

ASSESSMENT OF MICROBIAL CONTAMINATION OF HAND-WASHING FAUCETS IN GENERAL-ACCESS LAVATORIES AT A PRIVATE UNIVERSITY IN KENYA

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This study aimed at establishing the presence of microbial contamination on water faucets of different sites at a private university in Kenya. Samples were collected from five sites within the university where public rest rooms are situated. Microorganisms were isolated using standard laboratory procedures. The organisms were identified by staining procedures and biochemical tests. The presence of the organisms was compared among the sites. Gram staining revealed that 49% of the plates contained gram positive bacteria, 20 % contained gram negative bacteria, 26% were polymorphic and 5% were bipolar organisms. The organisms isolated included *Staphylococcus* sp., *Escherichia coli*, *Streptococcus* sp., *Klebsiella* sp., *Bacillus subtilis* and fungi. The total contaminated plates for male and female lavatories were equal. The study found that faucets at university lavatories are contaminated with bacterial not fungal organisms. These organisms are potentially pathogenic and may be harmful to students and workers by accidental infection. Sensor water faucets are recommended to aid in infection control in lavatories at university settings.

Keywords: Faucets, lavatories, microbial organisms

Introduction

Public restrooms are important sanitary conveniences that ensures safe disposal of fecal matter that would otherwise contaminate environment and risk human health. Nonetheless, their use is not without risk to public health (Mohammed et al., 2015; Mkrtychyan, Russell, Wang, & Cutler, 2013). Among other risks, the sanitary installations such as hand-washing facilities can aid in disease transmission depending on their nature and use. The risk is even greater when coupled with the fact that many people, especially the younger cohort, reportedly use their mobile phones in restrooms for such activities as text messaging, web browsing, and email (Truong, Kientz, & Eun, 2013).

The type of water taps installed in public restrooms determine the safety of their use. Sensor faucets that do not require contact to operate are the safest, but most restrooms lack these; having instead hand-operated faucets that necessitates contact between the user and the tap (Hong, Chen, & Hsu, 2016). These types of faucets facilitate the transfer of pathogens from contaminated hands to the tap and vice versa (Cottam, 2016).

A number of studies have demonstrated that restroom faucet handles harbor a myriad microbes that could endanger the health of the public (Dayaganon et al., 2014; Scott, 2013; Kim & Kim, 2014; Sabra,

2013). Pathogens acquired from these surfaces can cause many diseases including gastrointestinal, respiratory, and dermatological infections (Scott, 2013). It is thus possible that these facilities could contribute significantly to the glaring global burden of environmentally-acquired diseases which is estimated to account for up to 23% of global deaths. Especially is this important in Africa and South Asia where feco-oral transmissible diarrheal infections are the second leading cause of death among children under the age of 5 years (Vohra & Blakely, 2013; Prüss-Üstün, Wolf, Corvalan, Bos, & Neira, 2016).

Studies in similar settings indicate that public restrooms not only harbor more microbial load than private ones but they also harbor pathogens, of public health concern, not common in private restroom (Ejim, Egbuta, & Egberongbe, 2016).

Problem Statement

Hand-washing facilities are installed in lavatories to enhance personal hygiene and thereby reduce infection by feco-oral transmissible pathogens. Whereas this purpose is best served by automatic faucets that do not require contact with hands to release water, or by pedal-type faucets that the users operate with their leg, and to some extent by the press-release button-types, in many cases, the water taps are fitted



with hand-operated knobs/turners. This necessitates the transfer of pathogens from contaminated hands to the tap and vice versa (Cottam, 2016).

The problem is worse in public-access lavatories not only due to the number and diversity of people accessing these facilities, but also because most of them are not supplied with hand-washing soap or detergents, hence many people simply run water over their hands (Sabra, 2013). Worse still would be the situation in the event of outbreak of feco-oral transmissible epidemics. It is thus evident that this scenario defeats the purpose of hand-washing, compromises the health of the users and endangers public health.

Justification

The possibility of restroom faucet handles harboring harmful pathogens thereby facilitating the spread of infectious diseases especially in clustered populations underscores the need for action to eliminate or minimize this hazard. Knowledge of the microbial profile of these sanitary facilities would help quantify the problem and inform requisite interventions while bolstering the scientific knowledgebase on this important public health issue. While studies of this nature have been conducted in other places—with some yielding glaring results (Mkrtychyan et al., 2013), no extant literature exists for this study area.

Study Objectives

Broad

- To assess contamination of hand-washing faucets with potentially pathogenic microbes in public access lavatories at a private university in Kenya.

