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Review Article

The World Health Organization's Clean Hands Save Lives: A concept applicable to equine medicine as Clean Hands Save Horses

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Summary

Even before the discovery of germs, the practice of hand hygiene had revealed itself as a crucial element in the fight against infectious diseases. In fact, supported by the historical discoveries and more recent evidence based data, the World Health Organization considers hand hygiene as the pillar of infection control, particularly when related to nosocomial infections. Therefore, the World Health Organization has a strong focus on "Clean Hands Save Lives" campaigns, a principle that is easily translatable into "Clean Hands Save Horses". Considering the recognised importance given to skin health and integrity as the first principle of good hand hygiene, using decontamination methods and products that are the least harmful to the skin is mandatory. This is why the currently accepted presurgical hand preparation methods do not involve aggressive brushing and disinfecting soaps anymore. Rather, hands should be washed with a neutral pH friendly soap first before a hydroalcoholic solution is applied. Although the principles and benefits of proper hand hygiene have been recognised in the healthcare world, one of the major drawbacks remains the lack of compliance with established protocols. To increase compliance, equine clinics should work on improving product accessibility, enhancing staff and client education as well as helping each other to remember to actually do it. This article reviews historical and current facts on hand hygiene and relates it to equine practice. Clean equine care is safer equine care: it's all in your hands!

Evidence-based history: cleaning hands saves lives

The focus on the medical importance of hand hygiene was largely initiated in the 19th century through the pioneering and independent work of Alexander Gordon, Oliver Wendell and Ignas Semmelweis. A dramatic decrease in puerperal fever followed their discoveries and implementation of their controversial theories on hand sanitation routines (Rotter 1998).

Shortly after, Joseph Lister introduced the antiseptic principles into the practice of surgery (1867) (Jessney 2012). However, it was only when combining these findings with Louis Pasteur's (1864) 'germ theory of disease' (Toledo-Pereyra 2009) that the development of aseptic technique became reality (see **Textbox 1**). It categorically became clear that instead of fighting infections the focus should be turned to prevention. In retrospect, these findings and the development of hand hygiene and aseptic technique have been shown to have had the greatest positive effect on patient survival with regards to nosocomial diseases over any other medical advancement so far.

Despite this, healthcare associated infections (HAIs) remains a devastating problem in both human and veterinary medicine. In human hospitals in developed countries, where hygiene would be considered to be at its best, HAIs are estimated to affect 5–15% of hospitalised patients and 9–37% of patients admitted to intensive care units (Vincent 2003; WHO 2009). Overall HAI figures on this are not available for equine practice, although they are unlikely to be different. Focusing only on surgical site infections (SSIs), a review of 6797 surgeries revealed a mean infection risk independent of type of surgery of 7.3% in horses, varying from 0% in clean procedures to up to >60% in procedures categorised as dirty (Zetterman 2015).

Healthcare associated infections and in particular SSIs cause problems with higher morbidity and mortality rates of patients leading to additional treatment and use of antibiotics, prolonged hospitalisation and decreased patient welfare. They eventually cause substantial economic costs for the community/patient, and in veterinary care for the patient owner and insurance companies (Morley 2004; WHO 2009). During recent decades, resistance towards antimicrobials has increased, leading to reduced infectious disease control possibilities and an additional increase in patient morbidity and mortality (Frimodt-Møller *et al.* 2006). The fact that resistance towards antimicrobials is increasing, only strengthens the proverb 'Prevention is better than cure' stated by Erasmus in the 1500s.

As HAIs have revealed to often be transferred from the hands of healthcare personnel to the patients, hand hygiene

Textbox 1: What's in a word?

Antisepsis = combating sepsis.

Asepsis = preventing sepsis.

Surgical site infections used to be the culprit of surgical failure in the early days of surgical interventions. Sepsis was in fact so common it was initially thought to be a natural part of wound healing until Lister introduced methods to combat sepsis (ANTI-sepsis methods) and to improve outcomes. However, it was only with the germ theory of disease that one understood that sepsis could more easily be prevented than cured by avoiding germ introduction. Hence, the term A-sepsis or working germ-free from the start.

