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Original Research Article

Consumer Antibacterial Soaps: Effective or Just risky? Examination of the evidence

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Abstract: Much has been written recently about the potential hazards versus benefits of antibacterial (biocide)–containing soaps. The aim of this study was to evaluate the Bar soap from 20 different Dental clinics for microbial contamination, while it was "in-use". This prospective study was performed with 40 samples between November and December 2015, at Dental clinic at Vellore in Tamilnadu, India. Of the 40 samples obtained from the bar soap, 100% yielded positive culture. This study was designed to determine the colonization of the in-use hand washing soaps in clinic settings. Swabs from surfaces of bar soaps via their applicator tips; at the working stations of the clinic were taken. Conventional microbiologic methods were used for culture of the swabs and identification of the isolates. Of the 40 samples obtained from the bar soap, 100% yielded positive culture. A total of 10 different genera of organisms were isolated. Each bar soap was found to harbor 2-5 different genera of micro organisms. Heavily used soap had more micro organisms compared to less used soap. The microbial load of the "in-use" bar soap constituted a mixed flora of gram positive, gram negative, aerobes, anaerobes, and fungi. The results indicate that the bar soap under "in-use" condition is a reservoir of microorganisms and hand washing with such a soap may lead to spread of infection. Hand hygiene has the potential to prevent diseases and reduce health care–associated infections. The proper drying of hands after washing should be an essential component of effective hand hygiene procedures.
Keywords: Bar soap, Dentistry, Hand hygiene, Hand washing, Microbial load, Soap contamination.

INTRODUCTION

For generations, hand washing with soap and water been considered a measure of personal hygiene. Bacteria are very diverse and present every where such as in soil, water, sewage, standing water and even in human body. Bacteria's that attacks on human body is of great importance with reference to health [1].

The most common cause of healthcare-associated infections is person-to-person transmission of nosocomial pathogens via the hands of healthcare personnel (Sickbert-Bennett, Weber, Gergen-Teague, &Rutala, 2004).

Hand carriage of bacteria is an important route of transmission of infection between patients or from the health care worker to thepatient [2].

The microbial flora of the skin was first described by Price in 1938.

Hand hygiene has been considered to be the most important tool in Nosocomial infections control. Failure to perform appropriate hand hygiene is supposed to be the leading cause of Nosocomial infections and the spread of multi resistant microorganisms, and has been recognized as a significant contributor to outbreaks [3].

Microorganisms carried on the skin of the human body of two distinct populations: Resident and Transient [Lowbury *et al*. 1964].

The resident microorganisms survive and multiply on the skin. The transient microorganisms represent recent contaminants of the hands acquired from colonized or infected patients/clients or contaminated environment or equipment. Transient microorganisms are not consistently isolated from most persons.

In contrast to the resident microorganisms, the transient microorganisms found on the hands of healthcare personnel are more frequently implicated as the source of Nosocomial infections. Pathogens that may be present on skin, as transient types include: *Escherichia coli*, *Salmonella spp*., *Shigella spp*., *Clostridium perfringens*, and Hepatitis A virus. The most common transient microorganisms include gram negative *coliforms* and *Staphylococcus aureus.* Hand

washing with plain soap is effective in removing most transient microorganisms [3].

In general, resident flora is less likely to be associated with infections, but may cause infections in sterile body cavities, the eyes, or on non-intact skin [12].

The mechanical action of washing and rinsing removes most of the transient microorganism present [4].

Health care workers wash their hands in two ways:

- The social hand wash, which is the cleaning of hands with plain, non-medicated bar or liquid soap and water for removal of dirt, soil, and various organic substances;
- The hygienic or antiseptic hand wash, which is the cleaning of hands with antimicrobial or medicated soap and water. Most antimicrobial soaps contain a single active agent and are usually available as liquid preparations. Appropriate hand washing results in a reduced incidence of both nosocomial and community infections [4].

Much studies have been written and debated regarding the use of bar versus liquid skin cleansers in relation to infection control [5].

The purpose of this study was to investigate whether the soap bar under "in-use" condition was contaminated with microorganisms and if so, to isolate the different types of microorganisms.

MATERIALS AND METHODS

Place of study

The soap survey was carried out in 20 different Dental clinics in Vellore.

