

HEALTHCARE WORKERS AND HAND HYGIENE PRACTICE: A LITERATURE REVIEW

SHABIB AL-BUSAIDI (NURSING)

Abstract: It is disturbing that the hospitalisation of patients can lead to hospital acquired infection (HAI) and that according to recent research, poor hand hygiene is seen as a contributory factor. This article provides a literature review of current research on this topic. It examines the importance of hand hygiene in healthcare situations, describes effective hand-hygiene procedures, comparing the clinical and cost-effective uses of alcohol hand-rubs with hand washing, and it identifies the various professional and organisational barriers to proper practice among healthcare workers. It concludes with the strategies recommended to improve standards especially in places with limited facilities and resources.

Keywords: Hand hygiene, Hand-rub, Hand washing, Healthcare workers, Nosocomial infection.

Introduction

The provision of healthcare worldwide is always associated with a potential range of safety problems. Yet, despite advances in healthcare systems, patients remain vulnerable to unintentional harm in hospitals (Devnani et al. 2011; Mani et al. 2010).

One of the most significant, current discussions in healthcare delivery in hospitals is healthcare associated infection (HAI), sometimes called hospital acquired infection (Mani et al. 2010; Momen & Fernie 2010) or nosocomial infection, which is 'any infection that a person develops as a result of treatment in hospital' (Minnaar 2008, 2).

Hand hygiene was thought to be a key factor in reducing hospital acquired infection during the initial development of healthcare systems (Akyol 2007; Ott & French 2009). The battle with HAI started when the Hungarian obstetrician, Semmelweis (1847), observed that puerperal fever was more common on a maternity ward, where physicians and medical students provided care to women in labour, than it was on the ward where midwives assisted deliveries. He noted that physicians and medical students were contaminating their hands while performing autopsies and later attending the examination of women without hand washing. Arguably, he was the first to recognise the importance of hand washing in controlling the transmission of infection (Akyol 2007; Meers et al. 1992; Trampuz & Widmer 2004). Equally important was the work of Florence Nightingale during the Crimean war, when she called for basic public health in a military hospital in Scutari in 1854. Her

interventions to improve personal hygiene, cleanliness in the hospital environment, living conditions and food, led to a decrease in the number of deaths. She was one of the first who identified the relationship between nursing and infection control (Meers et al. 1992; Minnaar 2008; Smith & Lokhorst 2009).

Despite the magnitude of HAI problems and the importance of adherence to infection control policies, hand hygiene practice has remained unacceptably low (Takahashi & Turale 2010; Trampuz & Widmer 2004). Hand hygiene compliance rates in different developed countries rarely exceed 50% (Mani et al. 2010; Maxfield & Dull 2011; Ott & French 2009). For instance, figures show that in the USA it is 50%, in Switzerland 42% and in the UK 32% (Takahashi & Turale 2010). Hence, poor compliance has resulted in high morbidity and mortality. In the USA, there are between 1.7 and 2 million people who contract HAI and 88 to 99 thousand deaths are attributed to HAI annually. Furthermore, HAI affects nearly 10% of hospitalised patients and presents major challenges in healthcare facilities. Consequently, annual medical expenses have increased in the USA to approximately \$ 4.5 billion (Maxfield & Dull 2011; Smith & Lokhorst 2009; Trampuz & Widmer 2004).

Momen & Fernie (2010) report that in Canada approximately 8 thousand patients die from HAI annually. Canadian hospitals spend up to \$100 million per year treating patients with HAI. European countries also have a high percentage of HAI: in the UK, for example, each year approximately 9% of people admitted to hospital contract HAI; this is one of the highest percentages in Europe (Nazarko 2009). The estimated number of deaths due to HAI among hospitalised patients in the UK is 500 patients annually (Smith 2009; Takahashi & Turale 2010). The situation is even worse in developing countries, where resources and facilities are limited. According to Oguniola & Adesiji (2008), the results from a survey conducted across 14 developing countries to evaluate the problem size of HAI, showed a wide range of nosocomial infection, from 3 – 13.4% in an individual hospital. However, Devnani et al. (2011), from another study conducted in developing countries, have reported a higher rate of HAI, 6 – 27%. Sadly, more than 1.4 million people worldwide become seriously ill from HAI at any time in their hospitalisation (Devnani et al. 2011; Momen & Fernie 2010).