Some key facts on hand hygiene

Proper hand hygiene is a key pillar in infection control, particularly in the avoidance of hospital-acquired infections.

Research in hand hygiene is a very active field and, based on the scientific knowledge, the evidence-based hand hygiene methods in 2016 have changed compared to the well-known scrubbing methods with soaps.

Current recommendations are to decontaminate hands by washing with neutral pH nondisinfecting soaps for a maximum of 1 min and to thoroughly but gently dry the skin before application of a hydro-alcoholic solution for at least 1.5 min.

Although every reasonable person understands the necessity of proper hand hygiene, compliance remains largely unsatisfactory.

Increasing compliance in the hospital can be achieved by better product accessibility, education and role models.

Key to proper hand hygiene is proper skin health. Skin care creams are crucial in the establishment of an effective hand hygiene protocol.

is the simplest, wisest and most effective way to reduce HAIs (Jumaa 2005; Pittet *et al.* 2006). Both in public and especially in medical settings, hand hygiene is an essential pillar in the prevention of infectious diseases.

This fact is clearly supported by the many studies that find a temporal association between implementation of hand hygiene policies and the concurrent reductions in HAIs (Larson 1988; Allegranzi and Pittet 2009; Chen *et al.* 2011; Stone *et al.* 2012; Sickbert-Bennett *et al.* 2016). For instance the British *Clean Your Hands* campaign held between 2004 and 2008 revealed halving of the number of methicillin-resistant *Staphylococcus aureus* (MRSA) bacteraemias and *Clostridium difficile* infections together with a tripling use of alcohol rub substances (Stone *et al.* 2012). In veterinary medicine, no such temporal associations have been studied. However, MRSA is part of the infection control challenges faced by equine healthcare practitioners (Weese *et al.* 2006; Wieler *et al.* 2011) and hand hygiene was shown to be a protective factor against MRSA colonisation of equine veterinarians (Anderson *et al.* 2008). Therefore, investments made in improving hand hygiene policies in equine healthcare practice can be expected to provide positive returns.

The hand's skin and its microbiota: partners and enemy

There seems to be a *contradictio in terminis* in hand disinfection. Pathogenic microbiota is easily transmitted through hand carriage and needs to be eliminated by hand hygiene protocols. By contrast, when optimising hand hygiene, it is crucial to keep in mind that our resident skin microbiota needs to be protected as it helps in creating a barrier to keep pathogenic microbiota out. Obtaining a good balance between pathogenic and nonpathogenic bacteria situated on the hands, as well as maintaining the natural skin barrier and environment of our hands intact is the first goal. Proper hand hygiene starts therefore with respecting the natural environment of the skin barrier.

