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# BACTERIAL FLORA OF COMMONLY USED SOAPS IN THREE HOSPITALS IN NIGERIA

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## ABSTRACT

*Objectives:* **To obtain general information on soap use and soap bacterial flora, and to assess the risk of transmission of organisms from contaminated soap to patients.**
*Design:* **Descriptive study.**
*Setting:* **Three hospitals in an urban area of Lagos, Nigeria. A teaching (761 bed) hospital, a general hospital (a 51 bed secondary healthcare facility) and a private hospital (a 30 bed private community with a surgical specialty).**
*Results:* **Bar soaps were much more commonly used than liquid soaps. Out of the thirty six bar soaps and their receptacles studied, 19 (52.8%) were found wet, nine (25%) dry, five (13.9%) very dry, and three (8.3%) in a pool of water. A total of 39% soaps and 75% of receptacles were contaminated. Thirty three percent of the dry soaps and 68.4% of the wet soaps were contaminated. None of the very dry soaps and all in a pool of water were contaminated. The bacteria isolated from soaps included *Pseudomonas aeruginosa* (89.5%) and *Klebsiella pneumoniae* (10.5%), while *Pseudomonas aeruginosa* (70.6%), *Klebsiella pneumoniae* (14.7%), *Staphylococcus aureus* (11.8%) and *Serratia marcescens* (2.9%) were isolated from the receptacles. The antibiogram showed that the *Pseudomonas aeruginosa* isolated from the soaps and their containers (sinks) were distinct from those obtained from colonised or infected wounds. The soap contamination rates correlated with the conditions in which the soaps were kept.**
*Conclusion:* **The type of soap containers in particular, played a vital role in keeping the soap dry or wet. In all the hospitals studied, the policies on soap use, if any, were not in agreement with the recommended guidelines. The healthcare workers need to be re-educated on these guidelines.**

## INTRODUCTION

Handwashing is the single most important infection control measure known. Effective handwashing requires among other things availability of soap which helps to mechanically remove transient hand flora, thus preventing cross-transmissions and hospital infections (1,2).

Soaps used may be in bar or liquid forms, and these may be antiseptic or non-antiseptic (plain soap). While plain soap is adequate for handwashing in most of the hospital wards, antiseptic soap, which contains antimicrobial agents is valuable in areas where there are vulnerable immuno-compromised patients and a high level of infection transmission is a concern. The antiseptic soap not only removes transient flora mechanically but also chemically kills contaminating and colonising resident flora and have long-term residual chemical activity (2,3). Therefore, antiseptic soap is the only option in the theatre where both the resident and transient flora needs to be excluded completely (2,4). Even in the

wards where plain soap is adequate liquid soap is preferred to bar soap because studies have shown that liquid soaps do not get contaminated as often as bar soaps (2,5). This is because they do not make contact with the hands of the users while still in the dispenser, unlike the bar soaps which users have to hold to use (5).

Examples of organisms that have been isolated from contaminated soaps include; gram-negative rods such as *Pseudomonas aeruginosa, Klebsiella spp, Proteus spp* and gram-positive cocci such as *Staphylococcus aureus* (6,7). These are bacteria that have been associated with wound infection, the most common type of nosocomial infection (8,9) in most hospitals (10,11). The bar soaps, apart from becoming contaminated with these bacteria, support their growth and allow them to multiply (2). Thus, it has been a concern that such organisms may get transmitted from soaps to vulnerable patients through the hands of hospital staff or the patients themselves. Despite this concern, there has been no study to show that contaminated soaps may serve as a source of hospital infection. There are however recommended ways of preventing or reducing soap contamination. Such recommendations include keeping the soaps dry by placing them on a drainable rack such as a perforated receptacle and a second layer (12,13).

Although some of the hospitals in Lagos have infection control programmes in place, they are at different levels of development. Some may not even have policies on soap use based on recommended guidelines. This study was carried out in three different hospitals in Lagos to obtain general information on soap use and bacterial flora, and to compare bacteria in soaps with those isolated from wounds in the same wards.