Hand hygiene practice among HCWs is considered to be the single most clinical and cost effective measure to prevent HAI, a view recognised internationally (Momen & Fernie 2010; Ott & French 2009; Takahashi & Turale 2010). The World Health Organisation (WHO) strongly emphasise the essential need for hand hygiene during healthcare delivery, to avoid possible infection and subsequent complications; hence, the 'Clean Care is Safe Care' programme, launched by WHO in

2005 as part of the 'First Global Patient Safety Challenge'. This programme offers new guidelines on hand hygiene training, observation and performance reporting in healthcare settings.

Aims / Method

This paper aims to identify factors impacting on hand hygiene practice and outlines the strategies to improve it, based on the best available evidence. The literature search covered printed and online sources, including CINAHAL, Medline and ScienceDirect, and was limited to full text, written in English and published in the past ten years. Key words used in the search included: hand wash, hand hygiene, hand cleansing, hand decontamination, hand-rubs, infection control and substitutes to hand washing. The search was divided into the following categories: hand hygiene in healthcare, effective hand hygiene technique, infection control policies, professional and logistic barriers, and strategies to improve practice.

Findings

1. Hand hygiene in healthcare

Nurses' hands come into close contact with patients and are frequently contaminated during routine patient care: e.g. auscultation and palpation or while touching contaminated surfaces, devices or materials such as changing of dressing (Kampf & Loffler 2010; Karabay et al. 2005; Ogunsola & Adesiji 2008). Therefore, hand hygiene is considered an essential, cheap and most effective means of preventing cross infection (Kampf & Loffler 2010; Karabay et al. 2005). This method is designed to save lives and provide a safe treatment atmosphere for all patients and HCWs, regardless of the setting (Nazarko 2009; Ogunsola & Adesiji 2008).

Although Trampuz & Widmer (2004) and Karabay et al. (2005) use different terms for hand hygiene, such as hand antisepsis, disinfection, degerming, decontamination or sanitising, in this paper hand hygiene refers to either hand washing with antimicrobial soap or hand disinfecting with an alcohol-based hand-rub. The aim of hand hygiene is to remove dirt and limit the microbial counts on the skin, to prevent cross transmission of pathogens between patients (Trampuz & Widmer 2004; Werner 2007).

Since nurses are present 24 hours a day, 7 days a week in the healthcare setting, it is essential to comply with hand hygiene policy and maintain patient safety. Furthermore, nurses are obliged by regulatory registration councils, such as in the U.K's Nursing and Midwifery Council (NMC), to safeguard patients and to act as the patient advocate. Nurses are professionally and ethically

accountable for their actions. The NMC's 'Code of Standards and Conduct' requires nurses and midwives to 'provide a high standard of practice and care at all times' (NMC 2008, 2). Yet, despite the momentum for hand hygiene, some nurses are still presenting with low compliance because they perceive it as not their problem, that it is something to do with infection control staff and they have to deal with it (Cambell, 2010; Maxfield & Dull 2011). Furthermore, Nazarko (2009) indicates that nurses often fail to practise hand hygiene because they are busy and they feel hand hygiene takes up precious time. In addition, nurses often perceive that gloves can be used as an alternative to hand hygiene. They usually tend to remove the gloves without washing their hands or use the same gloves to deliver intended care to multiple patients. Even when they remove their gloves, only 20% of nurses actually clean their hands (Ott & French 2009). Moreover, Canham (2011) and Kampf & Loffler (2010) claim that nurses avoid hand hygiene because they are frightened that skin problems such as dermatitis could develop, especially with alcohol hand-rubs.

According to Collins & Hampton (2005), hand hygiene should be considered before invasive procedures, after contact with contaminated devices or materials, and with high risk, infectious patients. Moreover, Kampf & Loffler (2010) claim that hand hygiene should be advocated before beginning work, at the end of work, and after visiting the rest room (toilet). However, Canham (2011) argues that hand hygiene requirements depend on the type of procedure, the degree of contamination and the persistence of antimicrobial action on the skin. Even when nurses spend a longer time on hand hygiene, their technique is often poor compared to other HCWs in terms of leaving large areas unwashed effectively, i.e. wrists, thumbs, nail beds and between fingers.