The bacterial colonisation of our skin is divided into resident and transient microbiota. Resident skin microbiota is mainly found under the superficial cells of the *stratum corneum* (Montes and Wilborn 1969) and is not usually regarded as pathogenic on intact skin (Kampf and Kramer 2004). Resident microbiota has a protective function by inducing 'colonisation resistance' by microbial antagonism and competing for nutrients in the ecosystem (Allaker *et al.* 1989; Cogen *et al.* 2008). Transient microbiota is acquired by contact with other people, animal, or contaminated environmental surfaces; these microbes only colonise the superficial layers of intact skin and are the most common cause for inducing HAIs. Of interest is that hands of surgical staff show higher bacterial counts and more pathogenic organisms than are found on hands of other medical staff (Coelho *et al.* 1984). One reason for this is that the surgical staff have increased contact with infected wounds, but far more important are the deleterious effects on skin integrity and skin resident microbiota caused by regular disinfectant contact (Kampf and Kramer 2004; Kampf and Ennen 2006). Each hand wash detrimentally alters the water lipid layer of the superficial skin creating a loss of protective agents such as amino acids and natural antimicrobial factors (Kampf and Kramer 2004). Prolonged or repeated washing leads to damaged barrier function of the *stratum corneum* resulting in the skin becoming more permeable for toxic agents and bacteria (Hassing *et al.* 1982; Larson *et al.* 1986a,b). Moreover, scrubbing causes small excoriations and thus damages the skin, also increasing the risk of colonisation of the skin by pathogenic bacterial species (Larson *et al.* 1998). Personnel from the veterinary healthcare sector have been found to have significantly lower skin intactness and moisture score, as well as significantly higher bacteria loads and counts of potential pathogenic bacteria compared to personnel in the human healthcare sector (Thorup 2014). These findings may be explained by the differences in work environment and routines, and naturally occurring bacteria in patient species. Many vets work in dry, cold and wet conditions and thereby quickly develop skin irritation and damage. Further, personnel in the veterinary healthcare sector tend to perform significantly more hand washes and significantly fewer hand rubs per case than their counterparts in the human healthcare sector (Thorup 2014), thereby compromising skin integrity concurrently leading to higher pathogenic colonisation potential. MRSA, which is currently a global focus, can act as a commensal and a potential pathogen in both man and several animal species. Nasal MRSA carriage is commonly recognised and attempts at MRSA eradication have been made through nasal decontamination protocols. However, less attention has been paid to MRSA skin carriers despite the established link between healthcare workers with skin disease and MRSA carriage and transmission (Albrich and Harbarth 2008). Repeated hand washing has been shown to be a common cause for development of occupational irritant contact dermatitis (Malik and English 2015). Healthcare staff with chronic skin conditions in either the animal or human sector could therefore act as reservoir and vectors for MRSA in their patients.

Presurgical hand asepsis standards in 2016

Halsted's first principle of surgery is aseptic technique. Ironically, the birth of the surgical glove lies within the introduction of hand asepsis techniques in Halsted's surgical ward. Halsted's scrub nurse developed severe dermatitis due to the solutions used at the time. The Goodyear Rubber company was asked to develop a rubber glove for her to use as a substitute to hand asepsis procedures (Lathan 2010).

Currently the wearing of surgical gloves by members of the operating team is standard procedure to prevent bacterial transfer from hands to the operating wound. Considering that unnoticed glove punctures are reported to occur in up to 60% of used gloves (Burrow and Pinchbeck 2006) and glove puncture doubles the risk of infection (Misteli *et al.* 2009), surgical glove wearing can never be a substitute for proper presurgical hand preparation (Eklund *et al.* 2002).

The purpose of correct presurgical hand preparation is to remove and/or kill transient skin organisms and to reduce resident bacterial microbiota for the duration of a surgical procedure. This should be achieved while minimising damage to the skin that might promote rebound bacterial overgrowth or compromise future hand antisepsis attempts. Techniques involving aggressive cleaning of the skin with alkaline medicated soaps, such as for example chlorhexidine (CHX) scrubs, have shown to have deleterious effects on the local defence mechanisms of the skin (Rotter 2004). Techniques involving brushes and scrubbing cause small excoriations, consequently damage the skin, and increase the risk of skin colonisation by pathogenic bacteria species without providing any additional effect on instant bacterial reduction (Larson *et al.* 1998; Okgün Alcan and Demir Korkmaz 2012). If hands are visibly soiled and surgical scrub is to be carried out, current recommendations are to use a soft sponge for forearms and hands, and a soft brush for the fingertips, if any aids are to be used (WHO 2009).

Different products are available for aseptic preparation of the hands. They are divided into aqueous soaps containing an active ingredient and alcohol-based solutions. Aqueous solutions containing either povidone–iodine (PVP) or CHX have been standard for many decades, but alcohol-based hand rubs (AHR) have been described for surgical hand-preparation for more than a century (Kampf and Kramer 2004). Randomised controlled trials showing any significant differences in SSI rates between any of the above mentioned methods are not available, although the use of AHR is considered superior for a number of other reasons (Widmer 2013). The antibacterial efficacy of products containing high concentrations of alcohol significantly surpasses that of any medicated soap currently available (Kampf and Ostermeyer 2004). The initial reduction of the resident skin microbiota is so rapid and effective with AHR that bacterial regrowth to baseline values on the gloved hand takes more than 6 h (Rotter *et al.* 2007). These observations were also confirmed in a veterinary trial that compared the activity of a AHR solution to CHX and PVP soap (Verwilghen *et al.* 2011a).