Sample selection

To begin with, fresh soap bars (popular brand of medicated soap) commonly used by the Dentists, purchased from the supermarket were placed at the Dental clinic hand washing stations. This bar soap was intended to be used by the Dentist and the other auxiliaries in the clinic. None of them were aware of the aim of the study. This was done to eliminate any kind of bias that could have influenced the results.

The soap sample was taken on 2 occasions, the first sample from fresh (unused) soap [T_0], and the second sample after 7 days of use [T_7].

The soap bar was weighed before and after the 7 day period to maintain uniformity and to measure the soap use respectively. The soap samples were obtained (in duplicate) by using sterile cotton swabs moistened with phosphate buffer solution (PBS). Under sterile conditions, the moistened cotton swab was slid in a single stroke over the top portion of the soap, which was placed in the soap dish at the wash station in the Dental clinic. The swab was immediately introduced into a sterile test tube containing 2ml of PBS. At no time did the swab come in contact with the tester's fingers or the outside of the tube. Sterility control samples were taken. As additional control, vigilance was kept on the microbial count of the water supply. The test tubes were transferred to the Hi Tech Diagnostic center, Vellore where the microbiological analysis was performed.

Preparation of Inoculum

The test tubes were vigorously shaken for 30 seconds. Preliminary tests were done to evaluate whether direct streaking of the swab or streaking of PBS inoculum would yield higher recovery of microorganism from bar soaps. The results showed that the use of direct swab method yielded high recovery of microorganisms and no negative samples, in contrast to lower yields and some negative values when the PBS inoculum was used. Thereafter for the culturing of microorganism, direct streaking of the swab was the method of choice. One cotton swab was used to streak 2 Agar plates; Chocolate agar for Gram positive aerobes and facultatives Mackonkey Agar for Gram negative aerobes and Mackonkey agar for Gram negative aerobes and facultative, and Blood Agar for anaerobes. These plates were incubated for 48 hours at 37^0C aerobically and anaerobically. Sabouraud's dextrose agar was used for fungi and was incubated for 5 days at 37°C. After incubation, the plates were counted for microbial colonies and expressed as colony forming units (CFU/per bar of soap). Identification was initially based on the morphological characteristics and then on the reaction to specific biochemical test.

Identification of isolated bacteria

Identification of bacteria was done by using different biochemical tests. These tests were based on the gram stain reaction of bacterial strains. Tests includes, Oxidase test, Catalase test, Urease test, Motility test, Acid production from glucose, Mannitol, Sucrose, Lactose, Maltose, Coagulase test, Dnase test, Indole test, Eosine methylene blue test, Triple sugar iron reactions, Methyl red test, Voges proskauer test, and Nitrate reduction test following chesseborugh (Cheesbrough, 2001). (**Table 2**).

RESULT

The bar soap samples were obtained from 40 hand washing stations at 20 different Dental clinics. At $T_{(0)}$ (fresh unused bar soap), 37 samples were found to be free of microorganisms, while only 3 samples showed the presence of *Staph. epidermidis.* The sterility controls for swab, PBS, and culture plates. At $T_{(7)}$ (sample after 7 days of use), 100 %(n=40) yielded positive culture. The data of the microbial isolates is collectively represented in **Table 1**. The microbial load of the "in use" bar soap constituted a mixed variety of gram positive, gram negative, aerobes, anaerobes, and fungi. The total

microbial population obtained from bar soap represented 10 different genera.

The soaps were found to harbor 2 to 5 different genera of microorganisms per bar. **Table 1** also summarizes the frequency of isolation of the microorganisms from 40 samples. *Staph. epidermidis (100%)* was a common feature in all the samples, while pathogenic *Staph. aureus* was found in 6 samples. *E coli* and *Klebsiella* had a major share of occurrence, i.e 92.5% and 87.5%samples respectively. **Table 3, Graph .1** compares the microbial isolates of the present study with two other previous studies [14, 15].

DISCUSSION

The most common hand-cleaning agents are bar soap and liquid soaps. An antibacterial soap can remove 65% - 85% of bacteria from human skin [Osborne and Grube 1982].

