Characterization of *Staphylococcus aureus* Isolated from Selected Individuals in Lead City University, Ibadan, Nigeria

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Abstract: *Staphylococcus aureus* is a versatile human pathogen which causes a broad spectrum of significant opportunistic infections ranging from a relatively mild involvement of the skin and the soft tissue to life threatening systemic illness such as sepsis, pneumonia, pustules and boils, as well as toxin-mediated syndromes like toxic shock, scalded syndrome and food poisoning. Fifty swab samples were collected randomly from different parts of the human face which were the nostrils, lower jaw and ear regions. The swab samples were collected from four individuals within Lead City University premises. All the samples were collected with the aid of sterile swab sticks for microbial analysis. The samples collected were inoculated onto Mannitol Salt Agar which is selective for *Staphylococcus* species. The bacterial isolates were all examined and characterized biochemically using standard microbiological methods. Tests carried out included catalase test, haemolytic test, Voges Prokaeur test, coagulase test and sugar fermentation tests. The sensitivity of the isolates to ten specific antibiotics was determined using the disc diffusion method. The antibiotics used were Pefloxacin (10ug), Gentamycin (10ug), Ampiclox (30ug), Zinnacef (20ug), Amoxicillin (30ug), Rocephin (30ug), Ciprofloxacin (10ug), Streptomycin (30ug), Septrin (30ug) and Erythromycin (19ug). Twelve isolates of the fifty samples collected grew golden yellow on Mannitol Salt agar. They were catalase test positive and coagulase test positive. These were suspected to be *Staphylococcus aureus*. This signifies a probable low proportion of suspected *Staphylococcus aureus* in the total bacteria isolated from the head region of the selected individuals. These twelve bacterial isolates suspected to be *Staphylococcus aureus* were sensitive to all the ten antibiotics used. It is concluded that the specific antibiotics used in this study will be effective in controlling infection with these suspected *Staphylococcus aureus* isolates in the selected individuals.
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1. Introduction

Staphylococcus aureus is a spherical – shaped bacterium, a member of the firmicutes and often found in the respiratory tract, nose and on the skin. It is a facultative anaerobe that can grow in the absence of oxygen and can live as a commensal (Masalha, 2001). Even though *S. aureus* is not always pathogenic, it is a common cause of skin infections such as skin abscesses. It causes respiratory tract infections such as sinusitis and it is a common cause of food poisoning. Pathogenic strains frequently promote infections by producing virulence factors such as potent protein toxins and the expression of cell-surface proteins that bind and inactivate antibodies. Notwithstanding, in spite of the lot of research and development so far, presently there is no approved vaccine for *S. aureus*. Staphylococcus was first identified in 1880 in Aberdeen, Scotland, by the surgeon Sir Alexander Ogston in pus from a surgical abscess in a knee joint (Ogston, 1984). This name was later amended to "*Staphylococcus aureus*'' by Friedrich Julius Rosenbach (Whonamedit Dictionary of Medical Eponyms,) who was credited by the Official System of Nomenclature at that time. An appraisal of about 20% of the human population are long-term carriers of *S. aureus* (Kluytmans *et al*., 1997) which can be found as part of the normal skin flora of the nostrils (Kluytmans *et al*., 1997; Cole *et al*., 2001) and as a normal inhabitant of the lower reproductive tract in women (Senoki *et al*., 2009; Hoffman *et al*., 2012). *S. aureus* usually cause a range of illnesses ranging from minor skin infections such as pimples, impetigo, boils, cellulites, folliculitis, carbuncles, scalded skin syndrome and abscesses, to life – threatening diseases such as pneumonia, meningitis, osteomylitis, endocarditis, toxic shock syndrome, bacteremia and sepsis. It is still one of the five most common causes of hospital – acquired infections and is often the cause of wound infections following surgery. Each year, around 500,000 patients in hospitals of the United States contract a staphylococcal infection, chiefly by *S. aureus* (Bowersox, 1999).

In general terms, *Staphylococcus aureus* belongs to the family *Staphylococcaeae*. It affects all known mammalian species, including humans. Due to its

ability to affect a wide range of species, *S. aureus* can be readily transmitted from one species to another. This includes transmission from humans and animals and otherwise.

S. aureus belongs to the genus Staphylococcus, which has more than 20 species. *Staphylococcus aureus* is a Gram-positive coccus. Its pathogenic determinants have contributed to emergence of infections in both nosocomial and community settings (Onwubiko *et al*., 2011).