In that study, a 1.5 min application of an AHR solution was performed, and the 3 h residual effect on CFU reduction of AHR revealed to be significantly better than for traditional hand scrubbing with PVP and CHX. A recent publication performed in veterinary students challenged this finding and suggested CHX containing products to be superior to alcohol products (Chou *et al.* 2016). However, in this trial, the efficacy of CHX was probably overestimated due to the absence of neutralisation agents in the testing media (Kampf *et al.* 2005a,b; Reichel *et al.* 2008; Kampf 2009). Testing guidelines as the European norm guidelines (2005) and the US Food and Drug Administration tentative final monograph norm (FDA 2015) clearly state that all efficacy studies should include neutralisation of the active ingredients in the testing method in order not to overestimate the activity of the tested substance. The conclusions made in the above mentioned study by Chou *et al.* (2016) are therefore unreliable based on currently accepted testing methods. Further single time point efficacy is not the only factor to consider. Veterinarians reporting to use medicated soaps containing CHX self-report skin health scores (mostly on dryness) that are lower than people using AHR solutions (Verwilghen *et al.* 2014), which is in line with the observations that long-term use of medicated soaps significantly increases the risk of dermatitis (Verwilghen *et al.* 2011b).

Many AHR solutions are available over the counter, although it should be noted that not all of them are fit for purpose i.e. suitable to use for presurgical hand preparation. When choosing an AHR solution, the product should meet the EN12791 (see **Textbox 2**) or equivalent standard required for presurgical hand-rub formulations (Rotter 2004). Many available hygienic gels for instance will not meet the surgical standards and are therefore not suitable for presurgical hand asepsis.

Some veterinarians wrongfully still believe that they should combine the benefits of action of aqueous medicated solutions and AHR by using both in their protocol (Verwilghen

Textbox 2: What are the European Standardisation norms?

CEN (2005), the European Committee for Standardisation, is an association that brings together the National Standardisation Bodies of 33 European countries. This association is responsible for developing and defining voluntary technical documents known as standards that can be used as a rule, guideline or definition. The American Food and Drug Administration produces similar technical documents.

In relation to hand hygiene, two standards exist.

EN 12791 Chemical disinfectants and antiseptics related to surgical hand disinfection – This document specifies a test method simulating practical conditions for establishing whether a product for surgical hand disinfection reduces the release of hand microbiota according to the set requirements for presurgical hand asepsis.

EN 1500 Chemical disinfectants and antiseptics related to hygienic hand rub – This document specifies a test method simulating practical conditions for establishing whether a product for hygienic hand rub is suitable for use in areas and situations where disinfection is medically indicated.

Information retrieved from www.en-standard.eu and www.cen.eu

et al. 2011b, 2014). However, medicated soaps have a similar or lower efficacy than hand rubs alone (Cimiotti *et al.* 2004; Loffler and Kampf 2008; Verwilghen *et al.* 2011a). Combining both does not provide any additional benefit, on the contrary considering the increases in the risk of dermatitis, it eventually contributes to make the skin more difficult to decontaminate (Verwilghen *et al.* 2011b).

Additionally, hand washing prior to the use of AHR application has shown to alter negatively the effectiveness of AHR solutions, particularly if hands are not completely dried before AHR application (Hübner *et al.* 2006a).

Prewashing of hands should therefore be minimised as much as possible and it has been suggested there is no reason to include a hand wash before AHR solutions are applied unless hands are visibly soiled (Hübner *et al.* 2006a,b).

Nevertheless, as mentioned above, bacterial loads and numbers of potential pathogenic bacterial species are different between the personnel in the human and veterinary healthcare sector (Thorup 2014). Until further objective data are available, a short hand-wash with a gentle, pH neutral and nonmedicated soap and thorough drying of the hands before the AHR application remains advisable for a presurgical hand hygiene protocol in veterinary settings. In this way, bacterial spores mostly carried in organic material on hands can be eliminated.