When in use, bar soaps are frequently misused because they are typically stored in contact with moisture and remain moist for long periods of time. It is usually kept in a container, on or next to a wash basin. More often than not, it resides in surface water. The resulting jelly mass is unsightly, difficult to use effectively. This supplies an environment which provides the perfect opportunity for bacteria and organisms to grow. Most bars of soap in communal areas are used by a number of different people. This means that one bar of soap can be in direct contact with skin bacteria from more than one-person, and may harbor live pathogenicbacteria. Cross infection can and does occur under these circumstances [6].

In 1975 and 1985 guidelines on hand washing practices in Hospitals were published by the Centers for Disease Control (CDC), which recommended hand washing with non-anti microbial soap between client contacts and washing with antimicrobial soap before and after performing invasive procedures or caring for clients at high risk. Use of waterless antiseptics agents was recommended only in the situations where sinks were not available [7].

When using a bar of soap, the CDC (Centre for Disease Control) recommends placement on a drainable rack between uses [7].

Soap racks that promote drainage of all water from the bar should be installed. In addition, there should be easy access to replacements when soap is lost, dropped, melted, or consumed. Small soap bars were also recommended that can be changed and used in preference to larger bars that are more likely to melt or become colonized with bacteria [7].

McBride et al reported that bar soaps were found to have higher bacterial cultures after use than liquid soaps [7].

Liquid soap on the other hand is much better to use. Liquid soap is dispensed straight from a plastic container. It has not been exposed to skin bacteria or other contaminants. As a result, cross contamination is not likely to occur, providing a more cleaning and more hygienicalternative [8].

In an epidemiological study, the researchers isolated several strains of *Pseudomonas* from 45 of 353 environmental samples used by multiple providers (13%) and found that the 5 most common strains were frequently found on patients. They also affirmed that the hands are a major vehicle for the transfer of *Pseudomonas* bacteria and implicated bar soap in its spread [9,10].

In another study, Kabara and Brady obtained samples from bar and liquid soaps from 26 public bathrooms which were investigated. Liquid soaps were found to be negative for bacteria, while 100% of the 84 samples obtained from bar soaps yielded positivecultures [11].

Transmission of Pathogens by Hands [12]

- Hand washing, hand antisepsis or protective barrier used by the Dentist must be inadequate, inappropriate or entirely omitted.
- Organisms are present on the patient's skin, or have been shed on to inanimate objects immediately surrounding the patient.
- Organisms must be capable of surviving for at least several minutes on the Dentist's hands.
- Organisms must be transferred to the hands of the Dentist.
- The contaminated hand or hands of the Dentist must come into direct contact with another patient or with an inanimate object that will come into direct contact with the patient.
- Transmission of pathogens from one patient to another via the Dentist's hands requires five sequential steps.

Hand Washing Guidelines [12]

- Dry hands with a paper towels or by using wall mounted automatic air drying machines. Pat skin to dry. Do not rub as this might cause skin to crack. Reusable hand towels should be avoided as it may lead to bacterial colonization.
- If using antiseptic rub, take an adequate amount and rub on all surfaces for the recommended time. Let the antiseptic dry on its own.
- Lather with antibacterial soap bar or antibacterial liquid soap using friction. Cover all surfaces of hands and fingers paying particular attention to the thumbs, fingertips, between the fingers, and the backs of the hands, as these are the area most commonly missed. If antibacterial liquid soaps are used the

dispensers should be mounted close to the wash basins in easy to reach area.

- Periodic water checks should be conducted to ensure optimum water quality and no bacterial colonization in water storage tanks.
- Remove all hand jewellery including wrist watches. Avoid using artificial nails and nail polish during clinical procedures.
- Rinse hands under running water. Water at room temperature or warm is ideal. Avoid hot water.
- Specialists should be consulted when a minimal sign of skin irritation shows and adequate treatment should be taken up.
- Wash thoroughly under running water. Turn off faucet with wrist/elbow.
- Whenever possible pictorial recommendations should be kept over wash basins to endorse and educate effective hand washing.

Remember To Wash Hands [12]

- After contact with a patient (e.g., shaking hands with the patients).
- After contact with body fluids, mucous membranes, and oral wounds or ulcers.
- After contact with inanimate objects (including medical equipment) in the immediate vicinity of the patient.
- After removing gloves.
- Before donning sterile surgical or examination gloves.

Where hands do not appear to be soiled, an alcohol-based hand rub should be used.