Collins & Hampton (2005) and Nazarko (2009) claim that physicians generally have excellent hand hygiene skills compared to nurses. Karabay et al. (2005) note that hand hygiene compliance is seen more in junior nurses and newly recruited staff, and Akyol (2007) claims that hand hygiene compliance is higher among nurses compared to physicians and other HCWs. Ott & French (2009) suggest that the attitudes and behaviour towards hand hygiene is a complex issue, involving the perception of its effectiveness, staff's values and beliefs and existing barriers. In order to achieve high compliance rates with hand hygiene, Cambell (2010) suggests that the defaulters should be disciplined as though they have violated hospital policy, starting with personal counselling to verbal warning and eventually to a written warning placed in their file.

Hand hygiene is not only the nurses' responsibility, it is a shared responsibility between hospital administration, key leaders, patients and others stakeholders. Collins & Hampton (2005) report that,

on average, patient involvement actually increases hand hygiene compliance by 50% if, for example, a simple question is asked of the healthcare provider, such as: 'did you wash your hands?'. Duncan & Dealey (2007) observe that the majority of patients feel confident to ask HCWs to wash their hands. However, some patients feel that asking HCWs to wash their hands before healthcare delivery is a betrayal of trust, and some of them feel that they might be labelled as a trouble maker and so prefer not to ask. According to Penzias (2010) the patient usually feels reassured if he/she observes HCWs practise proper hand hygiene in the hospital environment.

2. Effective hand hygiene techniques

Effective hand hygiene involves the removal of visible soiling and the reduction of microbial colonisation of the skin. Healthcare workers' hands can be contaminated by two types of pathogens: transient (contaminating) and resident (normal or colonising) microorganisms (Mani et al. 2010). Resident flora colonise deeper skin layers and, compared to transient flora, is difficult to remove mechanically, i.e. by hand washing. Fortunately, resident flora tends to be less aggressive and is, therefore, less likely to cause serious infection. Negative staphylococci and Corynebacteria are examples of this group. These bacteria tend to grow in hair follicles and remain relatively inactive over time (Akyol 2007; Canham 2011; Werner 2007).

Transient flora, on the other hand, colonise the superficial skin layers for a short time. The hands of HCWs are often contaminated with transient flora by direct contact during daily patient care activities, environments or equipments. However, these micro-organisms are easily removed by mechanical methods, such as friction in hand washing. *Staphylococcus aureus* and *Candida* species are examples of transient flora. These bacteria have the ability to induce HAI among patients and HCWs (Akyol 2007; Canham 2011; Werner 2007).

Taking into consideration the above information regarding transient and resident bacteria, effective hand hygiene, either by hand washing with antimicrobial soap or alcohol based hand-rub, is evidently the way to minimise the cross infection risk. Effective hand washing is the application of a plain (non-antimicrobial) or antiseptic (antimicrobial) soap onto wet hands; then vigorous rubbing together of both hands to form a lather, covering all the surface of the palms, tops of the hands, base of the fingers, between the fingers, back of the fingers, fingers tips, fingernails, thumb and wrists for one minute (Akyol 2007; Canham 2011; Trampuz & Widmer 2004). Equally important is that fingernails should be short. Artificial fingernails or extenders are potential traps for bacteria and should be avoided. New nail polish on natural nails does not aggravate microbial load; however,

chipped nail polish can harbour bacteria (Canham 2011). Wearing jewellery, such as rings or hand watches, could lead to the bacterial colonisation on the skin underneath them. After soaping and rubbing, hands should be rinsed thoroughly to remove all the lather. Rinsing with hot water should be avoided, because it could cause skin dryness (Kampf & Loffler 2010; Mani et al. 2010; Smith 2009). Smith (2009) reports that hand position (hands up, hands down, hands lateral) during hand washing procedure and water flow showed no difference in microbial counts.