Independently of the efficacy or skin tolerance factors, there is an additional concern with the use of medicated soaps. Acquired resistance is emerging not only against antibiotics but also against other antimicrobials such as antiseptics, particularly CHX (Lepainteur *et al.* 2013; Wong *et al.* 2013). Therefore, the use of medicated soaps should be restricted to only those situations where they cannot be replaced by a good alternative.

In summary, based on current evidence the recommended protocol for presurgical hand asepsis (Widmer *et al.* 2010; Widmer 2013) should preferably be performed using an alcohol-based product. Following the steps mentioned in poster 1 (**Supplementary Item 1**), attempts should be made to keep hands clean, without nail polish or jewellery, with short and clean nails and exempt of wounds. Hands are gently washed with a neutral pH skin friendly and nonmedicated soap, then thoroughly dried with a nonsterile towel before application of the alcohol product. The alcohol should be rubbed for an appropriate time (see manufacturer's recommendations of product used) focusing on the areas often missed, and is then allowed to dry completely before donning gloves and/or gown.

Outside the surgical theatre

Although a great proportion of HAIs are SSI, many have another origin. Bad hand hygiene policies outside the operating environment are well known to be a cause of, for example, catheter site infections, respiratory and urinary infections (Carter *et al.* 2016; Septimus and Moody 2016). In fact, even a proportion of SSI can be linked to bad hygiene precautions during bandage change and wound inspections. Hand hygiene outside the surgery theatre therefore has the same aims and importance as in the surgery theatre. Here transient skin organisms have to be removed and/or killed, with the focus of not spreading infection between patients as well as keeping the medical care members themselves protected from infections and reducing the spread of contaminants within the medical facility. The issue of skin integrity remains the same as with preoperative preparation. However, due to the relatively high number of hand hygiene procedures that healthcare staff are subjected to perform on a daily basis, hand washing can more quickly result in dermatitis and subsequent increased skin colonisation by pathogenic bacterial species (Larson *et al.* 1998; Okgün Alcan and Demir Korkmaz 2012). Emphasis on maintaining the intactness and moisture of the skin is therefore crucial for the efficacy aspect, but probably even more for compliance to hand hygiene acts. Damaged skin will normally result in a highly unpleasant burning sensation when hydroalcoholic solutions are used. Unfortunately, this often results in blaming the AHR, where it is in fact the repeated washing that is at the origin of the skin irritation. The end result is avoidance of hand hygiene acts. Current guides for hand hygiene for healthcare personnel is based on provision of good hand care instructions and to avoid excessive washing but choosing AHR instead whenever possible. When hands are visibly soiled with body fluids or other organic material they should be washed with a gentle pH neutral nonmedicated soap. When not visibly soiled, alcohol hand rub should be used, as the rub will decontaminate the hands while still maintaining skin intactness and moisture (WHO 2009; Thorup 2014). Introduction of hand lotion at the workplace of healthcare staff to be used during and at the end of the workday has shown to be beneficial to maintain skin intactness and moisture (Ramsing and Agner 1997; Berndt *et al.* 2000; McCormick *et al.* 2000) and will eventually also increase compliance.

In equine veterinary situations, water and soap may not always be readily available, particularly in outside practice. Hand-washing when visibly soiled can therefore be challenging. Traub-Dargatz *et al.* (2006) investigated the efficacy of an AHR and an alcohol–CHX mix after general examinations in horses and found both to reduce bacterial hand load more significantly than a hand wash alone. The degree of soiling on the hands was, however, not defined in this trial. More recently, the efficacy of a 30 and 60 s hand rub with either an alcoholic or nonalcoholic rubbing solution was tested against a 1 min hand wash with neutral soap alone and together with a 30 s alcoholic rub in soiled conditions in relation to a standardised general examination in horses (Verwilghen *et al.* 2016). In this study the degree of visible hand soiling was calculated to be up to 20% of hand surface. None of the protocols revealed to have the same efficacy as the combination of hand wash and 30 s of alcohol. Although a 30 and 60 s application of the alcohol solution only and 60 s of the nonalcoholic solution demonstrated a significantly greater efficacy than a hand wash with soap alone. These data therefore provide evidence that in the absence of water, a 30–60 s AHR is an alternative to water and soap for good hand hygiene following a general clinical examination where hands have become visibly soiled.