Infections with *Staphylococcus aureus* has been a general problem in individuals in the western part of the tropics. The acquisition of multiple resistances to antibiotics has posed addition problems to the eradication of infections by this organism. The presence of *S. aureus* in the nasal carriage and facial parts of the human body is an evidence of human exposure to the organism from the environment. Multiple antibiotic resistances to the organism can cause serious health problems.

Resistances to antibiotics arise from misappropriation and misuse of drugs whether recommended or self-medicated. The evolution of resistant strains becomes a problem to both the infected individual and the physician. Eradication of infections by *Staphylococcus aureus* demands studying evolving strains of the isolate with the attempt to combating the genetic evolution of this societal menace. The specific objectives of this research study were to isolate *Staphylococcus aureus* from the nasal carriage and facial parts of selected individuals of Lead City University, Ibadan, Nigeria, determine the physical and biochemical characteristics of the isolated strains, and determine the antibiotic sensitivity of the isolated strains.

2. Material and Methods

Collection of Samples

Twelve different samples used were collected from the ear region, the nostrils and lower jaws of four individuals within Lead City University, Ibadan, Nigeria and were described as follows:

Nostril	Lower Jaw	Ear Region
Sample 1a	Sample 1b	Sample 1c
Sample 2a	Sample 2b	Sample 2c
Sample 3a	Sample 3b	Sample 3c
Sample 4a	Sample 4b	Sample 4c

Sterile swab stick was used for the collection of each sample. Samples were labeled correctly.

Culture

Mannitol Salt Agar (MSA) was used for culturing. Sterile MSA plates were inoculated using swab sample sticks. The plates were incubated at 37^{o}C for up to 48 hours (Bachoon *et al*., 2008). The distinctive colonies observed after 48 hours of growth were sub-cultured into fresh media plates of Nutrient Agar. Sub-culturing was done for purity (Cheesborough, 2006).

Identification of Staphylococcal Isolates

The bacterial isolates were identified by Gram staining reaction for microscopic structure and arrangement. Biochemical tests which were catalase test, coagulase test, haemolytic test, voges proskauer test, arabinose fermentation test, lactose fermentation test, glucose fermentation test and antibiotics susceptibility testing were then carried out (Cheesborough, 2006).

Antibiotic Susceptibility Test

Disc diffusion method (Kirby-Bauer method)

Antibiotic Susceptibility Testing (AST) was carried out using the Kirby-Bauer method (Baker *et al*., 1983). Sterile Diagnostic Sensitivity Test (DST) agar plates were inoculated with the test organisms. A wafer containing discs of different antibiotics was placed on an inoculated plate and pressed very gently to have a good contact between the antibiotic and the inoculated agar. This was done using a sterile forceps. The antibiotics were allowed to diffuse into the medium within 30 minutes. The plates were then incubated at 37^{o}C for 24 hours. The plates were afterwards examined for zones of microbial growth inhibition around each disc. Clear zones were measured with a transparent ruler. The results were interpreted according to the recommendations of National Committee for Clinical Laboratory Standards, Sub-Committee on Antimicrobial Susceptibility Testing (2002). The antibiotics used were: Pefloxacin (10ug), Gentamycin (10ug), Ampiclox (30ug), Zinnacef (20ug), Amoxacillin (30ug), Rocephin (30ug), Ciprofloxacin (10ug), Streptomycin (30ug), Septrin (30ug) and Erythromycin (19ug).

3. Results

In this study nostril samples, lower jaw samples and ear region samples were collected from 4 different individuals (a total of 12 samples) within Lead City University, Ibadan Nigeria.

From the results of the investigation, it was observed that the isolates from the samples were all Gram-positive cocci, in clusters and mannitol test positive (Table 1). Members of the genus *Staphylococcus* are Gram positive cocci and mannitol test positive.

The biochemical tests carried out by standard bacteriological methods on the 12 samples are presented in Tables 2 and 3. The isolated strains were all catalase positive. This further confirms the isolated strains as belonging to the Genus *Staphylococcus*, Species *aureus*. The result showed that all the samples

collected in this study all tested positive to coagulase and in sugar fermentation test for lactose, the isolates responded negative during this test. In further identifying *S. aureus,* there was no gas reaction observed from the isolates in this case. A total of 12 isolates were confirmed as *Staphylococcus* specie, while 11 were positive to haemolysis. However, the isolates were also observed negative to Voges Proskauer test.