Hand drying is equally important to prevent cross infection, because microorganisms thrive in a damp environment. Moreover, proper hand drying is required before wearing gloves, as trapped moisture under gloves can cause skin irritation and increase the harbouring of bacteria. Paper towels are effective for drying hands plus the friction created by their use enhances organism removal from the skin. Taps should not be touched again by freshly washed hands; a paper towel can be used instead to turn the water off. Although a hand dryer is as good as hand towels, paper disposable hand towels are quicker and more effective (Canham 2011; Collins & Hampton 2005). The friction generated by vigorous hand rubbing with soap and hand drying with paper towels removes dirt and loosely adherent flora, i.e. most transient flora and a small portion of resident flora from hands (Trampuz & Widmer 2004).

Alcohol based hand-rub is recommended for hand decontamination in all clinical settings apart from visibly soiled hands (Canham 2011). Alcohol hand-rub uses alcohol instead of water. In contrast to the mechanical (friction) removal of flora in hand washing, alcohol works by killing the flora. Alcohol hand-rub differs from hand washing because it acts on the microorganisms by denaturing their proteins and thus has the ability to eradicate all transient flora and most resident flora (Trampuz & Widmer 2004). It also takes less time than hand washing, between 15 to 30 seconds. The process of alcohol hand-rub starts by applying a sufficient amount of the alcohol based hand-rub product (liquid, gel or foam) according to the manufacturer's recommendation (usually between 3 to 5 ml), and spreading it all over the hands, especially the areas between fingers, thumbs and fingernails. The effective concentration of alcohol should be 60% to 95%; concentrations of greater than 95% are not recommended because they have less water which is essential for the protein denaturation of microorganisms, thus making them less potent (Canham 2011; Kampf & Loffler 2010; Smith 2009).

HCWs should adopt either procedure for hand hygiene, either alcohol hand-rub or hand washing with antimicrobial or non-antimicrobial soap, but use the latter if hands are visibly soiled. Using both procedures simultaneously is not recommended, as it doubles both cost and time. Trampuz &

Widmer (2004) argue that using alcohol hand-rub immediately before or after hand washing could cause dermatitis and further recommend wearing powder-less gloves to avoid possible alcohol reaction with residual powder. However, Kampf & Loffler (2010) maintain that using alcohol hand-rub after hand washing could reduce irritation caused by hand washing detergents, since this method also removes detergent from the skin.

Clearly, skin irritation and dermatitis are a professional hazard. Unfortunately, damaged skin can harbour bacteria and may contribute to cross infection (Canham 2011; Collins & Hampton 2005; Kampf & Loffler 2010). Trampuz & Widmer (2004) further claim that hand washing removes lipids from the skin, while alcohol hand-rub only redistributes them. However, both procedures can induce skin dryness. Additionally, Collins & Hampton (2005) and Werner (2007) argue that frequent hand washing, hot water, harsh soap and rough hand paper towels are precipitating factors in skin dryness and subsequent skin infection. Therefore, skin protection products, such as hand lotions or creams, should be considered and used regularly in order to reduce dryness and promote regeneration of the skin cells (Kampf & Loffler 2010).

3. Hand hygiene and infection control policies

Hand hygiene needs a multiple interventions approach in order to make it a sustainable practice within healthcare. Cambell (2010) argues that hand hygiene is not only the responsibility of the Infection Control Department and recommends a multidisciplinary approach: hospital administration, other key leaders and nursing leaders are the key to success for hand hygiene compliance within a hospital. Moreover, Maxfield & Dull (2011) suggest that HCWs' culture and hospital atmosphere should consider the Infection Control Department as a resource and partner rather than an enforcer. Thus, infection control staff can play a vital role in hand hygiene compliance by encouraging patients' monitoring of hand hygiene by observation. Ott & French (2009) claim that hand hygiene adherence goes beyond education and training, as it involves continuous motivation towards change and how that change can be sustained.

4. Professional and organisational barriers

Many factors lie behind poor hand hygiene adherence among HCWs. Among nurses a lack of awareness and scientific knowledge regarding hand hygiene is considered significant (Akyol 2007; Mani et al. 2010; Trampuz & Widmer 2004). Karabay et al. (2005) claim that lack of proper infection control during training programmes, in which students observe their peers with patients, could lead to bad hand hygiene practice. Interestingly, Ott & French (2009) found that nurses' attitudes and

cultures at work have a great influence in students' clinical development and, in order to be accepted within that culture, they tend to follow their mentors and other HCWs. For instance, to be perceived as an efficient member of the team, students tend to perform hand hygiene inadequately, because they want to appear as busy as their mentors and think they do not have adequate time for hand hygiene.