Outside the surgical theatre, the WHO guidelines on hand hygiene in human healthcare recommends the five moments for hand hygiene when caring for patients (**Supplementary Item 2**). An act of hand hygiene should be performed: (1) before touching the patient; (2) before a clean/aseptic procedure; (3) after body fluid exposure risk; (4) after touching the patient; and (5) after touching patient surroundings (WHO 2009). Few healthcare staff members manage to follow these guidelines in practice; even in the

human healthcare sector. Realising that human healthcare staff report significantly higher numbers of daily hand hygiene acts than their counterparts in the veterinary sector (Thorup 2014), the compliance with the above is likely to be even lower in the veterinary sector.

As mentioned in the presurgical preparation section, not all available products are suitable for the specific purpose. In the present conditions a product that has been tested against the EN1500 complies with the necessary standards for hygienic disinfection and should be favoured. Products meeting the EN 12791 criteria generally also meet the less stringent criteria set for hygienic disinfection described in the EN1500 standards (see **Textbox 2**).

Compliance as a risk factor

In a historical perspective, those we now consider as the grandfathers of infection control and aseptic technique, all suffered during their respective eras from what is known as the 'Semmelweis effect'. Even supported by tangible facts and scientific proof, these great minds met great scepticism about their findings and the concurrent implementation of policies.

Unfortunately, things are not necessarily different now. In 2016, the benefits of proper hand hygiene are commonly accepted knowledge. From childhood, we are lectured on the fact that microbes have the potential to create infections, hands carry microbes and washing hands reduces microbial contamination. However, we largely fail to comply and do the latter. Even in the human and veterinary healthcare sectors, where hand hygiene is taught throughout academic education and is known to be a basic pillar of infection control, compliance is unacceptably low. Educational level and sex were shown to affect compliance with hand hygiene procedures. Being a woman or a nurse yields significantly more hand hygiene procedures per patient than being male or a doctor (Thorup 2014). Even in human medical settings, only slightly more than 50% of physicians wash their hands before patient contact (Laustsen *et al.* 2009). At first sight our sector seems to do better since 87–100% of veterinarians self-report to wash their hands before patient contact (Hunt Gerardo *et al.* 2013). However that is in total contradiction with video observation studies in small animal clinics where as few as 3% of observed veterinarians performed an act of hand hygiene before examining a new patient (Anderson *et al.* 2014). An observational study conducted at a human surgeon's congress showed that 20% of male surgeons did not use hand hygiene in relation to toilet visits (Burcharth *et al.* 2014). Even though the study was done in a situation without patient contact, it is a worrying finding in this specific group of the highly educated medical staff, where hand hygiene should be so deeply ingrained a routine. Additionally, there seems to be a large discrepancy between what we think we do and what we really do.

Increasing compliance: a communal effort

The main problem today is not the lack of knowledge, the lack of recognition of the necessity or the lack of available efficient products – it is rather an issue of everyday compliance by healthcare staff to perform the acts of hand hygiene. Here, every healthcare individual carries their own responsibility, yet can be supported in many ways.

TABLE 1: Description of components of interventions to promote hand hygiene compliance in healthcare settings based on WHO-5 (from http://www.who.int/gpsc/5may/tools/en/ and (Luangasanatip *et al.* 2015)