Specific

- To establish the occurrence of contamination of hand-washing faucets with microbes

Table 1

Sample Matrix

		Gender		Total
		Gents	Ladies	
Sampled taps	Chapel	3	3	6
	Humanities	3	3	6
	Auditorium	3	3	6
	Room X	2	2	4
	Library	3	3	6
Total		14	14	28

- To characterize microbes obtained from the hand-washing faucets
- To determine the predominant microbe(s) on the hand-washing faucets

Methods

Study Area

The study was conducted at an undisclosed private university in Kenya. The institution hosts a population in excess of 2000, including faculty, staff and students.

Study Design

The study employed a descriptive cross-sectional design.

Study Sites

The samples were collected from five (5) designated sites where public-access lavatories are located including the university's auditorium, chapel, library, humanities building and an undesignated "Room X". Both male and female restrooms were studied.

Sampling

Sampling technique was purposive and samples were taken from all hand-washing faucets in the study sites.

Sample Frame

A total of 28 samples (14 from gents and 14 from ladies) were taken for analysis as illustrated in table 1.

Laboratory Analysis

A total of 28 samples were collected from both male and female restrooms using sterile cotton swabs and immediately inoculated in Mueller Hinton broth to determine presence of microorganisms. After 24 hours, all positive samples were cultured in nutrient agar for 24-48 hours to further magnify growth and then sub-cultured in MacConkey and EMB agar for differentiation. Microbes were characterized by colony morphology, microscopy, gram stain, string test and catalase reaction. The research was conducted in the month of May, 2017.

Statistical Analysis

The data was descriptively analyzed on SPSS version 23 and Ms Excel and presented on charts and tables.

Ethical Considerations

No identifying information was given concerning the university. The research outcome will only be shared with relevant stakeholders in order to uphold confidentiality. The outcome will be instrumental in informing requisite intervention for the safeguarding of public health.

Results and Discussion

Occurrence of Contamination

As illustrated in figure 1, all (100%) the samples exhibited growth in both Mueller Hinton broth (the initial inoculation media) and nutrient agar (the subsequent culture media). In a broad sense this established the incidence of microbial contamination on the faucets thereby necessitating further analysis for characterization.

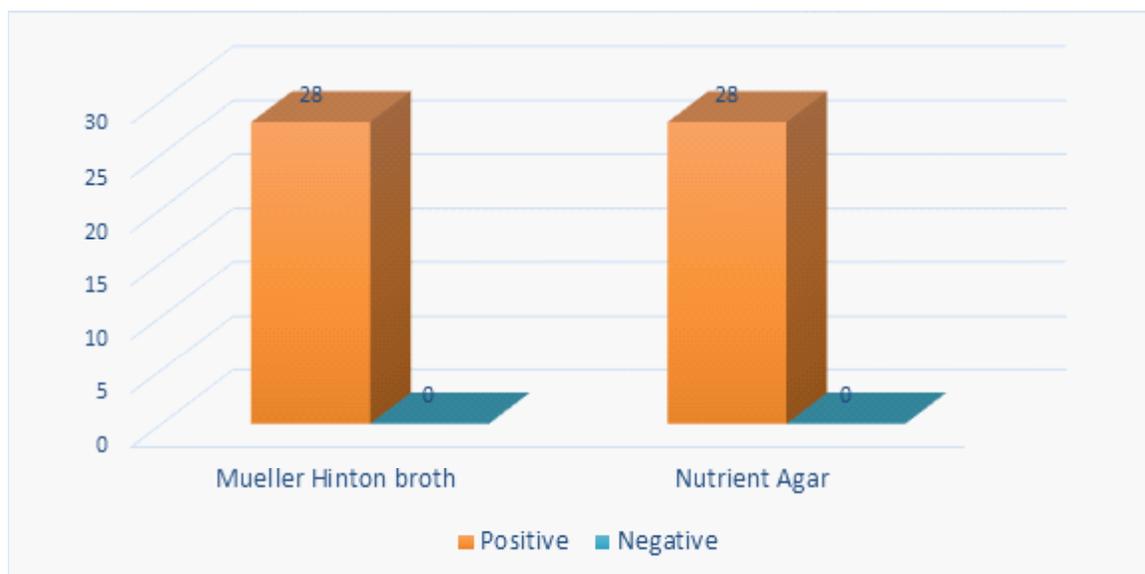


Figure 1. Growth of microorganism in Mueller Hinton broth and nutrient agar.

