

Hygiene Risk and the Virtual Handshake: A Case of the Biometric Identification Machine

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Abstract

This study was carried out to assess hand hygiene practices in the context of an institution that uses biometric identity machines to monitor employee attendance. The study involved 103 employees. The study revealed that 67.3% of the respondents felt the institution had adequate hand hygiene facilities but only 51.4 % said they always disinfect their hands after using the toilet. 33.6% said they *never* disinfected their hands when using the biometric machine due to unavailability of hand hygiene facilities and or consumables. It also emerged that 24.3% of respondents did not know the correct hand washing procedure. To aggravate the situation, 85% of respondents said there were no informative hand hygiene signs illustrating the correct hand washing procedure. This indicates that a potential health risk existed as at the institution at the time of study. Unavailability was due either to the equipment being absent or the disinfectant not being filled into the dispensers. Disinfection *both before and after* using the biometric machine is strongly recommended as this would maximize health benefits both to the individual and to the wider employee population. A number of other actions will also need to be implemented to ensure safer use of hand hygiene facilities at the institution.

Keywords: Disinfection, disinfectant, biometric identification machine, hand hygiene facilities, hand hygiene practices, hand hygiene consumables.

1. Introduction

Being able to accurately monitor or track employee movements and or attendance is critical to productivity in an organisation, particularly in privately owned organizations which need to tightly control profits and expenditure. The advent of biometry and the biometric machines brought promises of better achievement of this goal through the possibility of identifying employees via a number of biological parameters including finger and palm morphology. The role of poor hand hygiene in the spread of pathogens long been recognised (Whitby et al, 2007; Pittet, 2001 and O'Boyle et al, 2001). Deeply ingrained practices such as shaking hands as a way of greeting have been criticised because of their potential to spread pathogens bacterial and viral pathogens. Biometric identity machines such as the Biometric Hand Geometry Reader or other variants that read finger/thumb geometry may be criticised much in the same way. In an environment where the biometric machine is used, every individual using the machine *literally shakes hands with every other person using the same machine, albeit 'virtually'*. This creates a potential health risk situation if good hand hygiene is not practiced or supported. This study set out to explore these and other issues in the context of an organization utilising the biometric hand/finger geometry reader.

2. Objectives

1. To assess the availability and suitability of on-campus hand hygiene facilities.
2. To assess the hand disinfection procedure currently used by employees when using the biometric machine
3. To assess employee knowledge of proper hand washing procedure.
4. To propose/recommend strategies of addressing the identified hand hygiene practice gaps so as to reduce/alleviate hygiene risk in the use of biometric identification machines.

3. Justification

Poor hand hygiene is implicated in many cases of pathogenic disease outbreaks and spread (Pittet, 2001). In situations where employees are required to log-in and out on a biometric identification machine, practically every user “shakes hands” with everyone else using the same machine. This might indeed be called the “*virtual handshake*”. O’Boyle (2001) points out that the rate of non-adherence to recommended effective hand washing procedure in the clinical/medical set up is often lower than 70%. Given the fact that the clinical set up is many times more stringent in hand hygiene demands than other contexts, it is conceivable that the “*virtual handshake*” network created by the biometric machines presents a real health risk in the workplace. Even when using biometric machines with built-in antimicrobial features, there are situation-specific variables that may not be fully addressed by the system. Examples include the rate microbial build-up versus the rate of disinfection by the incorporated antimicrobial technology. Consequently, there remains a significant risk, even if not immediate, of widespread distribution of microbes that may fall anywhere on a risk continuum from completely harmless, to outright deadly. It becomes necessary, therefore, first to evaluate the status quo with respect to hand hygiene facilities and practices for a given environment and secondly to propose strategies to help alleviate the specific potential health risk(s) associated with that environment.

4. Methodology

4.1. Data Collection Method

The data collection method used was an anonymised survey involving employees at a private company who are required to routinely log in and log out on a biometric identification machine. 150 questionnaires were distributed and 107 were returned. This represented a response rate of 71.3%, which was deemed satisfactory. Of the 107 questionnaires returned 4 were spoiled (incomplete information provided), therefore the usable questionnaires were 103.

4.2. Data Collection Tool

The data collection tool was a questionnaire designed to collect three broad sets of data as follows: **Section A**-Availability and suitability of hand hygiene facilities, **Section B**- Personal Hand Hygiene Practices and **Section C**- How participants used (or would use) hand disinfectant when using the biometric machine or visiting the toilet. There were no open-ended questions in the questionnaire.

5. Literature Review

5.1. Skin/Hand Micro-Flora and Hygiene

Davis (1996) uses an analogy of geographic regions to represent different areas of the human body. He states that because each region has different environmental characteristics, it supports different types of microorganisms. The human skin carries two groups of microorganisms namely resident and transient flora (Pittet, 2001). The former consists of relatively fixed types of microorganisms regularly found in a given area at a given age. Transient micro-flora consist of non-pathogenic, potentially pathogenic

and/or pathogenic microorganisms that inhabit the skin or mucus membrane temporarily (hours, days or weeks). Transient micro-flora are of greatest concern especially in hospital environments, but resident micro-flora may also be problematic for patients who are immune-compromised due to disease or some types of treatment such as chemotherapy or surgery. Pittet (2001) argues that transient flora are easily removed by effective hand washing. This may be through such actions as shaking hands in greeting or other less obvious ways such as touching or coming into contact with contaminated surfaces or poor hand hygiene when using shared toilets. According to the Centres for Disease Control, up to 80 percent of infections are transmitted by hands (www.chatelaine.com/health/wellness/do-handshakes-spread-germs/) in this way.