In our study a self-designed protocol was used to investigate the microbial contamination of the bar soap under "In use" condition in the Dental clinic set up. The results showed that all (100%) the bar soaps under "in use" condition yielded positive culture, indicating that "in use" bar soaps were depots of microorganisms. This result is in accordance with other similar study reports [13-15].

In the study by Kabara JJ and Brady MB [11], who investigated bar and liquid soaps from 26 public lavatories for microbial colonies, of the 84 samples from the bar soap, 100% yielded positive culture and the microbial population obtained from the bar soap represented over 16 different genera (**Table 3**).

In a study conducted by McBride ME[7] 92-96% of the samples from the "in use" bar soaps (with and without antibacterial) yielded positive culture (microorganisms listed in **Table 3**).

In a study conducted in the household setting, Brook SJ and Brook I [13] studied the microbial content of 14 bars of soap. The major bacteria isolated were *Staphylococcus species* and *Enterobacteriaceae.* It was also observed that the number of bacteria isolated from heavily used soaps which were wet were higher than from infrequently used soaps that were dry.

In the present study, the diverse microorganisms (**Table 1, 2**) found on the "in use" bar of soap suggests that bar soap may be an important reservoir of infection. Though the microbial isolates belong to the normal commensals of the body and also constitute the normal environmental flora, the pathogenic *Staph. aureus* was also isolated. *Staph.aureus* (also called as Hospital Staphylococci), *E coli* and *Klebsiella* which are isolated are shown to be the prime organisms that cause nosocomial infections. The other microorganisms, though normal commensals, are potential pathogens. The use of such a contaminated product may thus serve as a continuous source of infection and re-infection for the users [14]. The involvement of bar soap in the outbreak of infection in the hospital has been mentioned earlier by Kabara JJ and Brady MB [11]and Jacques Let al [14].

Table-1: Microbial isolates and frequency of isolation of microorganisms from 40 "In use" bar soap

Microorganisms No. of times isolated	Microorganisms No. of times Isolated	Percentage %
Aerobic spore bearers	10/40	25%
Aspergillus niger	8/40	20%
Candida parapsilosis	10/40	25%
Diphtheroids	5/40	12.5%
E.coli	37/40	92.5%
Klebsiella sp	35/40	87.5%
Propionibacterium acnes	3/40	7.5%
Staph.aureus	8/40	20%
Staph.citreus	23/40	57.5%
Staph.epidermidis	40/40	100%

Table-2: Characteristics of the bacterial strains.

TEST	*S. aureus*	*E. coli*	*Klebsiella pneumoniae*	*Bacillus subtilis*	*Staph .epidermidis*
Oxidase	NA	-ve	- ve	+ve	- ve
Catalase	+ve	+ve	+ve	+ve	+ve
Motility	NA	+ve	- ve	+ve	- ve
Lactose	NA	+ve	+ve	+ve	+ve
EMB	NA	+ve	-ve	NA	NA
Indole	NA	+ve	- ve	NA	NA
+ve Citrate	NA	-ve	+ve	+ve	NA
V P	NA	-ve	+ve	NA	NA
M R	NA	+ve	-	NA	NA
TSI	NA	Y/Y/+/-	Y/Y/+/-	NA	NA
Urease	NA	-ve	+ve	NA	+ve
Mannitol	+ve	NA	NA	NA	- ve
Maltose	NA	-ve	- ve	- ve	+ve
Pigment	Golden	-ve	- ve	- ve	- ve
Coagulase	+ve	NA	NA	NA	- ve
DNase	+ve	NA	NA	NA	NA
Sucrose	+ve	-ve	+ve	+ve	+ve

As is evident from Table 2, there is variation in the isolates of the microorganisms from the "in-use" bar soap compared to; however this can be attributed to the fundamental differences in the procedural aspects, soap brands, site of the study, and experimental protocol. For example,