According to Ott & French (2009), nursing students usually receive training on standard infection control precautions during the first seven weeks. However, the training benefits decline from the first to the third year of study. Therefore, it is essential to emphasise infection control knowledge in every year of study. Nazarko (2009) found that pre-registration nursing students do not receive a broad education programme in infection control. Takahashi & Turale (2010) report that education and seminars are fundamental in promoting hand hygiene and help staff to comply with the institutional protocols of infection control. Although 90% of the NHS trusts provide induction training in infection control for their staff, many trusts fail to provide annual updates (Nazarko, 2009).

Misconceptions regarding hand hygiene are also believed to contribute to low compliance; for instance, when gloves are used as an alternative to hand hygiene, or the notion that skin irritation arises from frequent hand hygiene practice (Karabay et al. 2005; Mani et al. 2010; Trampuz & Widmer 2004). In addition, increased workloads, under-staffing, limited time, lack of role models among colleagues or seniors, lack of organisational pledge to good hand hygiene practice, disagreement with guidelines and protocols and lack of motivation have all contributed to poor compliance with hand hygiene and infection control measures (Akyol 2007; Mani et al. 2010; Karabay et al. 2005).

Lack of hand hygiene products and facilities, such as running water, sinks, antiseptic or non-antiseptic soaps, alcohol hand-rubs and hand paper towels, can also play a major role in poor hand hygiene practice (Akyol 2007; Kampf & Loffler 2010; Mani et al. 2010). Unavailability of facilities is even worse in developing countries. Ogunsola & Adesiji (2008) report that most wards in Nigerian hospitals lack adequate facilities for effective hand hygiene and use the bucket and bowl method as an alternative to running water. Likewise in India, Devnani et al. (2011) report that insufficient or inconveniently positioned sinks, inadequate access to soap and water, unavailability of hand paper towels or electrical dryers are obstacles which hinder appropriate hand hygiene practice.

5. Strategies to improve compliance of hand hygiene

To improve HCWs compliance with hand hygiene, it is then necessary to consider the hindering factors mentioned above and attempt to turn them to enhancer factors. For example, staff education and proper follow up training in hand hygiene practice is important to identify situations where hand hygiene is reasonable; the infection control team can be involved in attaining this. Equally important is to clarify nurses' misconceptions in terms of glove usage and skin problems in order to achieve a better adherence to hand hygiene practice. The unit or ward manager is responsible for ensuring that hand hygiene products are always available and are in accessible places: inside and outside of every patient room, nursing station, offices etc. (Kampf & Loffler 2010).

Smith & Lokhorst (2009) suggest that promotional material, such as posters, can be placed in noticeable areas of the hospital to remind HCWs, patients, and visitors about the importance of hand hygiene practice. Additionally, videos can be used on the wards to show patients the significance of hand hygiene in preventing cross infection and to ask or remind HCWs to practise hand hygiene before healthcare delivery. Placing proper hand hygiene technique illustrations above sinks or near to alcohol hand-rub dispensers can be helpful as well. Maxfield & Dull (2011) point out that every nurse should be held responsible for reminding co-workers to practise hand hygiene, thereby raising the sense of accountability between the working team. Moreover, nurses with good hand hygiene could gain recognition by, for example, announcement in the hospital newsletter, an accolade which may encourage others to do likewise. Messages about hand hygiene practice could also be set on computer screen savers to motivate computer users.

In terms of improved practice, there is also much evidence for recommending alcohol hand-rub, because of its clinical benefits and cost effectiveness. Collins & Hampton (2005) explain that the potential for hand washing to wash away skin's oils and fats essential for healthy skin is less likely to occur with alcohol hand-rub usage. In other words, alcohol hand-rub redistributes the lipids in the skin layers. Moreover, alcohol hand-rub dispenses with paper towels. Canham (2011) finds that alcohol hand-rub contains various emollients which are better tolerated by HCWs than hand washing. According to Trampuz & Widmer (2004), factors such as colour, odour and consistency of alcohol hand-rub products could influence HCWs acceptance of the product. Additionally, alcohol hand-rub dispensers can be readily positioned and easily accessed: at the patients' bed side, waiting areas, inside and outside of patients' rooms, in the nursing stations and next to computers (Penzias 2010; Trampuz & Widmer 2004).