5.2. Reasons for Failure to Adhere to Recommended Hand Hygiene

O'Boyle (2001) cites the following reasons for failure to adhere to hand hygiene recommendations in the medical set up:

- Knowledge about hand hygiene,
- Awareness of personal hand washing practices,
- Types of hand hygiene products,
- Accessibility of supplies

5.3. Control of Infection Spread by Hands

5.3.1. Hand Washing & Disinfection

The term hand hygiene includes several actions intended to decrease colonization with transient flora (Pittet, 2001). The most effective method of controlling spread of infections by hands is the disinfection and use of the correct hand washing procedure. Hand washing refers to washing hands with an un-medicated detergent and water or water alone (Pittet, 2001). Hygienic hand washing refers to the same procedure but an antiseptic agent is added to the detergent. In the context of this study, hand washing refers to both terms. Another important term in hand hygiene is hand disinfection which, according to Pittet (2001), refers to the use of an antiseptic (medicated soap or alcohol) to clean hands. Different authors outline slightly differing steps for effective washing and or disinfection of hands.

The disinfection and hand washing steps outlined below are proposed by the World Health Organisation (WHO) (www.who.int/gpsc/5may/Hand_Hygiene_Why_How_and_When_Brochure.pdf)

1. Wet hands with water
2. Apply enough soap to cover all hand surfaces
3. Rub hands palm to palm
4. Rub hands right palm over left dorsum with interlaced fingers and vice versa
5. Rub hands palm to palm with fingers interlaced
6. Rub backs of fingers to opposing palms with fingers interlocked
7. Do rotational rubbing of left thumb clasped in right palm and vice versa
8. Do rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa
9. Rinse hands with water
10. Dry hands thoroughly with a single use towel (or blow dryer)
11. Use towel to turn off tap

After these steps one's hands will be clean enough to be safe.

The hand disinfection procedure is as outlined below:

1. Apply a palmful of the product in a cupped hand, covering all surfaces
2. Rub hands palm to palm
3. Rub hands right palm over left dorsum with interlaced fingers and vice versa
4. Rub hands palm to palm with fingers interlaced
5. Rub backs of fingers to opposing palms with fingers interlocked
6. Do rotational rubbing of left thumb clasped in right palm and vice versa

7. Do rotational rubbing, backwards and forwards with clasped fingers of right hand in left palm and vice versa
 8. Dry hands thoroughly with a single use towel (or dryer)
- After these steps one's hands will be clean enough to be safe.

5.3.2. Technological Interventions

Since ancient times, the silver ion has been known to be effective against a broad range of microorganisms (Jung et al, 2008). In recent times, attempts have been made to exploit this property in a number of situations including medical environments, medical equipment, toilet seats to name a few. The technology has even found application in biometric identification machines that read palm or finger/thumb morphology where silver ions are incorporated on the platen of the devices to reduce microbial contamination thereby promoting hygiene (Taylor et al, 2009). Jung et al (2008) outlines a number of ways in which the silver ions are thought to act:

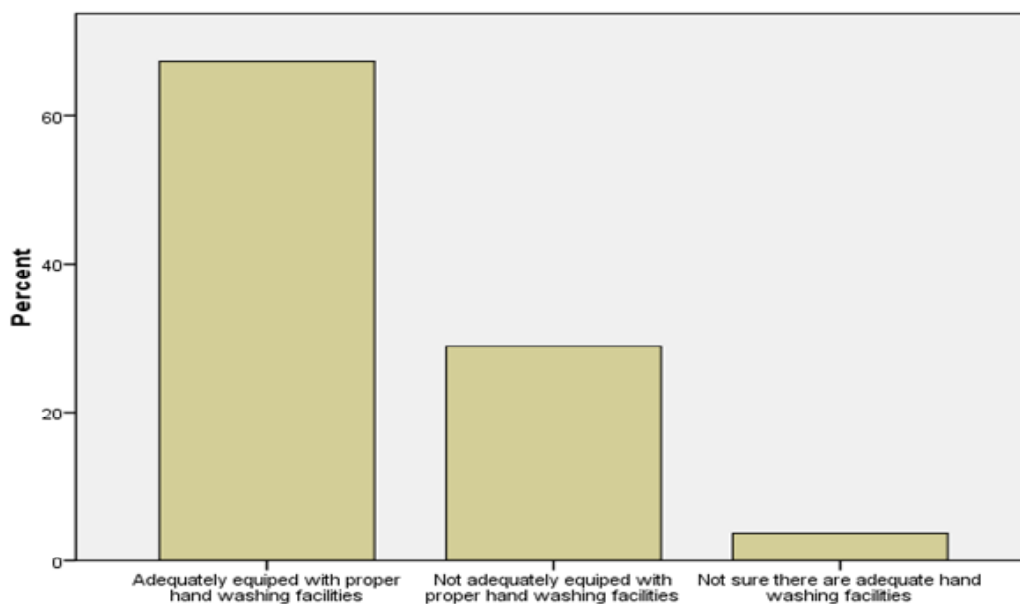
- Interaction of silver ions with thiol groups
- Binding of key functional groups of enzymes by silver ions
- Cause leakage of K^+ ions from bacteria
- Inhibiting bacterial growth and cell division
- Damaging the cell envelop and contents of bacteria
- Causing structural abnormalities (enlarged cells etc)
- Interacting with nucleic acids (how this helps antimicrobial activity is unclear).