## MATERIALS AND METHODS

*Study design:* The study was carried out in three hospitals in Lagos; Lagos University Teaching Hospital (LUTH), Randle General Hospital, Surulere (RGH, a secondary health care facility) and Osuntuyi Medical Centre (OMC, a private hospital with surgical specialty), Agege from June to July, 2006.

Swabs of soap and soap receptacles were collected from all the hospitals' wards, neonatal units and theatres for culture. Soaps were defined as very dry (if it appeared unused though may be old or smaller than usual), dry (obviously used but without some or drops of water on it), wet or moist (with some water or sludge on soap or container) and in a pool of water. Wound swabs were also collected from the in-patients. All specimens were cultured in the Department of Medical Microbiology and Parasitology, College of Medicine, University of Lagos (CMUL).

A simple questionnaire was administered to the nurses met in the wards to get general information on soap use. The study proposal was approved by the LUTH Research and Ethics Committee.

*Sample collection and processing:* Swabs were collected by rotating the sterile swab sticks, around all the exposed surface of the soap or soap receptacles. Surface specimens were collected from clean wounds after cleaning with saline while for infected wounds, the specimens were collected from the base of the wounds after removing slough with saline.

Samples were inoculated on MacConkey agar (oxoid) and blood agar base (oxoid) to which 5-7% human blood has been added. The plates were incubated at 37°C in air and 5-10% $CO_2$ for 24-48 hours. Plates that showed growth of a single type of organism was stored on nutrient and blood agar slants for biochemical tests and antibiogram, while those that showed mixed growth were sub-cultured to obtain pure cultures before storing them. All bacteria were identified by standard laboratory methods (14).

*Antibiogram:* Antibiotic sensitivity was performed on Mueller-Hinton agar by disc diffusion method in accordance with National Committee for Clinical Laboratory standards (14) (NCCLS now Clinical Laboratory Standards Institutes (CLSI)). All antibiotics were oxoid products and included: nitrofurantoin 30μg, nalidixic acid 30μg, gentamicin 10μg, ofloxacin 5μg, amoxicillin-clavulanic acid 30μg, ciprofloxacin 5μg, cotrimoxazole 30μg, ceftazidime 30μg, cefoxitin 30μg, augmentin 30μg, tetracycline 30μg, imipenem 30μg, amoxicillin 30μg, ceftriaxone 30ug, amikacin 30μg and cefotaxime 30μg. Reference strains *Staphylococcus aureus* ATTC 29213, *E. coli* ATTC 25922 and *Pseudomonas aeruginosa* ATCC 27853 were used for quality control of procedures.

The antibiogram was analysed for similarities and differences in sensitivity and resistance patterns of isolates.

## RESULTS

This study revealed very useful information on soap use and flora. Thirty two soap stations were studied in LUTH wards, while eight and six stations were studied in RGH and OMC respectively (Table 1), making 46 stations in all. Seven (5.1%) out of the stations had liquid soaps while one (2.17%) had powdered soap in place. The Liquid soaps were found in one of the children's wards and Guinness eye clinic in LUTH, and the male surgical ward in RGH while the powdered soap was found in the Psychiatric ward in LUTH. Two (4.3%) stations in OMC had no soap. Consequently, only 36 (78. 26%) stations that had bar soaps in use were sampled. Plain soaps were found in 34 of the soap stations; 25 in LUTH, five in RGH and four in OMC. The brands of bar soaps found were Lux (thirty-three) and Sunlight (one) (Table 1). Antiseptic bar soaps (okin and carats) were found in two wash hand stations in RGH (theatre and the accident and emergency).