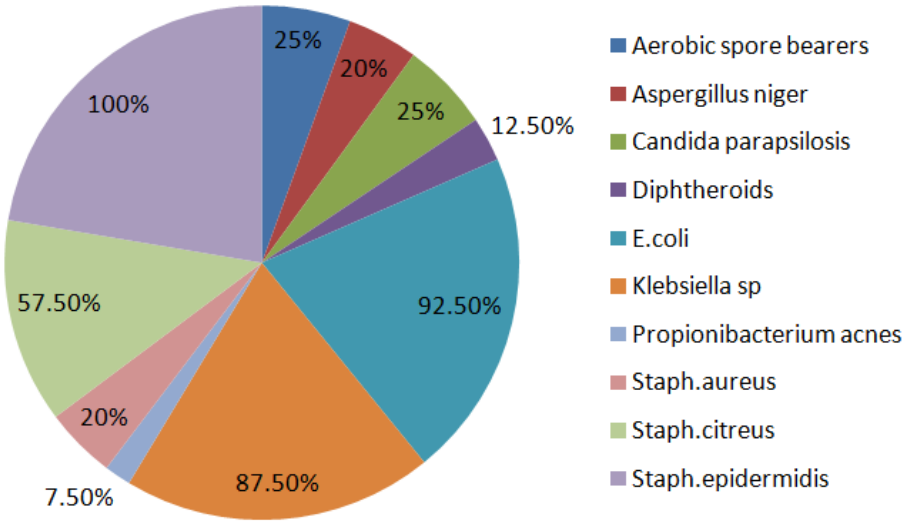
Our study is of a cross-sectional nature or single sampling (T_0 and T_7) in contrast to the multiple sampling (T0, T1, T2, T3, T4, T7) studies of Kabara JJ and Brady MB[11] and McBride ME [7].

Interestingly, it has been observed in the longitudinal study of McBride ME [15], the microbial flora of "in use" soap products displayed a variation in number and there also existed sporadic appearance and disappearance of different microorganism over the period of time, indicating that the organisms were continuously being removed either mechanically or due to the self sterilizing activity of the soap, as is described by Bannan EA and Judge LF [15].

Our findings may have implications for health professionals and medical educators aiming to design effective programs to promote hand hygiene practices.

Table-3: Summary of different isolates found on "in-use" Bar Soaps

	Kabara JJ and Brady MB	**McBride ME**	**Present study (Dental Clinic)**
Gram negative	*Citrobacter freundi* *Klebsiella sp.* *Pseudomonas sp*	*E coli* *Acinetobactor calcoaceticus* *Flavobacterium odoratum* *Flavobacterium sp*	*E coli* *Klebsiella sp.*
Gram positive	*Staph. epidermidis* Staph. *coag negative* *Strep. faecalis* *Strep. mutans* *Strep. faecium varidurans* *Bacillus cereus* *Bacillus sp.*	*Staph.aureus* *Staph.warneri* *Staph.epidermidis* *Staph.capitis* *Staph.simulans* *Staph.haemolyticus* *Coryneforms* *Micrococcus sp* *Bacillus sp*	*Staph.aureus* *Staph.citreus* *Staph.epidermidis* *Bacillus sp* *Diphtheroids*
Fungi	*Alternaria sp.* *Aspergillus fumigatus* *Pencillium sp.* *Rhodotorula sp.*	*Candida parapsilosis* *Aspergillis niger* *Nocardia sp.* *Aspergillis candidus* *Streptomyces sp.* *Pencillium sp.*	*Candida parapsilosis* *Aspergillis niger*
Anaerobes	*Bacteroides sp.* *Clostridium sp.* *Fusobacterium sp.* *Propinibacterium sp.*	*Propionibacterium acnes* *Eubacterium* *Peptococcus saccharolyticus*	*Propionibacterium acnes*



Graph-1: Microbes isolated Percentage %

CONCLUSION

Hand washing is considered the single most important intervention for prevention of nosocomial infections in patients and health care workers. Unfortunately, compliance with standard protocols for hand hygiene in the health care environment has been generally poor.

The findings of this study have shown that the "in-use" bar soap is in fact a harbor for microorganisms, thereby possibly causing greater harm and thus nullifying the original purpose of hand washing.

This study report should be considered as an "eye opener" by every individual Dentist whose duty towards all the patients collectively is to protect them from cross-infection. Hence, this attempt to create awareness.

As alternatives for the adjuncts used for hand washing, the Dentists could use a disinfectant which is not exposed to the environment or to the previous user's hands, like the liquid soap, single use soap tablet, and soap strips or surgical scrubs.

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