This finding contrasts that of Elsergany, Mousa, Ahsan, Khalfan, and Eissa (2015) in which 75% of swabs from public restrooms tap handles were positive. This is likely because microbial contamination of restroom faucets is a function of many variables — including user's hygiene, frequency of use, cleaning and disinfection regimen and microbial survivability—all of which may differ from place to place.

A number of studies have demonstrated that restroom faucet handles harbor a myriad microbes that could endanger the health of the public (Dayaganon

et al., 2014; Scott, 2013; Kim & Kim, 2014; Sabra, 2013; Chengula et al., 2014). Pathogens acquired from these surfaces can cause many diseases including gastrointestinal, respiratory, and dermatological infections (Scott, 2013), but identification of specific strains is essential to remedial action.

Isolation and Characterization of Microbes

Based on gram staining and cell morphology most of the microbes identified were gram positive



(49%) and cocci were more frequent than bacilli (51%). 15 samples were catalase positive, 2 were string test positive, 3 showed greenish metallic sheen on EMB agar and 5 exhibited pink colonies on MacConkey Agar

(MAC). Organisms were identified as Fungi (42%), *Staphylococcus* spp (37%), *Streptococcus* spp (7%), *E. coli* (7%), *Klebsiella* spp (5%) and *Bacillus subtilis* (2%).

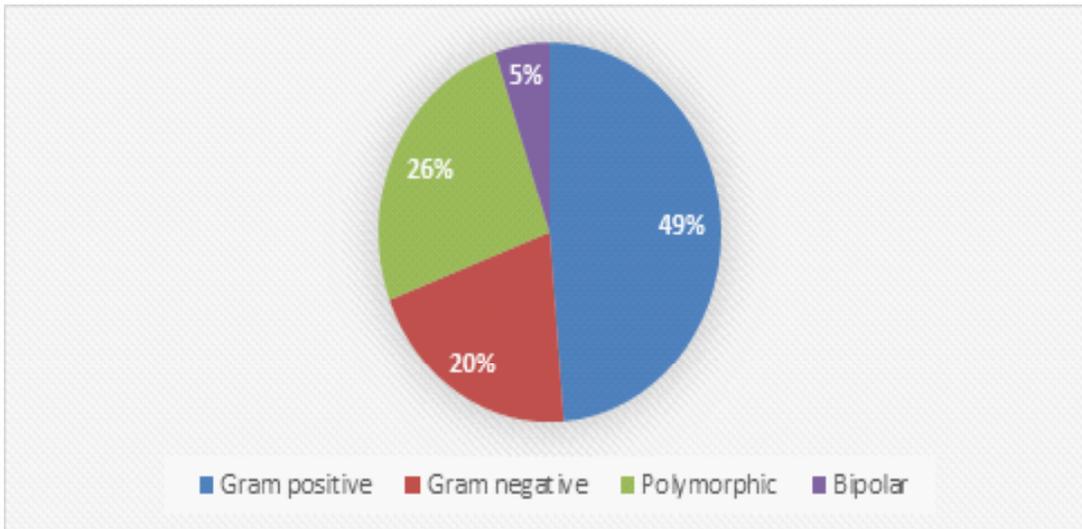


Figure 2. Results of gram staining.

The predominance of gram positive bacteria in this study is not unusual. Gram positive bacteria are generally hardy and survive longer on environmental surfaces thus more frequently recovered (Adwan, Salama, & Hasan, 2016). On the other hand, the gram negatives, though relatively less abundant in this study, are no less-threatening. Majority of gram negative bacteria are pathogenic and many have become multidrug-resistant over the years (Li, Plésiat, & Nikaido, 2015; Wellington et al., 2013; Zowawi et al., 2015).

The presence of *E. coli* on some of the faucet

handles (identified by green metallic sheen on EMB) indicate fecal contamination and bespeaks inadequate hygiene. This could result in transmission of feco-oral infections especially among the youth who reportedly use their mobile phones in restrooms for such activities as texting, browsing, and emailing (Truong et al., 2013). Besides, many serotypes of *E. coli*, including EPEC, ETEC, EIEC, EAEC and EHEC, are a common cause of global morbidity and mortality especially in developing countries (Croxen et al., 2013; Meng, LeJeune, Zhao, & Doyle, 2013).