**Table 1**

*General information on soap - use*

| | LUTH | RGH | OMC | Total |
|---|---|---|---|---|
| Total No. of soap stations studied | 32 | 8 | 6 | 46 |
| Types of soap in stations | | | | |
| Bar | 25 | 7 | 4 | 36 |
| Liquid | 6 | 1 | – | 7 |
| Powdered | 1 | – | – | 1 |
| Brand of bar soaps in stations | | | | |
| Lux / Joy (toilet soap) | 25 | 4 | 4 | 33 |
| Sunlight (toilet soap) | – | 1 | – | 1 |
| Carats (antiseptic soap) | – | 1 | – | 1 |
| Okin (antiseptic soap) | – | 1 | – | 1 |
| Average no. of beds per ward | 27 | 11 | 3 | 41 |
| Average no. of sinks per ward | 3 | 1 | <! | <5 |
| Average no. of sinks in - use per ward | 1 | 1 | <! | <3 |
| Average rate of soap replacement (week) | 3 | 2 | 2 | |
| If patients share soap with HCW | No | No | No | |
| Condition of soaps in stations (average) | | | | |
| Very dry | 5 | – | – | 5 |
| Dry | 6 | 2 | 1 | 9 |
| Moist or wet | 13 | 3 | 3 | 19 |
| Pool of water | 1 | 2 | – | 3 |
| Location of soaps | | | | |
| Soap dish with receptacle with a 2nd layer | 2 | 2 | – | 4 |
| Soap dish with receptacle without a 2nd layer | 7 | 1 | – | 8 |
| Soap dish without receptacle | 6 | 2 | 3 | 11 |
| Sink | 10 | 2 | 1 | 13 |

LUTH = Lagos University Teaching Hospital; OMC = Osuntuyi Medical Centre; RGH = Randle General Hospital; HCW = Health Care Worker

Although, the three hospitals differ in size and extents of general provision for handwashing, the conditions in which the soaps were met were similar. As shown on Table 1, most of the soaps were wet. Only nine out of 36 soaps were dry. Only four out of 36 soaps were placed in a dish with a receptacle and second layer. Twenty four of the bar soaps (66.66%) were placed in soap dish without receptacle or directly on the sinks.

Table 2 shows the levels of soap contamination in the various hospitals. The contamination rates of soaps were high (38.9%), but the contamination rates of receptacles were higher (75%) with *Pseudomonas aeruginosa* being the most commonly isolated organism (Table 3). The bacteria isolated from soaps included *Pseudomonas aeruginosa* (89.5%) and *Klebsiella pneumoniae* (10.5%), while *Pseudomonas aeruginosa* (70.6%), *Klebsiella pneumoniae* (14.7%), *Staphylococcus aureus* (11.8%) and *Serratia marcescens* (2.9%) were isolated from the receptacles. Thirty three out of all the 50 bacteria isolated came from the wet soaps and soap receptacles. Thirty three percent of the dry soaps and 68.4% of the wet soaps were contaminated. None of the very dry soaps were contaminated but all the three soaps lying in a pool of water grew *Pseudomonas aeruginosa.*

The antibiogram showed no unique sensitivity or resistance patterns. The sensitivity and resistance patterns of the soaps isolates and wound swab isolates were completely different. However, the patterns were similar for isolates from soaps and receptacles in wards $B_3$, $E_2$, $E_4$ and $E_6$ (Table 4).

**Table 2**

*Rates of soap and wound contamination in LUTH, RGH and OMC*

| Hospital | Soaps | | Receptacles | | Wounds | |
|---|---|---|---|---|---|---|
| | Number | No. (%) | Number | No. (%) | Number | No. (%) |
| LUTH | 25 | 8 32.2 | 25 | 20 80 | 28 | 27 96.4 |
| RGH | 7 | 5 71.4 | 7 | 6 85.7 | - | - |
| OMC | 4 | 1 25 | 4 | 1 25 | - | - |
| Total | 36 | 14 38.9 | 36 | 27 75 | 28 | 27 96.4 |

LUTH = Lagos University Teaching Hospital; RGH = Randle General Hospital; OMC = Osuntuyi Medical Centre