Tables 4 - 7 show the antibiotics susceptibility tests carried out using the disc diffusion method on the isolates. It shows the sensitivity of the isolates to the various antibiotics used in this study.

Table 1: Characteristics of colonies and morphology of isolates

Sample	Mannitol test	Gram stain	Morphology characteristics
1a (Nostril)	White colonies	Gram+ve cocci	In clusters
1b (Lower jaw)	White colonies	Gram+ve cocci	In clusters
1c (Ear region)	Yellow colonies	Gram+ve cocci	In clusters
2a (Nostril)	White colonies	Gram+ve cocci	In clusters
2b (Lower jaw)	Yellow colonies	Gram+ve cocci	In clusters
2c (Ear region)	Yellow colonies	Gram+ve cocci	In clusters
3a (Nostril)	White colonies	Gram+ve cocci	In clusters
3b (Lower jaw)	Yellow colonies	Gram+ve cocci	In clusters
3c (Ear region)	Yellow colonies	Gram+ve cocci	In clusters
4a (Nostril)	White colonies	Gram+ve cocci	In clusters
4b (Lower jaw)	Yellow colonies	Gram+ve cocci	In clusters
4c (Ear region)	Yellow colonies	Gram+ve cocci	In clusters

Key: (+) – Positive
(-) – Negative

Table 2: Biochemical tests carried out on isolates

Sample	Catalase test	Coagulase test	Haemolytic test	VP test
1a	+	+	+	-
1b	+	+	+	-
1c	+	+	+	-
2a	+	+	+	-
2b	+	+	+	-
2c	+	+	+	-
3a	+	+	+	-
3b	+	+	-	-
3c	+	+	+	-
4a	+	+	+	-
4b	+	+	+	-
4c	+	+	+	-

Table 3: Sugar fermentation test on isolates

Sample	Arabinose	Lactose	Glucose	Gas production
1a	+	-	-	-
1b	-	-	-	-
1c	-	-	-	-
2a	-	-	-	-
2b	-	-	+	-
2c	-	-	-	-
3a	-	-	-	-
3b	-	-	+	-
3c	+	-	-	-
4a	-	-	++	-
4b	-	-	-	-
4c	-	-	-	-

Key: (-) – Negative (pink color)
(+) – Positive (yellow color)
(++) – Positive (yellow/orange color)

Table 4: Antibiotic susceptibility test on samples from individual 1

Antibiotic	Sample 1a	Sample 1b	Sample 1c
Pefloxacin (10ug)	Sensitive	Sensitive	Sensitive
Gentamycin (10ug)	Sensitive	Sensitive	Sensitive
Ampiclox (30ug)	Sensitive	Sensitive	Sensitive
Zinnacef (20ug)	Sensitive	Sensitive	Sensitive
Amoxicillin (30ug)	Sensitive	Sensitive	Sensitive
Rocephin (30ug)	Sensitive	Sensitive	Sensitive
Ciprofloxacin (10ug)	Sensitive	Sensitive	Sensitive
Streptomycin (30ug)	Sensitive	Sensitive	Sensitive
Septrin (30ug)	Sensitive	Sensitive	Sensitive
Erythromycin (19ug)	Sensitive	Sensitive	Sensitive

From Table 4 above, the strains of *S. aureus* isolated from individual 1 were sensitive to all the antibiotics used in this investigation.

Table 5: Antibiotic susceptibility test on samples from individual 2

Antibiotic	Sample 2a	Sample 2b	Sample 2c
Pefloxacin (10ug)	Sensitive	Sensitive	Sensitive
Gentamycin (10ug)	Sensitive	Sensitive	Sensitive
Ampiclox (30ug)	Sensitive	Sensitive	Sensitive
Zinnacef (20ug)	Sensitive	Sensitive	Sensitive
Amoxacillin (30ug)	Sensitive	Sensitive	Sensitive
Rocephin (30ug)	Sensitive	Sensitive	Sensitive
Ciprofloxacin (10ug)	Sensitive	Sensitive	Sensitive
Streptomycin (30ug)	Sensitive	Sensitive	Sensitive
Septrin (30ug)	Sensitive	Sensitive	Sensitive
Erythromycin (19ug)	Sensitive	Sensitive	Sensitive

The strains of *S. aureus* isolated from individual 2 were sensitive to all the antibiotics used in this investigation (Table 5).