Manufacturers of biometric hand geometry readers who have incorporated the silver ion technology in their products claim that it inhibits bacterial growth thereby mitigating hygiene concerns and also lasts for the life of the product (Ingersoll Rand, 2009). These claims are, presumably, supported by research such as carried out by Taylor et al (2009). Available literature however seems to suggest that this technology must be treated just as one element in a wider infection control scheme. Its effectiveness may also be a function of situation-specific variables which may need to be evaluated on a case-by-case basis.

6. Results Analysis

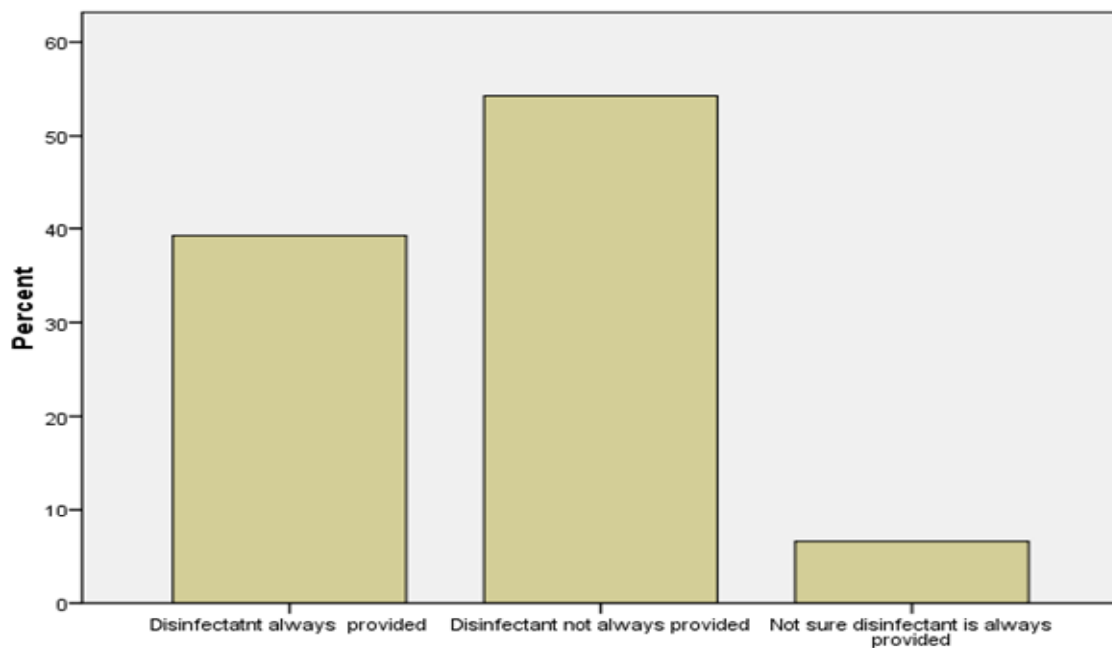
6.1. Availability and User Friendliness of Hand Hygiene Facilities/Consumables

Figure 1: Availability of hand hygiene facilities in on-campus toilets



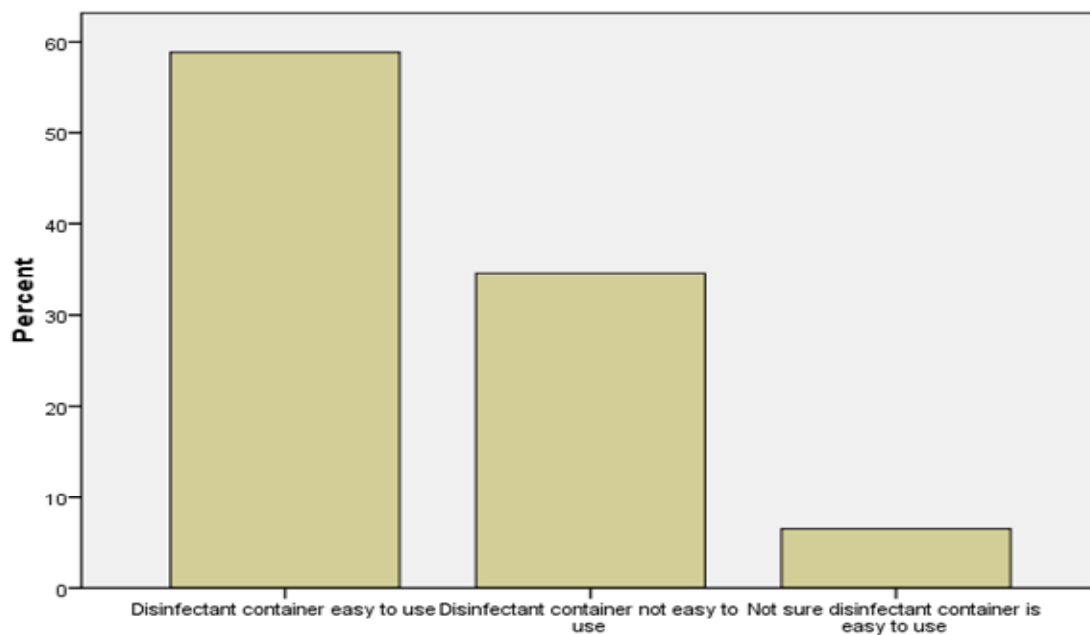
- Most people (67.3%) stated that the on-campus toilets are adequately equipped with proper hand-washing facilities.