**Table 3**

*Bacteria isolated from soaps, soap containers (or sinks) in LUTH, RGH and OMC*

| Organism isolated | Wet/moist soaps (n = 19) No. (%) | Soaps in pool of water (n = 3) No. (%) | Dry soaps (n = 9) No. (%) | Sinks (n = 13) No. (%) | Soaps containers (n = 23) No. (%) |
|---|---|---|---|---|---|
| *Pseudomonas aeruginosa* | 11 57.9 | 3 100 | 3 33.3 | 5 38.5 | 16 69.6 |
| *Klebsiella pneumoniae* | 2 10.5 | 0 | 0 | 4 30.8 | 1 4.3 |
| *Staphylococcus aureus* | 0 | 0 | 0 | 2 15.4 | 2 8.7 |
| *Serratia marcescens* | 0 | 0 | 0 | 0 | 1 4.3 |
| Total | 13 68.4 | 3 100 | 3 33.3 | 11 84.7 | 20 86.9 |

LUTH = Lagos University Teaching Hospital; RGH = Randle General Hospital; OMC = Osuntuyi Medical Centre

**Table 4**

*Antibiotic sensitivity pattern of isolates*

| Antibiotic | Nitrofurantoin | Gentamicin | Nalidixic | Oiloxacin | Augmentin | Tetracycline | Cefoxintin | Ciprofloxacin | Cefotaxime | Imipenem | Amoxicillin-Clavullanate | Ceftriaxone | Amikacin | Ceftazidime | Amoxicillin | Cotrimoxazole |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Samples | | | | | | | | | | | | | | | | |
| $B_2$ soap | R | S | R | S | S | S | R | S | S | S | S | S | S | R | S | S |
| $B_2$ container | R | S | R | S | S | S | S | R | S | S | S | S | S | R | R | S |
| $B_2$ wound | R | R | R | R | R | R | R | R | R | S | R | R | S | R | R | R |
| $B_3$ soap | R | S | R | S | S | S | S | S | R | S | R | S | S | R | R | R |
| $B_3$ container | R | S | R | S | S | S | S | S | R | S | R | S | S | R | R | R |
| $B_3$ wound | R | S | R | S | R | R | S | R | R | S | R | R | S | R | R | R |
| $E_2$ soap | R | S | S | S | R | S | R | S | R | S | R | S | S | R | R | S |
| $E_2$ container | R | S | S | S | R | S | R | S | R | S | R | S | S | R | R | S |
| $E_2$ wound | R | S | R | S | R | R | R | S | R | S | R | S | S | R | R | R |
| $E_4$ soap | R | S | S | S | R | S | R | S | R | S | R | R | S | R | R | S |
| $E_4$ container | R | S | S | S | R | S | R | S | R | S | R | R | S | R | R | S |
| $E_4$ wound | R | S | R | S | R | S | R | S | R | S | R | S | S | R | R | S |
| $E_4$ wound | R | S | R | S | S | R | S | S | S | S | S | S | S | R | S | S |
| $E_4$ wound | R | S | S | S | S | R | S | S | S | S | S | S | S | S | S | S |
| $E_4$ wound | R | S | R | S | R | R | R | S | R | S | R | R | S | R | R | R |
| $E_6$ soap | R | S | S | S | S | R | S | S | S | S | S | S | S | R | S | S |
| $E_6$ container | R | S | S | S | S | R | S | S | S | S | S | S | S | R | S | S |
| $E_6$ wound | R | S | S | S | R | R | R | S | R | S | R | S | S | R | R | R |

S = sensitivity; R = resistance

## DISCUSSION

A review of all hand washing stations in the three hospitals showed that bar soaps were much more commonly used. Liquid soaps were found only in one of the children's wards and Guinness eye clinic in LUTH, and the male surgical ward in RGH. Out of the 36 bar soaps used, only two were antiseptic and they were found in the theatre and the accident and emergency unit of the RGH. While antiseptic soaps are preferred to plain soaps because they are more effective in reducing bacterial load on hands, they are not essential in the general wards as long as an effective handwash is carried out (15,16).