Table 6: Antibiotic susceptibility test on samples from individual 3

Antibiotic	Sample 3a	Sample 3b	Sample 3c
Pefloxacin (10ug)	Sensitive	Sensitive	Sensitive
Gentamycin (10ug)	Sensitive	Sensitive	Sensitive
Ampiclox (30ug)	Sensitive	Sensitive	Sensitive
Zinnacef (20ug)	Sensitive	Sensitive	Sensitive
Amoxacillin (30ug)	Sensitive	Sensitive	Sensitive
Rocephin (30ug)	Sensitive	Sensitive	Sensitive
Ciprofloxacin (10ug)	Sensitive	Sensitive	Sensitive
Streptomycin (30ug)	Sensitive	Sensitive	Sensitive
Septrin (30ug)	Sensitive	Sensitive	Sensitive
Erythromycin (19ug)	Sensitive	Sensitive	Sensitive

From Table 6 above, the strains of *S. aureus* isolated from individual 3 were sensitive to all the antibiotics used in this study.

Table 7: Antibiotic susceptibility test on samples from individual 4

Antibiotic	Sample 4a	Sample 4b	Sample 4c
Pefloxacin (10ug)	Sensitive	Sensitive	Sensitive
Gentamycin (10ug)	Sensitive	Sensitive	Sensitive
Ampiclox (30ug)	Sensitive	Sensitive	Sensitive
Zinnacef (20ug)	Sensitive	Sensitive	Sensitive
Amoxacillin (30ug)	Sensitive	Sensitive	Sensitive
Rocephin (30ug)	Sensitive	Sensitive	Sensitive
Ciprofloxacin (10ug)	Sensitive	Sensitive	Sensitive
Streptomycin (30ug)	Sensitive	Sensitive	Sensitive
Septrin (30ug)	Sensitive	Sensitive	Sensitive
Erythromycin (19ug)	Sensitive	Sensitive	Sensitive

The strains of *S. aureus* isolated from individual 4 were sensitive to all the antibiotics used in this study (Table 7).

4. Discussions

Staphylococcus aureus is the common cause of nosocomial infections (Chikere *et al*., 2008). The overall prevalence of *S. aureus* infection in this study is comparable to other studies done elsewhere in the world (Gelaw *et al.,* 2013). The results presented show that the frequency of *S. aureus* isolated from selected individuals is consistent with previous studies carried out in Nigeria (Gelaw *et al.,* 2013). One of the important sources of *S. aureus* for nosocomial infection is nasal carriage and the skin. Approximately one-third of people carry *S. aureus* on the skin at any time. carriage may be persistent or intermittent. Carriage itself does not cause any symptoms. Carriage is associated with skin and soft tissue infections (Cespedes *et al.,* 2002).

The occurrence of *S. aureus* in selected individuals may indicate poor infection control in the school environment, meanwhile the environment may be reservoir for *S. aureus*. Most transmission is thought to be from direct person to person contact. This disease has emerged as an increasingly common cause of community-associated infections in most cases (Moran *et al.,* 2006). *Staphylococcus aureus* is innocuous in most environments but with remarkable adaptability and versatility which has equipped it as a commensal and pathogen. It is one of the most infectious agents with high prevelance in various environments, institutions and communities (Akindele *et al.,* 2010). This study reports the isolation and identification of *Staphylococcus aureus* - coagulase positive *Staphylococci* and catalase positive cocci in individuals' samples at Lead City University, Ibadan, Nigeria. A total of 12 isolates from the nostrils, lower jaw and ear region were analyzed. The high incidence of *Staphylococcus aureus* observed in each individual's isolates shows the versatility of this organism amongst other *Staphylococci* which makes it the most endemic pathogen in individuals. The prevalence rates of *Staphylococcus aureus* observed in all the samples might be attributed to the level of *Staphylococcal* infection in this study area and the poor level of hygiene amongst others. It is well known that other *Staphylococci*, though being normal commensals of the body are also opportunistic pathogen of man (Baba *et al.,* 2002).

