteria isolated. Pattern of isolates antibiotics resistance was classified according to Magiorakos et al., [21]. The high multiple antibiotic resistance observed in this study also concur with the observation of Oluduro et al., [22], who observed that the isolates from door handles had 89.1% MDR, with a total of 68 resistance patterns and resistance to three antibiotics simultaneously were the most frequent (31.9%). This finding showed that the isolates



Keys: Tetracycline (TE), Cefuroxin sodium (CXM), Cefotaxime (CTX), Mupirocin (MUP), Ciprofloxacin (CIP), Ofloxacin (OFX), Perfloxacin (PEF), Oxacillin (OX), Erythromycin (E), Amoxicillin/clavulanic acid (AMC), Amoxicillin (AML), Cotrimoxazole (SXT).

Figure 1: Antibiotics Susceptibility Profile of *Staphylococcus aureus*.

S/N	ISOLATES	Antibiotics Resistant Pattern	MARI	CART	DR
1	F1a	CTX, CXM, AML	0.3	CEP, BET	XDR
2	D2b	CTX, CXM, AML, OFX	0.3	CEP, BET	XDR
3	I1b	AMC, CTX, CXM, AML, PEF, OFX	0.5	CEP, BET, FLU	MDR
4	H1b	AMC, CTX, CXM, AML, OFX	0.4	CEP, BET, FLU	MDR
5	H2c	AMC, CTX, CXM, AML, OX, OFX	0.5	CEP, BET, FLU	MDR
6	K2b	CTX, CXM, AML,	0.3	CEP, BET	XDR
7	I2	CTX, CXM, AML, OFX	0.3	CEP, BET, FLU	MDR
8	L1a	AMC, CTX, CXM, AML, OFX	0.4	CEP, BET, FLU	MDR
9	F1b	AMC, CTX, CXM, AML, OFX	0.4	BET, CEP, FLU	XDR
10	E2a	AMC, CTX, CXM, AML, PEF, OFX	0.5	BET, CEP, FLU	MDR
11	F2b	AMC, CTX, CXM, AML, OFX	0.4	BET, CEP, FLU	MDR
12	D2c	AMC, CTX, CXM, PEF, AML, OFX	0.5	BET, CEP, FLU	MDR
13	A2b	AMC, CTX, CXM, AML,	0.3	BET, CEP	XDR
14	A2a	AMC, CTX, CXM, AML	0.3	BET, CEP	XDR
15	H1a	CTX, OX, OFX, AML,	0.3	CEP, BET, FLU	MDR
16	I1a	CTX, CXM, AML, OFX	0.3	BET, CEP, FLU	MDR
17	H1c	CTX, CXM, OFX, AML,	0.3	CEP, BET, FLU	MDR
18	G2a	AMC, CTX, CXM, AML, OFX	0.4	BET, CEP, FLU	MDR
19	H2b	CTX, CXM, AML, OFX	0.3	BET, CEP, FLU	MDR
20	B1a	AMC, CTX, CXM, OFX, MUP, AML	0.5	BET, CEP, FLU, PS	MDR
21	J2	CTX, CXM, AML,	0.3	CEP, BET	XDR
22	F2a	AMC, CTX, CXM, OFX, AML,	0.4	BET, CEP, FLU	MDR
23	D1b	CTX, CXM, AML, OFX	0.3	CEP, BET FLU	MDR

24	K1b	AMC, CTX, CXM, AML, OFX	0.4	BET, CEP, FLU	MDR
25	L1b	AMC, CTX, CXM, AML	0.3	BET, CEP	XDR
26	M1a	AMC, CTX, CXM, AML, OX, OFX	0.5	BET, CEP, FLU	MDR
27	M1b	AMC, CTX, CXM, AML, OFX	0.4	BET, CEP, FLU	MDR
28	N2a	AMC, CTX, CXM, AML, OFX	0.4	BET, CEP, FLU	MDR
29	N2b	AMC, CTX, CXM, AML, OFX	0.5	BET, CEP, FLU	MDR
30	H2a	AMC, CTX, CXM, AML,	0.3	BET, CEP	XDR
31	M2p	AMC, CTX, CXM, AML,	0.3	BET, CEP	XDR
32	N2c	AMC, CTX, CXM, AML, SXT, OFX	0.5	BET, CEP, FLU, FPI	MDR
33	N2g	AMC, CTX, CXM, AML, OFX	0.4	BET, CEP, FLU	MDR
34	D2h	AMC, CTX, CXM, AML, OFX	0.4	BET, CEP, FLU	MDR

Keys: Tetracycline (TE), Cefuroxin sodium (CXM), Cefotaxime (CTX), Mupirocin (MUP), Ciprofloxacin (CIP), Ofloxacin (OFX), Perfloxacin (PEF), Oxacillin (OX), Erythromycin (E), Amoxicillin/clavulanic acid (AMC), Amoxicillin (AML). Class of antibiotics resistant to (CART), Degree of resistance (DR), Betalactam/Betalactamase inhibitors (BET), Folate pathway inhibitors (FPI), Cephalosporine (CEP), Fluoroquinolone (FLU), Macrolide (MAC), Pseudomonic acid (PS), MDR: Multidrug-resistant, XDR: Extensively drug-resistant NIL: neither MDR nor XDR. MDR: non-susceptible to ≥1 agent in ≥3 antimicrobial categories. XDR: non-susceptible to ≥1 agent in all but ≥2 categories. PDR: non-susceptible to all antimicrobial agents listed. PDR was not considered because not all the antibiotics contained in the proposal of Magiorakos *et al.,* (2012) are used in this study.