It has been shown that wet soap or soap sitting in a pool of water is more prone to contamination than dry soap. Keeping the soap dry is therefore a priority and studies have shown that soaps placed in a perforated dish on a receptacle were usually dry and, those on dishes with receptacle and another layer were even more dry because there was room for the water to drain out (17).

In LUTH, liquid antiseptic soaps were found in the theatre, but in RGH, antiseptic bar soap was found in the theatre (2). The bar soap in RGH was wet and was also found to be contaminated with *Pseudomonas aeruginosa,* a bacterium which is prevalent in wet conditions and grows easily in soaps (17,18).

The most prevalent organism contaminating the soaps in all the hospitals was *Pseudomonas aeruginosa,* followed by *Klebsiella pneumoniae, Staphylococcus aureus* and *Serratia marcescens. Pseudomonas aeruginosa,* and *Klebsiella pneumoniae* are ubiquitous in the environment, nutritionally versatile, and flourish in the wet areas of the hospital environment (18,19). They have been implicated in outbreaks associated with the wet areas of the wards (18).

*Staphylococcus aureus* is one of the most common gram-positive organisms in the hospital environment and a normal flora of the human body (20). It has been implicated in hospital outbreaks of food poisoning, wound infection and septicaemia (20). *Serratia marcescens* also has been implicated in hospital outbreaks especially because it is often drug resistant (21).

The organisms were isolated from both the soap and the receptacles and a preliminary screening by antibiogram showed that some isolates on the soaps might be similar to those on their containers. Although this similarity has to be confirmed by a more specific typing method, a higher contamination rate of 75% of containers (sinks) compared with 39% of soaps found in LUTH may mean that the receptacles were the sources of soap contamination. It is thought to be a potential source of contamination to the soap because contaminated sludge accumulates in the soap dish and ultimately contaminates the soap (6). It is thus important that the containers be kept free of sludge to reduce incidence of organisms in the soap containers and subsequently the soaps.

The antibiogram of the soap isolates and wound isolates were dissimilar suggesting that the soaps were not the source of the wound infection or colonisation. This may be a pointer to good aseptic practices during wound dressing suggesting that soaps may not be a direct source of contamination.

However, since an effective handwashing is the first step in aseptic procedure, it is unacceptable that soaps should harbour potentially pathogenic organisms with the potential for seeding the hands with these organisms thus increasing the risk for cross contamination, since this potential is clear it is recognised that bar soaps, whether antiseptic or plain must not be used in high risk areas like theatre, neonatal units and intensive care units, even though direct evidence for transmission was not obtained in this study. In addition, liquid soap is preferred in the wards, but if bar soaps must be used, they must be kept dry by keeping them in a receptacle that must be cleaned everyday to prevent a build up of sludge.

The source of bacteria that contaminate the soap usually is the hands of healthcare workers. Their hands get contaminated with these bacteria while performing common procedures like lifting a patient, taking a patient's pulse, blood pressure or even touching intact areas of the skin of hospitalised patients (21,22). A previous study revealed that soaps in constant use are the ones usually colonised by organisms and the longer they have been in use, the more likely they will get contaminated (5). This is confirmed in this study by the fact that the very dry (14%) soaps were not contaminated. Eighty percent of such soaps were new while the rest were old but appeared unused and no bacteria were cultured from them. It is then possible that use of small tablets of bar soaps would be associated with

a lower contamination rate because the soap would have finished before the organisms have time to proliferate. Such practice may also enhance a higher rate of cleaning of soap receptacles.

The findings of this study show that the policies on soap use in the studied hospitals, if any, are not in agreement with recommended guidelines (12). Despite the fact that this study showed no link between soap and clinical bacterial flora, the hospitals will need to follow the recommended guidelines on soap use in order to avoid soap contamination.

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