S. aureus is a frequent component of the human skin and the nose microbiota. However, it can also cause various skin diseases such as boils, impetigo, cellulitis, pustules, earbuscle and sometimes leading to systemic infections. The ability of *S. aureus* to colonize and infect the skin is apparently dependent on specific mechanisms that subvert host cutaneous defenses (Peschel and Sahl, 2006). However, it is clearly revealed that *Staphylococcus aureus* is predominant in all the isolates from the samples collected in this investigation.

The results of biochemical properties of isolated bacteria from the nostril, lower jaw and ear region from selected individuals were carried out. The antibiotic susceptibility tests indicate the isolates' sensitivity. *Staphylococcus* genus is a heterogeneous group of bacteria consisting of about 30 species (Brown *et al*., 2005). *Staphylococcus aureus* has been found to be the most clinical important species, with broad presence in nature (Hardy *et al*., 2004). It has been recognized as one of the most common cause of human infections such as wound infections and bacteremia (Anupurba *et al*., 2003). Nevertheless the introduction of antibiotics has lowered the mortality rate of *S. aureus* infections. Meanwhile, the bacteria have rapidly developed resistance mechanisms against many antimicrobial agents (Hardy *et al*., 2004).

Methicillin-resistant Staphylococcus aureus (MRSA) has been isolated and recognized more than 50 years ago (Palavecino, 2007). MRSA is a specific strain of the *S. aureus*, which is resistant to methicillin and all B-lactams. Later use of oxacillin as an alternative to methicillin in susceptibility tests resulted in the term 'oxacillin-resistant *S. aureus*' (ORSA) (Brown *et al*., 2005), which is resistant to numerous antibiotics. Before the development of antibiotics, invasive infections caused by Staphylococcus aureus have often been fatal (Palavecino, 2007). The global spread of MRSA constitutes one of the most serious contemporary challenges to the treatment of hospital-acquired infections (Szczepanik *et al*., 2007). MRSA carries a uniquely effective antibiotic resistance mechanism that can protect the microorganisms against all members of β-lactam antibiotics. This makes infections caused by these pathogens very difficult to manage and costly to treat (Hiramatsu *et al*., 2002; Aires *et al*., 2004).

Centre for Disease Control and Prevention (CDC) published a report in 2004 demonstrating that approximately 60% of all health care-associated *Staphylococcus aureus* infections in the United States are caused by MRSA (NNIS, 2004). *Staphylococcus aureus* was the second most common organism causing nosocomial blood stream infections, and the proportion of MRSA isolates increased from 22% in 1995 to 57% in 2001 (Palavecino *et al*., 2007). Recent reports also suggest that community-associated MRSA infections have become the dominant cause of community-associated *Staphylococcus aureus*, skin and soft tissue infections (Klein *et al*., 2007).

This current study has provided important data on the antimicrobial susceptibility patterns of *S.*

aureus to several antibiotics. The findings from this study can be used to guide choice treatment of *S. aureus* infections and may also inform the appropriate personnel on the guideline for the treatment. It is clearly shown that any of these antibiotics used during this case is confirmed to treat and handle these particular strains of *S. aureus* in individuals. Currently, vancomycin has been accepted worldwide as the last choice against MRSA infections (Robinson and Enright, 2004). Clinical isolates of vancomycin-resistant *S. aureus* (VRSA) have been reported recently (NNIS, 2004). The emergence of *S. aureus* isolates resistant to vancomycin and other wide range of structurally unrelated antibiotics have elevated MRSA into a multi-drug-resistance, making it more and more dangerous than ever in hospital environments and also in healthy environments (Norazah *et al*., 2003; Lu *et al*., 2005).

Nasal and skin carriage has been identified as important risk factors for the development of *S. aureus* infections. The carriage rate depends on different factors such as gender and age (Davis *et al*., 2004; Peacock *et al*., 2003). The individual, whose age is over 60 or of very young age is susceptible to these infections in most cases (Marshall *et al*., 2004). It has been reported that 80% of infections with *S. aureus* are endogenous, caused by the colonizing strain when it enter the body by any way or from the environment (Sakwinska *et al*., 2010). S. aureus can infect any part of the body, causing some diseases in humans and animals, ranging from skin infection, food poisoning, brain abscesses and outbreak in post operative wound infection (Kenneth, 2008). In cows, it causes some important diseases for example, mastitis (clinical and sub clinical) and respiratory tract infection, skin sepsis, tick pyemia in lamb and contagious skin necrosis (Knight, 1999). *S. aureus* is one of the major causes of serious infections, passively colonizing human skin and nasal passages of healthy individuals, although this opportunistic pathogen colonizes without causing diseases (Kloos *et al*., 1992).