Figure 2: Availability of hand disinfectant at the biometric machines

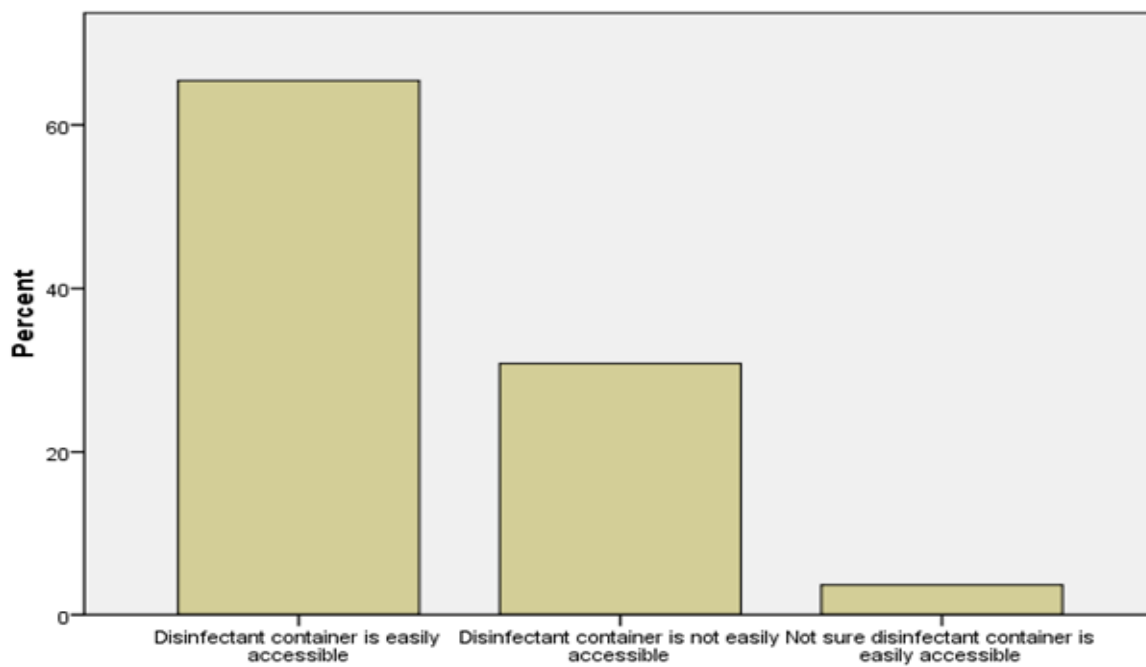


- Most people (54.2%) stated that hand disinfectant is not always provided or available at the biometric machines.

Figure 3 a: User Friendliness of hand hygiene facilities- disinfectant dispensing mechanism

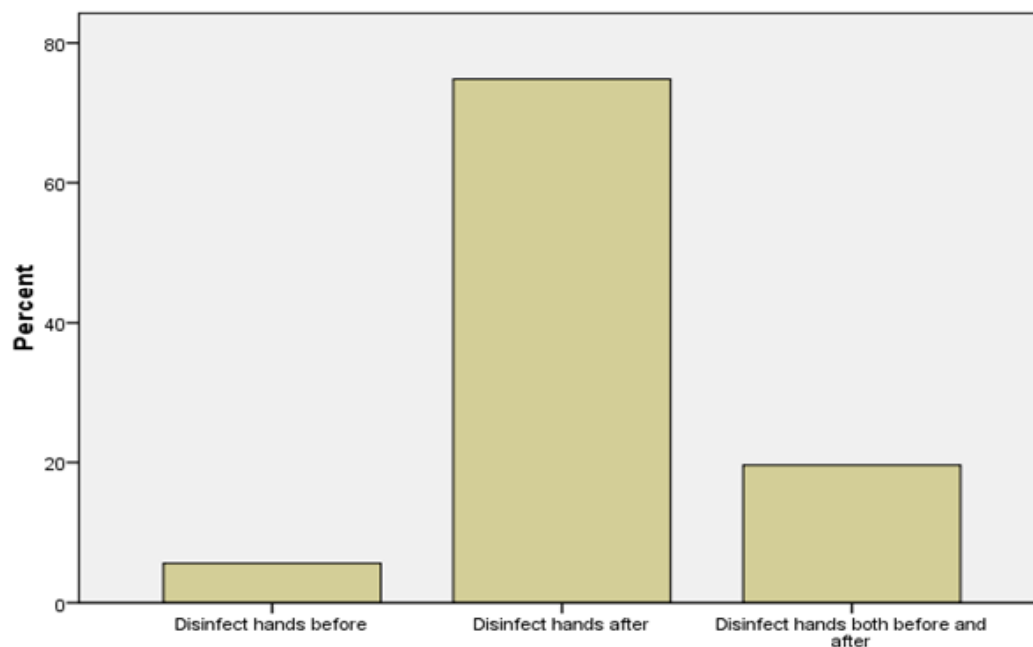


- 58.9% of respondents stated that the disinfectant dispensing mechanism at the biometric machines was easy to use.