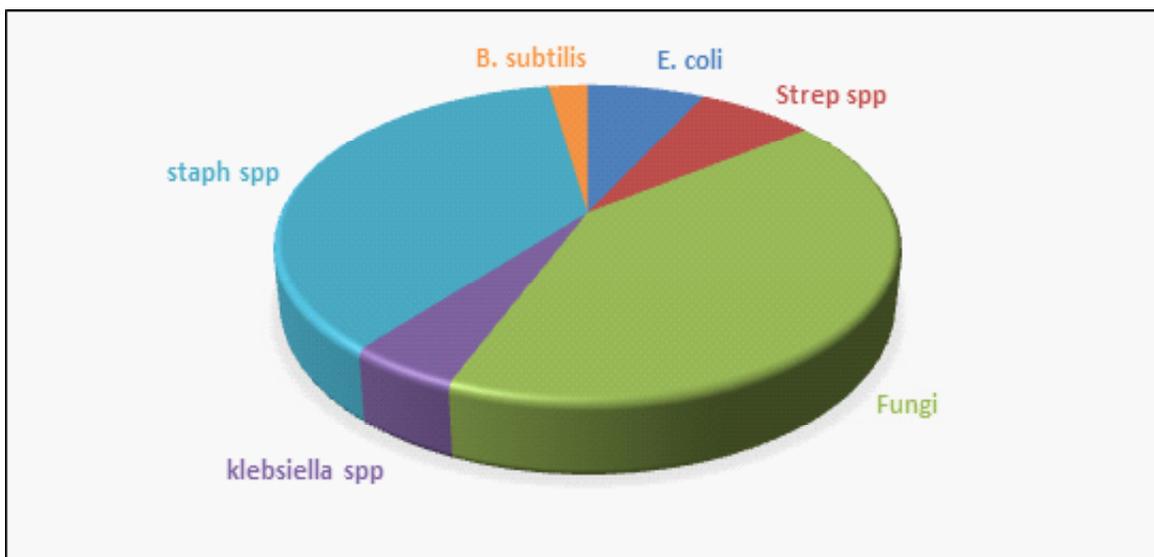


Figure 3. Proportions of isolated microorganisms.

Streptococcal infections constitute a heavy burden of disease globally among patients of all ages (Creti, 2017). Sinisterly, the pathogenicity of streptococci is not only restricted to virulent strains; even species considered normal flora have been implicated in life-threatening infections especially among immunocompromised (Krzyściak, Pluskwa, Jurczak, & Kościelniak, 2013; Butt et al., 2016). Moreover, certain avirulent, even beneficial, species have been found to act synergistically with fungi to promote infection (Xu, Jenkinson, & Dongari-Bagtzoglou, 2014). While further study is necessary to identify specific strains that colonized the faucets, the mere detection of this genus in the study does raise an alarm.

Bacillus subtilis is generally considered innocuous, though possibility of virulence has been documented. It is abundant in nature and able to adapt to severe changes in environment—especially through formation of biofilms and sporulation, which make them persist longer on fomites (Tan & Ramamurthi, 2014; Vlamakis, Chai, Beauregard, Losick, & Kolter, 2013).

The genus *Klebsiella* (though encumbered by taxonomic controversies) comprise several species some of which are highly pathogenic (Janda, 2015). Of these, *K. pneumoniae* has been repeatedly isolated from public restrooms in other studies (Chengula et

al., 2014; Sabra, 2013). This species is associated with severe community-acquired infections and is lately becoming resistant to last-line antibiotics making it a grave public health challenge (Holt et al., 2015). Further study to identify specific strains of *Klebsiella* on the faucets, and the restroom environment at large, is vital.

Predominant Microbial Contaminants

The predominant microbe on the faucets was *fungi* followed closely by *staphylococcus* spp. This is probably due to their ubiquitous and hardy nature. These findings corroborates those of Adwan et al. (2016) who also reported that fungi and staphylococcus spp were the predominant microbial contaminants on bathroom sink faucet handles at a Palestinian private university.

A wide variety of fungi, including *Candida*, *Cryptococcus*, *Aspergillus*, *Rhodotorula*, *Histoplasma*, *Pneumocystis*, *Saccharomyces* and *Fusarium* species have the ability to colonize various surfaces and form biofilms (Sardi et al., 2014). Although many of these species have also been isolated in toilet environments (Ejdys, Dynowska, Biedunkiewicz, & Sucharzewska, 2013), we recommend further study to characterize the specific strains in this study area.