All pathogenic strains of *Staphylococcus aureus* are coagulase positive while non pathogenic species are not. *S. aureus* is pathogenic, and other infections caused by *Staphylococcus* are septicemia, meningitis, pneumonia and osteomyelitis. All pathogenic species are manntiol fermenters, commonly found on skin and mucous membranes of warm blooded animals and in some food or curing brines.

Aminoglycoside antibiotics such as kanamycin, gentamycin, streptomycin, were once effective against staphylococcal infections, until strains evolved mechanisms to inhibit the aminoglycosides action which occurs via protonated amine and or hydroxyl interactions with the ribosomal RNA of the bacteria 30S ribosomal subunit (Carter *et al*., 2000). Three main mechanisms are currently and widely accepted: aminoglycoside modifying enzymes, ribosomal mutations, and active efflux of the drug out of the bacteria. Aminoglycoside-modifying enzymes inactive the aminoglycoside by covalently attaching either a phosphate, nucleotide, or acetyl moiety to either the amine or the alcohol key functional group (or both groups) of the antibiotic. This changes the charge or sterically hinders the antibiotic, decreasing its ribosomal binding affinity (Sakon *et al*., 1993).

The β-lactamase-resistant penicillins (methicillin, oxacillin, cloxacillin and flucloxacillin) were developed to treat penicillin-resistant *S. aureus*, and are still used as first-line treatment. Methicillin was the first antibiotic in this class to be used (it was introduced in 1959), but only two years later, the first case of MRSA was reported in England (Johnson *et al*., 2001). MRSA infections in both the community and hospital setting are commonly treated with non-B-lactam antibiotics, such as clindamycin (alincosamine) and co-trimoxazole (also commonly known as trimethoprim/sulfamethoxazole). Resistance to these antibiotics has also led to the use of new, broad-spectrum anti-gram-positive antibiotics, such as linezolid, because of its availability as an oral drug. First-line treatment for serious invasive infections due to MRSA is currently glycopeptides antibiotic (vancomycin and teicoplanin). A number of problems with these antibiotics occur such as the need for intravenous administration (no oral preparation is available), toxicity, and the need to monitor drug levels regularly by blood tests (Blot *et al*., 2002).

Due to the high level of resistance to penicillins and because of the potential for MRSA to develop resistance to vancomycin, the U.S Centers for Disease Control and Prevention has published guidelines for the appropriate use of vancomycin. In situations where the incidence of MRSA infections is known to be high, the attending physician may choose to use a glycopeptides antibiotic until the identity of the infecting organism is known (Hiramatsu *et al*., 1997). After the infection is confirmed to be due to a methicillin-susceptible strain of *S. aureus*, treatment can be changed to flucloxacillin or even penicillin as appropriate.

High susceptibility of *S. aureus* isolates to all antibiotics used during this study is an indication that these antibiotics can be used for empirical treatment of infections related to *S. aureus* in humans.

Conclusion

From this investigation, it is obvious that *S. aureus* is still the most common cause of nosocomial infection. It is demonstrated that the university school environment is at risk of the infection. Antibiotics

such as ampiclox or streptomycin and the likes are the best therapeutic options to treat *S. aureus* infections. When individuals ensure proper care for the body and skin, *S. aureus* might be reduced to minimal. Further studies can be preformed to illustrate the nasal carriage of *S. aureus* in individuals which may provide new ways of reducing *S. aureus* nasal carriage in order to control *S. aureus* infections affecting humans. The spread of *S. aureus* (including MRSA) generally is through human-to-human contact, although recently some veterinarians have discovered the infection can be spread through pets (Sing *et al*., 2008), with environmental contamination thought to play a relatively unimportant part. Emphases on basic hand washing techniques are therefore effective in preventing its transmission. The use of disposable aprons and gloves by individuals reduces skin-to-skin contact, in which it also reduces the risk of transmission.

Recommendation

Consequently, this study recommends enlightenment of individuals within the university school environment on ways to prevent transmission of this infection. Continuous surveillance is also necessary to track any epidemiological changes which are common with the organism. Importance of personal hygiene is required, emphasis on regular and thorough bathing or showers, frequent and daily changing of clothes. Sharing of skin care materials such as soaps, sponges or towels should be avoided absolutely.

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