Mani et al. (2010) claim that alcohol hand-rub is suitable for use in countries where resources are limited. In addition, alcohol hand-rub increases the potential of economic benefits by reducing annual costs, especially in countries where water has to be refined. There are also hidden costs: water decontamination, power for water heating and water drainage (Al-naami et al 2009).

Effective use of alcohol hand-rub means that HCWs must strictly adhere to the manufactures instructions, especially in terms of the amount used and the time needed to evaporate completely from the hands. Alcohol impregnated wipes are not as effective as alcohol hand-rub and not recommended for routine hand hygiene (Nazarko 2009; Trampuz & Widmer 2004; Werner 2007). According to Trampuz & Widmer (2004), alcohol hand-rub products have the tendency to ignite, depending on the type and concentration, although fires associated with such products are very rare. Nonetheless, alcohol hand-rub products should be stored away from high temperatures and containers should be designed to minimise evaporation.

Conclusion

Since the twentieth century hospital acquired infections have been recognised as one of the major challenges in the healthcare system. This is a worldwide problem, but there is a higher incidence in developing countries due to limited facilities and resources. Hospital acquired infections are closely linked to hand hygiene practice and serious attempts have been initiated by WHO to investigate and highlight the problem.

Nurses are professionally and ethically accountable for the care and safety of their patients and should adopt effective and frequent hand hygiene. This is a fundamental aspect of healthcare delivery, necessary to reduce the risk and spread of infection.

Scientific evidence recommends the use of alcohol hand-rub as an effective hand hygiene practice during patients' care compared to hand washing. Nonetheless, visibly soiled hands still need hand washing. However, this research survey indicates that nurses tend not to practise hand hygiene adequately and when they do it is often inappropriate. Overall this is attributed to misconceptions, to misplaced priorities in time keeping and to inadequate education regarding hand hygiene practice.

Improved hand hygiene practice needs a multifaceted approach involving both individual and facility factors. This should include improved training programmes and ongoing staff development. Most

importantly, patients should be empowered to monitor those employed in their care. Poor or insufficient access to hand hygiene facilities, e.g. running water, sink availability, antiseptic soaps or alcohol hand-rubs products, hand paper towels, also need to be addressed, together with work related factors such as understaffing and time management.

Infection control staff and hospital administration should play a more active role to improve and motivate HCWs to practise proper hand hygiene through greater knowledge dissemination such as in-service education and training, posters, leaflets, workshops, lectures, hospital guidelines, role models, availability of hand hygiene products and staff accountability. The WHO repeatedly point out that 'Patient Safety SAVES LIVES – Clean Your Hands'. This is the only solution to minimise HAI among patients, however, a multifaceted approach is needed to achieve it.

Appendix

Illustration of 'How to handwash', issued by the World Health Organization 2009:

http://www.who.int/gpsc/5may/How_To_HandWash_Poster.pdf

Illustration of 'How to handrub', issued by the World Health Organization 2009:

http://www.who.int/gpsc/tools/HAND_RUBBING.pdf

Illustration of the areas of hands frequently missed in hand washing, Burton Training Solutions:

<http://www.burtontrainingsolutions.com/page12.htm>

Acknowledgment

The author would like to thank Carolyn Gibbon (Principal Lecturer, School of Health, University of Central Lancashire), for her guidance, encouragement and useful suggestions on this manuscript.

References

Akyol, A.D. 2007. 'Hand hygiene among nurses in Turkey: opinions and practices', *Journal of Clinical Nursing* 16, 431-437.

Al-naami, M.Y., Anjum, M.N., Afzal, M.F., Al-yami, M.S., Al-qahtani, S.M., Al-dohavan, A.D., El-tinay, O.F., Karim, A.A., Khairy, G.A., Al-saif, A.A., Zubaidi, A.M., Al-obaid, O.A. & Al-saif, F.A. 2009. 'Alcohol-based hand-rub versus traditional surgical scrub and the risk of surgical site infection: a randomised controlled equivalent trial', *EWMA Journal* 9:3, 5-10.