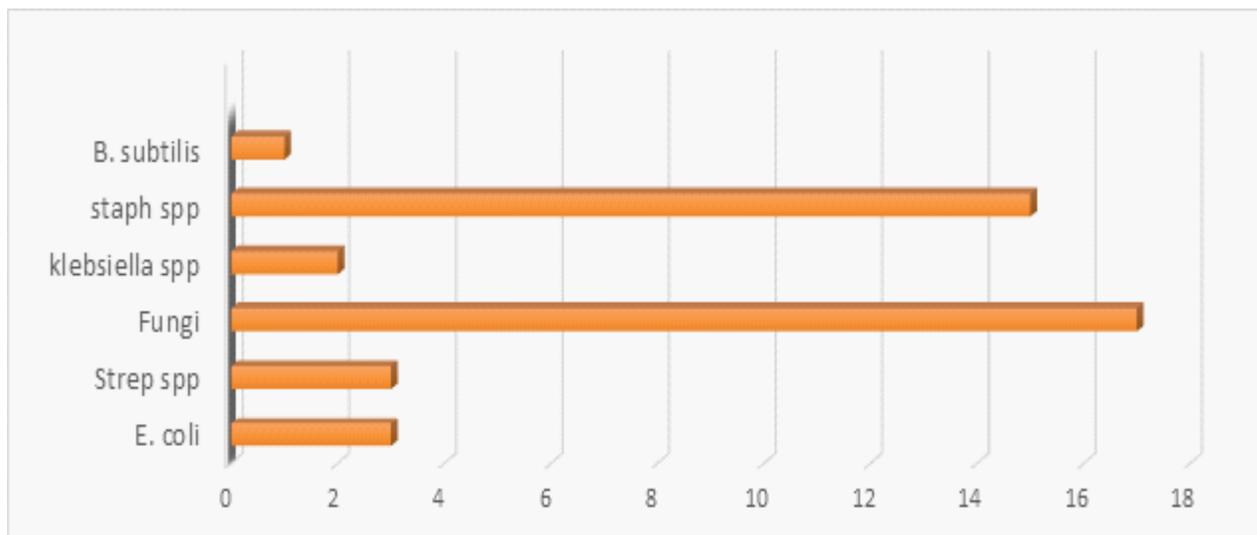


Figure 4. Predominance of fungi and staphylococci over the rest of identified microbes.

Moreover, fungal infections, many of which are environmentally acquired, are a major source of global morbidity and mortality and evidence of antifungal drug resistance is emerging in various parts of the world (Perlin, Shor, & Zhao, 2015; Vallabhaneni et al., 2017; Litvintseva, Brandt, Mody, & Lockhart, 2015).

The predominance of fungal microbes on the faucet handles thus constitutes a significant public health threat and underscores the need for preventive action.

The staphylococcus species that have been isolated in similar settings include *S. epidermidis* and



S. aureus. These organisms constitutes normal microbiota but have been implicated in various infections, some of which are life-threatening (Adwan et al., 2016; Thapaliya, Taha, Dalman, Kadariya, & Smith, 2017). Coupled with the emergence of antibiotic resistance in the species' pool, the public health implications of this finding cannot be underestimated. A study by Mkrtychyan et al. (2013) for instance, reported that nearly 40% of staphylococci isolated from public restrooms were antibiotic resistant.

Conclusion and Recommendations

Conclusion

This study was conducted to assess microbial contamination of hand-washing faucets in public-access restrooms at a Kenyan private university. Results obtained showed that all the faucets were contaminated by microorganisms —majority of which were fungi and bacteria of the genus *staphylococcus*. These findings concur with previous studies in similar settings to a great extent, highlight the health risks of hand-operated restroom faucets and echo the need for public health intervention.

On the whole, though this study did not determine gender differences in the incidence of contamination, it may be argued with logical certainty that women are at a greater risk of contaminating their hands through the hand-washing faucets because previous studies have shown that they practice hand washing more frequently than men (Borchgrevink, Cha, & Kim, 2013; Dickie, Rasmussen, Cain, Williams, & MacKay, 2017).

Recommendations

We recommend a robust cleaning and disinfection regimen, public education and engineering solutions to reduce/eliminate associated health risks. In order of preference we recommend the following public health engineering solutions for public restrooms: a) automatic faucets that do not require contact with hands to release water, b) pedal-type faucets that the users operate with their leg, and c) press-release button-type faucets that do not require the user to turn off after use.

Study Limitations

We acknowledge that microbial contamination is a function of many variables. As such, the findings of this study may not be generalizable even to all private universities in Kenya, let alone Kenya as a whole. We therefore recommend similar studies to be conducted in other places, as well as ongoing microbial surveillance for public restrooms in Kenyan Universities and other institutions of higher learning.

Moreover, this study did not, in many cases, identify the isolated microbes to species level. This was largely due to constrains in resource availability. Nonetheless, being the first of its kind in the study area, it still represents a significant advancement of knowledge in the field.

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