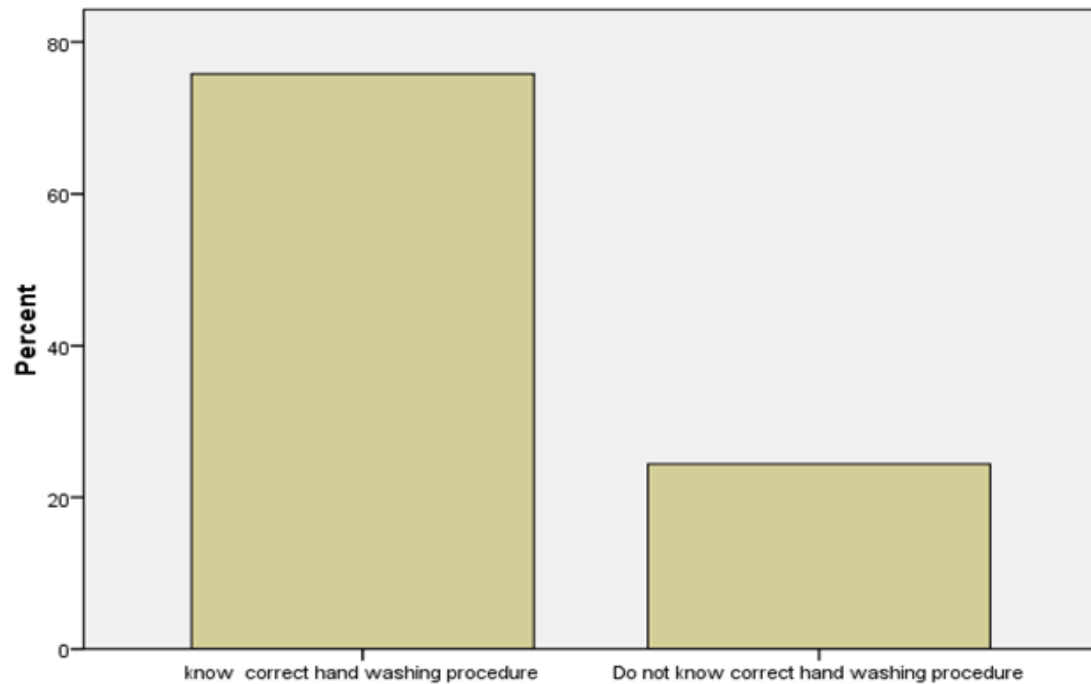
Figure 3 b: User friendliness of hand hygiene facilities- Positioning of hand disinfectant at biometric machines

- 65.4% of respondents felt that the hand disinfectant was placed in a position that was easily accessible

6.2. Knowledge of Hand Washing and Hand Disinfection Procedures

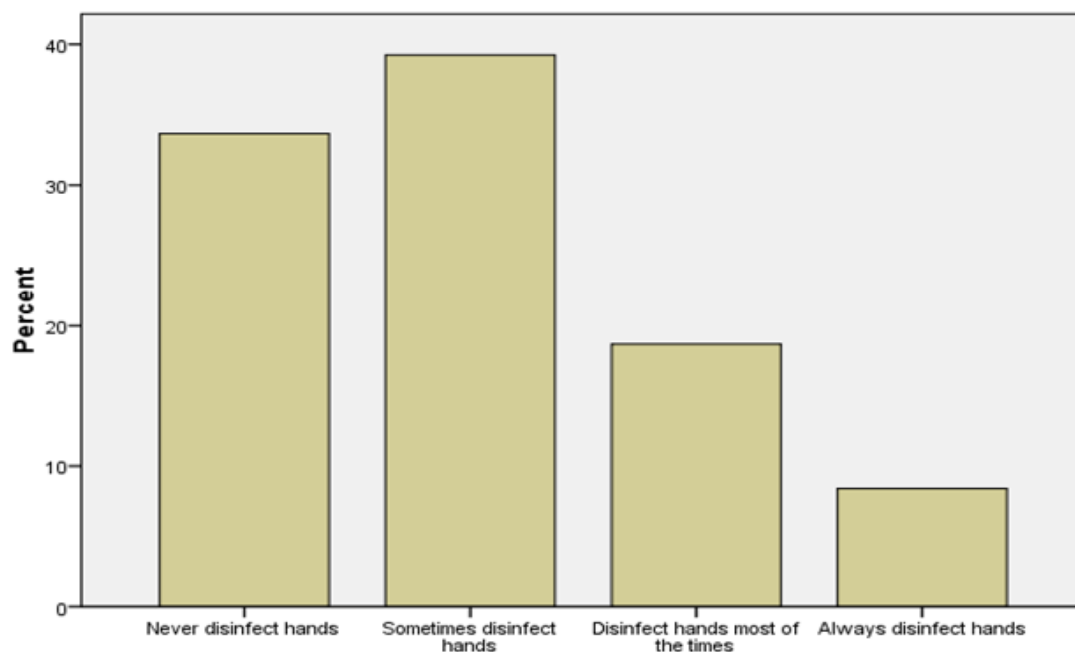
Figure 4 a: Knowledge of proper hand hygiene procedure- use of hand disinfectant at biometric machines

- 74.8% of respondents stated that they disinfect their hands only after using the biometric machine.