Cambell, R. 2010. 'Hand-washing compliance goes from 33% to 95% steering team of key players drives process', *Healthcare Benchmarks and Quality Improvement* 17:1, 5-6.

Canham, L. 2011. 'The first step in infection control is hand hygiene', *The Dental Assistant*, 42-46.

Collins, F. & Hampton, S. 2005. 'Hand-washing and methicillin-resistant staphylococcus aureus', *British Journal of Nursing* 14:13, 703-707.

Devnani, M., Kumar, R., Sharma, R.K. & Gupta, A.K. 2011. 'A survey of hand-washing facilities in the outpatient department of a tertiary care teaching hospital in India', *Journal of Infection in Developing Countries* 5:2, 114-118.

Duncan, C.P. & Dealey, C. 2007. 'Patients' feelings about hand washing, MRSA status and patient information', *British Journal of Nursing* 16:1, 34-38.

Kampf, G. & Loffler, H. 2010. 'Hand disinfection in hospitals-benefits and risks', *Journal of the German Society of Dermatology* 8:12, 978-983.

Karabay, O., Sencan, I., Sahin, I., Alpteker, H., Ozcan, A. & Oksuz, S. 2005. 'Compliance and efficacy of hand-rubbing during in-hospital practice. Medical Principles and Practice', *International Journal of the Kuwait University* 14:5, 313-317.

Mani, A., Shubangi, A.M. & Saini, R. 2010. 'Hand hygiene among healthcare workers', *Indian Journal of Dental Research* 21:1, 115-118.

Maxfield, D. & Dull, D. 2011. 'Influencing hand hygiene at spectrum health', *Physician Executive Journal* 37:3, 30-34.

Meers, P., Jacobsen, W. & McPherson, M. 1992. *Hospital infection control for nurses*. London: Chapman & Hall.

Minnaar, A. 2008. *Infection control made easy, a hospital guide for health professionals*. Kenwyn SA: Juta.

Momen, K. & Fernie, G.R. 2010. 'Nursing activity recognition using an inexpensive game controller: an application to infection control', *Journal of European Society for Engineering and Medicine* 18:6, 393-408.

Nazarko, L. 2009. 'Potential pitfalls in adherence to hand washing in the community', *British Journal of Community Nursing* 14:2, 64-68.

Nursing and Midwifery Council (NMC). 2008. 'The code: standards of conduct, performance and ethics for nurses and midwives'. Available at: <http://www.nmc-uk.org/General-public/What-people-should-expect-from-a-nurse-or-midwife/The-standards-we-expect-nurses-and-midwives-to-follow/The-code/>

Ogunsola, F.T. & Adesiji, Y.O., 2008. 'Comparison of four methods of hand washing in situations of inadequate water supply'. *West African Journal of Medicine* 27 (1), 24-28.

Ott, M. & French, R. 2009. 'Hand hygiene compliance among healthcare staff and student nurses in a mental health setting', *Mental Health Nursing* 30, 702-704.

Penzias, A., 2010. 'Don't get complacent with hand hygiene'. *ED Nursing* 13 (5), 54-55.

Smith, J.M. & Lokhorst, D.B. 2009. 'Infection control: can nurses improve hand hygiene practice?', *Journal of Undergraduate Nursing Scholarship* 11:1, 1-6.

Smith, S.M. 2009. 'A review of hand-washing techniques in primary care and community setting', *Journal of Clinical Nursing* 18:6, 786-790.

Takahashi, I. & Turale, S. 2010. 'Evaluation of individual and facility factors that promote hand washing in aged-care facilities in Japan', *Nursing and Health Sciences* 12:1, 127-134.

Trampuz, A. & Widmer, A.F., 2004. 'Hand hygiene: a frequently missed lifesaving opportunity during patient care'. *Mayo Clinic Proceedings* 79 (1), 109-116.

Werner, R. 2007. 'Hand washing and what happens if you don't', *Massage and Bodywork* 22:2, 114-118.

World Health Organization. 2013. '*The first global patient safety challenge: clean care is safer care*'. Available at: <http://www.who.int/gpsc/en/>