Table 4: Evaluation of the Antibiotic Resistance Pattern and Index (MARI) of *Staph. aureus.*

might have been pre-exposed to the antibiotics used in this study and emphasized the need for antibiotic surveillance in order to curtail the development of resistance.

Conclusion and Recommendations

This study on *Staphylococcus aureus* from door handles in A.B.U Zaria have proved that door handles serve as reservoir and route of microbial dissemination in disease outbreak. It also suggests the use of ciprofloxacin, erythromycin, tetracycline, mupirocin and oxacilline as the best antibiotics during infection associated with door *Staphylococcus* aureus. It also encourages the need to promote proper hygienic practice and adherence to antibiotic treatment in order to prevent the spread of resistance bacteria. For immediate action, this study suggests the use of silver coated door handles with antimicrobial activity in other to reduce the microbial load from this source, and frequent use of disinfectant/ hand sanitizer is recommended. Also proper periodic antibiotic surveillance should be encouraged to have referable documentaries in disease outbreak.

References

1. Miko BA, Herzig CT, Mukherjee DV, Befus M, Apa ZL, et al. (2013) Is Environmental Contamination Associated with Staphylococcus aureus Clinical Infection in Maximum Security Prisons?. Infect Control Hosp Epidemiol 34: 540-542.
2. Adriano MF, Denise de A, Marcelo AR, Margarete TG de A (2011) Methicillin-resistant Staphylococcus aureus on surfaces of an Intensive Care Unit. Acta paul enferm 24.
3. Gilberto EF, Scott TB, Dan K, Christian LL, Jesse S (2011) Microbial biography of public rest room surfaces. PLoS One 6: e28132.
4. Dhamani A (2008) How bacteria influence our environment.
5. Holden MT, Feil EJ, Lindsay JA, Peacock SJ, Day NP, et al. (2004) Complete genomes of two clinical Staphylococcus aureus strains: Evidence for the rapid evolution of virulence and drug resistance. Proceedings of the National Academy of Sciences of the United States of America 101: 9786-9791.
6. Quinn PJ, Carter ME, Markey BK, Carter GR (2000) Staphylococcus species. Clinical Veterinary Microbiology Mosby Edinburgh 118-126.
7. Pittet D, Mourouga P, Perneger TV (1999) Compliance with handwashing in a teaching hospital. Infection Control Program. Ann Intern Med 130: 126-130.
8. Todar K (2012) Bacterial Resistance to Antibiotics.
9. Charkraborty P, Nishith P (2014) Manual of practical microbiology and parasitology.
10. Cheesbrough M (2000) District laboratory practice in tropical countries (Part 2). Cambridge, University Press UK 134-143.
11. Clinical Laboratory Standard Institute (CLSI) (2014) Performance Standards for Antimicrobial Susceptibility Testing.
12. Paul S, Bezbaruah RL, Roy MK, Ghosh AC (1997) Multiple antibiotic resistance (MAR) index and its reversion in Pseudomonas aeruginosa. Lett Appl Microbiol 24: 169-171.
13. Kawo AH, Rogo LD (2008) Health implications of the bacterial load of computer keyboards. Int J Agric Sci Sci Engr and Technol Series 115-120.
14. Michael B (2002) Cross-contamination: Commercial facilities as over-loaded breeding grounds for diseases.
15. Ajayi A and Ekozien MI (2014) Sensitivity profile of bacterial flora isolated from bathroom. Elite Research Journal of Biotechnology and Microbiology 2: 1-3.
16. Kawo AH, Dabai YU, Manga SB, Garba GJ (2012) Prevalence and public health implications of the bacterial load of environmental surfaces of some Secondary Schools in Sokoto, North-western Nigeria. International Research Journal of Microbiology 3: 186-190.
17. Itah AY, Ben AE (2004) Incidence of enteric bacteria and Staphylococcus aureus in day care centers in Akwa Ibom State, Nigeria. Southeast Asian J Trop Med Public Health 35: 202-209.
18. Barker J, Jones MV (2005) The potential spread of infection caused by aerosol contamination of surfaces after flushing a domestic toilet. J Appl Microbiol 99: 339-347.
19. [No authors listed] (1980) Escherichia coli diarrhoea. Bull World Health Organ 58: 23-36.
20. Tagoe DN, Desbordes KK (2012) Investigating potential sources of transmission of healthcare associated infections in a regional hospital, Ghana. International journal of applied and basic medical research 2: 20-24.
21. Magiorakos AP, Srinivasan A, Carey RB, Carmeli Y, Falagas ME, et al. (2012) Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance. Clinical Microbial Infection 18: 268-281.
22. Oluduro AO, Ubani EK, Ofoezie IE (2011) Bacterial Assessment of Electronic Hardware User Interfaces in Ile-Ife, Nigeria. Journal of Basic and Applied Pharmaceutical Sciences 32: 323-334.