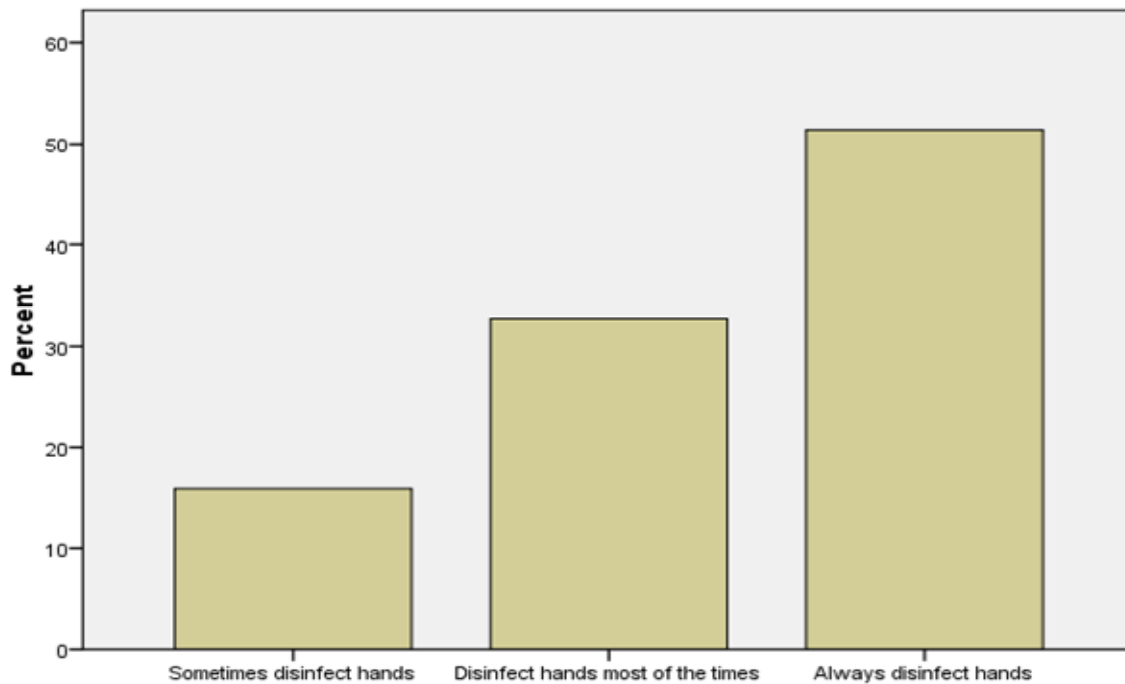
Figure 4 b: Knowledge of proper hand hygiene procedures- hand washing after using toilet

- 24.3% of respondents did not know the correct procedure for effectively washing hands after using the toilet

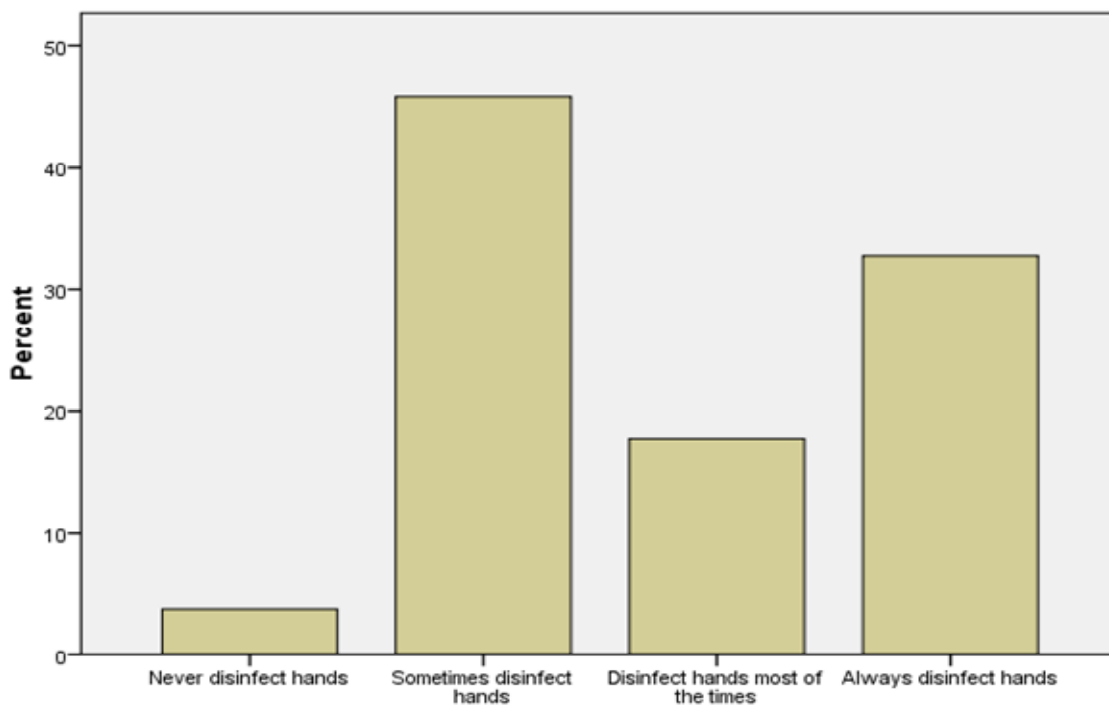
6.4. Routine Hand Hygiene Practices

Figure 5 a: Routine hand hygiene practices- use of hand disinfectant when using the biometric machine

- 33.6% of respondents stated that they never disinfect their hands when using the biometric machine

Figure 5b: Routine hand hygiene practices- hand washing after using the toilet

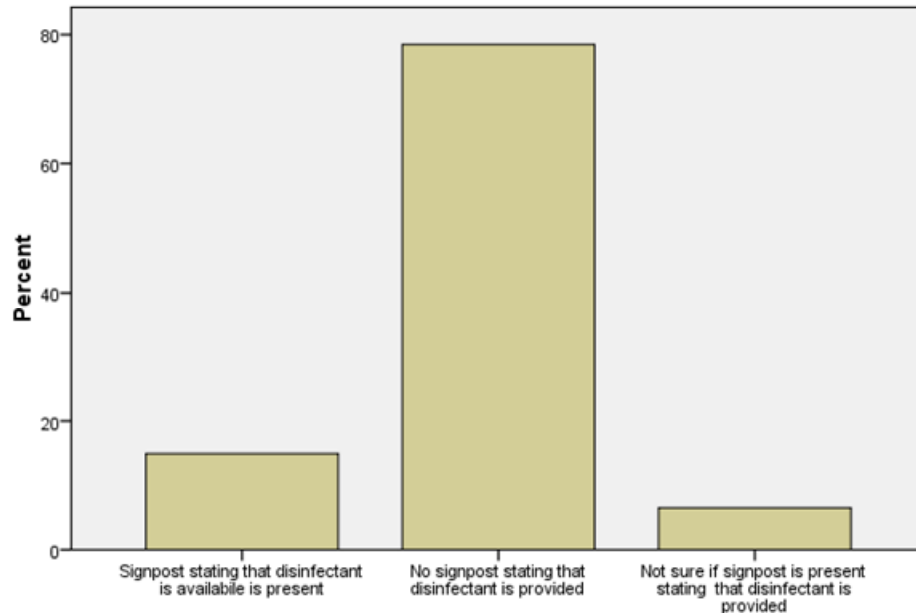
- 51.4 % of respondents always disinfect their hands after using the toilet.

Figure 5 c: Routine hand hygiene practices- hand disinfection after contact with general potential contaminants

- Only 32.7% of respondents stated that they always disinfect their hands after contact with general potential contaminants.

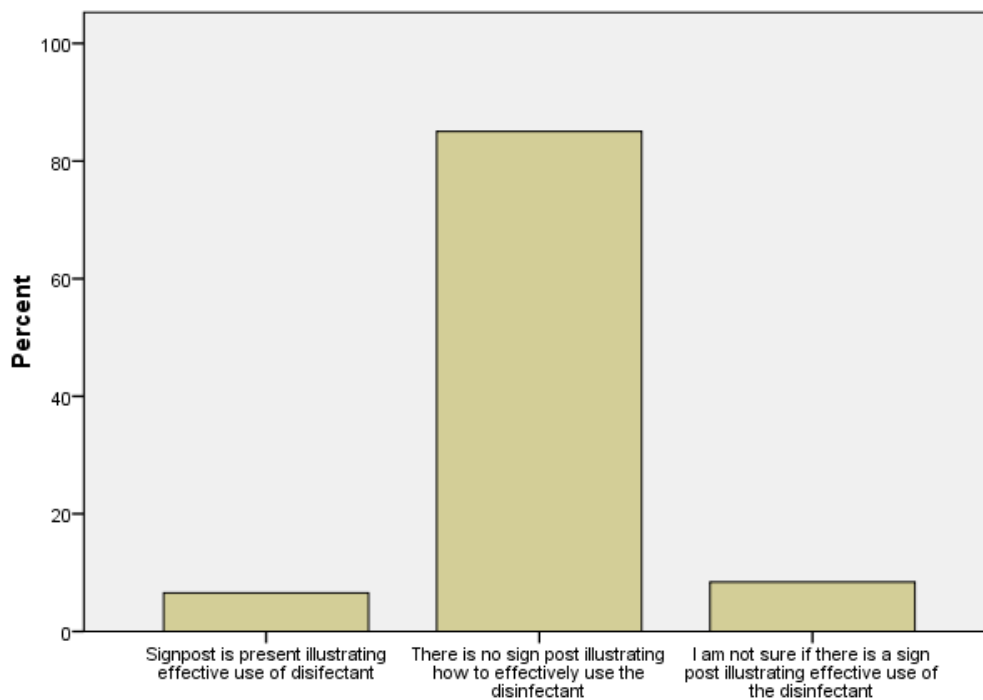
6.5. Presence of Informative Hand Hygiene Signage On-Campus

Figure 6 a: Presence of informative hand hygiene signage- provision/availability of hand disinfectant.



- 78.5% of respondents stated that there are no informative hand hygiene signage informing employees about the provision or availability of hand disinfectant at the biometric machines.

Figure 6 b: Presence of informative hand hygiene signage- illustrating correct hand washing procedure.



- 85% of respondents stated that there are no informative hand hygiene signage illustrating correct hand washing procedure.

7. Discussion

Responses to the survey questionnaire indicated that there were hand hygiene facilities for employees to use while on duty at the university premises. Most respondents (67.3%) indicated that the on-campus toilets that they regularly used were adequately equipped with proper hand-washing facilities (disinfecting soap, taps with running water, hand drying machines etc). The rest were either not sure or stated that such facilities/consumables were not provided in the on-campus toilets that they regularly used. When asked if they made use of provided hand hygiene facilities in the on-campus toilets, only 51.4 % of the respondents indicated that they always disinfect their hands after using the toilet. Further, it was noted that 24.3% of respondents did not know the correct procedure for effectively washing hands after using the toilet. The majority of respondents (85%) stated that there were no informative hand hygiene signs illustrating correct hand washing procedure. This implies that even if adequate and proper hand hygiene facilities and consumables are provided, a health risk would still exist as a result of improper hand washing procedure emanating from inadequate or absence of informative signage. Claims of unavailability of hand hygiene facilities and or consumables need to be investigated and corrected if found to be true. It must be noted that hand hygiene compromises in the toilets are probably the single greatest health risk facing employees at any workplace where use of biometric machines is mandatory. There are a good number of pathogens associated with the human gastrointestinal tract which may be transferred to the contact surfaces of biometric machines from where they can be passed all people who use the same machines. Examples of such pathogens include *Escherichia coli* (may cause diarrhea) and *Vibrio cholera* (the cholera pathogen).

The study established that 33.6% of the respondents *never* disinfected their hands when using the biometric machine. The reason(s) for this could not be established with certainty but could be linked to the following issues:

1. Unavailability of hand hygiene facilities and or consumables (54.2% of respondents stated that hand disinfectant was not always provided or available at the biometric machines). Onsite visits established that indeed there were no disinfectant dispensers at some sites, notably the machines where employees are identified using the thumb.
2. Absence of informative signs informing employees that hand hygiene facilities and consumables were available for them (78.5% of respondents stated that there were no informative hand hygiene signage informing employees about the provision or availability of hand disinfectant at the biometric machines).

It was however, established that most respondents (58.9%) felt that the disinfectant dispensing mechanisms were user friendly with respect to ease of operation (58.9%) and favourable positioning (65.4%). It would be useful to investigate reasons why some users felt that the disinfectant dispensing mechanisms were not user friendly as this may help increase usage of the hand hygiene facilities and consumables leading to improved hand hygiene practices and effectiveness.

The study found out that 74.8% of respondents disinfected (or would disinfect) their hands *after* using the biometric machine. This is the logical thing to do and it is what most people do or would do. However, there was a small group of respondents, ~ 19.6%, who indicated that they disinfected (or would disinfect) their hands *both before and after* using the biometric machine. While the questionnaire did not probe such respondents as to why they would do this peculiar thing, it is the researcher's conviction that such action would greatly reduce health risk to biometric machine users for the following reasons:

1. Disinfecting hands before using the biometric machine would have the effect of reducing the microbial load on the hands thereby reducing the quantity of microbes that an individual using the machine transfers to the machine's contact surface. Likewise the number of microbes that a subsequent user picks up would also be reduced.
2. Disinfecting hands after using the biometric machine would have the effect of reducing the quantity of microbes remaining on the user's hands after using the biometric machine, thereby safeguarding the individual's health.

This means that disinfecting hands before using the biometric machine safeguards others from the pathogens that may be present on one's hands. Disinfecting hands after using the biometric machine mainly safeguards the individual from the pathogens that may have come from others using the same machine. This is also the position of the World Health Organisation with regard to hand hygiene in medical environments (www.who.int/gpsc/5may/Hand_Hygiene_Why_How_and_When_Brochure.pdf). The same line of reasoning can be applied in workplaces that use biometric identification machines.

Although there are claims from manufacturers that some biometric machines are equipped with inherent antimicrobial technology, notably silver ion coating (Taylot et al, 2009), there is insufficient evidence about the efficacy of such technologies in the context of biometric machines. While it may be true that silver ions do have antimicrobial activity against some microorganisms, such activity is still a function of a myriad of situation-specific variables such as the rate of microbial build-up versus the rate of destruction of the microbes. Such technologies, therefore, should be treated as just one element in a wider microbial control scheme. Elements such as effective hand hygiene practices can therefore not be compromised or eliminated on account of technologies such as the silver ion technology. Therefore, for maximum benefit to be realised, it should be necessary to disinfect hands both before and after using the biometric machine.

8. Conclusion

A hygiene-related health risk existed at the institution at the time of the study. This risk emanated from the fact that:

1. Hand hygiene facilities were not available at all the biometric machine sites.
2. In some places where the hand hygiene facilities were present, the hand disinfectant or soap was not always provided.
3. Some employees did not know the correct hand washing procedure.
4. Hand washing and hand disinfection was not adhered always even where the hand hygiene facilities and consumables were provided.

These factors, combined with the fact that the most no antimicrobial agent has 100% antimicrobial efficacy means that a lot has to be done to significantly improve hand hygiene (Kampf and Kramer, 2004). This calls for a multi-strategy approach as no single approach is likely to yield appreciable results.

9. Recommendations

1. Install hand disinfection facilities at all biometric machine sites (including the machines that identifies by thump morphology).
2. Implement a stringent monitoring system to ensure that disinfectant and soap dispensers at the biometric machines and in the toilets are always filled up.
3. Put up signage next to the hand hygiene facilities encouraging staff to (i) use the disinfectant, (ii) use it correctly (itemise the recommended hand disinfection steps)
4. Encourage staff to disinfect hands both before and after using the biometric machine.
5. Incorporate hygiene awareness campaigns into the organizational calendar of activities.
6. Adopt and adapt some of the recommendations of Whitby et al (2007) e.g :
 - a) Education in how, when and why to perform hand hygiene, with an emphasis on the derivation of their community and occupational hand hygiene behaviour patterns.
 - b) Motivation of appropriate hand hygiene practices through role modelling and peer pressure from senior medical, nursing and administrative staff.
 - c) Cues to action should continue to be employed. For example, cartoon-like posters and alcohol-based hand rubs positioned close to high risk areas or provided in handy bottles to facilitate pocket carriage.

- d) Peer monitoring
- e) Influence a system change at the following several levels (Structural, Philosophical and Legislative)

10. Further Studies

1. Extensive situation-specific studies of microbial load and build up on silver ion coated biometric machines to enable the formulation of a Hygiene Risk Assessment Framework that can be widely applied to help different workplaces to appropriately monitor and control hygiene/health risk in their establishments

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