Component	Description
System change	Ensuring that the healthcare facility has the necessary infrastructure in place to allow healthcare workers to practice hand hygiene.
Training and education	All healthcare workers require clear and comprehensive training and education on the importance of hand hygiene, the 'My 5 Moments for Hand Hygiene' approach and the correct procedures for hand rubbing and handwashing.
Monitoring and feedback	Continuous monitoring is very helpful in measuring the changes induced by implementation and to ensure that the interventions have been effective in improving hand hygiene practices, perception and knowledge among healthcare workers.
Reminders at the workplace	Reminders in the workplace are important to prompt healthcare workers to practice hand hygiene and to inform patients and their visitors of the standard of care they should expect from their healthcare workers. Posters and pocket leaflets are among the most common types of reminder.
Institutional safety climate	Active participation at management level, creating an environment that allows prioritisation of hand hygiene
Goal setting	Setting of specific goals aimed at improving compliance with hand hygiene and can include healthcare associated infection rates
Reward incentives	Interventions providing any reward incentive for participants completing a particular task or reaching a certain level of compliance. Both nonfinancial and financial rewards are included
Accountability	Interventions involved with improving healthcare workers' accountability both at individual and unit level

Luangasanatip *et al.* (2015) compiled an evidence-based analysis of the efficacy of the WHO-5 practices (**Table 1**) and others meant to increase hand hygiene compliance in healthcare settings. This analysis mainly reveals that multifaceted interventions such as the WHO-5 are more efficient than singular interventions. Further adding goal setting, reward incentives and accountability to the WHO-5 will further increase the effectiveness of those programmes (Luangasanatip *et al.* 2015).

In the first instance, system change is crucial. Assuring functional (Kohan *et al.* 2002), filled and accessible product dispensers of both hand sanitation and gloves being available in the hospital is the first key to success. Increased accessibility is a major contributor to improved compliance (Cure *et al.* 2014; Cure and Van Enk 2015; Stackelroth *et al.* 2015). The physical location of the dispensers is recognised as an important component of hand hygiene practice improvements. Generally, it is accepted that dispensers by

the entrance of rooms and at the point of care (bedside, examination table etc.) are most effective (Cure *et al.* 2014). Cure and Van Enk (2015) further showed that not only location but mainly the visibility had a high impact on use. These factors have not been investigated in equine settings but this is likely to mean that placement of dispensers should be at the entrance of examination rooms and stable blocks, on stable doors and on medicine and bandage carts.

Hospital management can further contribute to assure some practicalities are dealt with. As an example, wearing jewellery reduces the ability to properly disinfect hands but also people wearing watches seem more reluctant to perform acts of hand hygiene. However, a watch is a necessary tool in our medical work life. If the management ensures there are enough visible working clocks on the clinic walls or provide personnel with pin-on watches, increased hand hygiene compliance can be obtained.

The type of product used is also of importance. The market has many different types of products available, from hard soaps over liquids, to gels and foams. The need to select hand hygiene products that are accepted by the healthcare practitioners has long been demonstrated (Ojajarvi 1981). Surely one does not go without the other, although making sure people are willing to use the product put at their disposal is likely to have a bigger impact on compliance than purely having something available (Kampf 2004). Soaps are generally disfavoured compared to alcohol products and moving from soap and water to purely alcohol products was shown to increase compliance (Maury *et al.* 2000). Some studies suggest that foam type products are preferred over gels (Carr *et al.* 2003).

As mentioned before, the long-term quality and integrity of the skin is a major contributing factor to proper hand hygiene and good skin health also contributes to increased compliance towards hand hygiene acts. Individuals with dry and painful skin, will be more likely to avoid disinfection. The regular use of hand creams can attenuate the downsides of hand sanitation. Choosing alcohol based products that contain emollients and making skin care products available in the clinic will indirectly increase compliance (Kampf *et al.* 2005a,b; Kampf and Ennen 2006).

Eventually, however, increased hygiene compliance can only be obtained by a general change in mind-set. Raising extra awareness by staff education helps modifying minds. However, educational campaigns have a limited impact, mostly in time (Kretzer and Larson 1998; Jansson *et al.* 2016) also in small animal settings (Anderson *et al.* 2014). Long-term benefit is to be found in the presence of good role models within the clinic (Lankford *et al.* 2003). Some human institutions have obtained very good increased compliance rates working with so-called hand hygiene ambassadors (Cheng *et al.* 2016). Those ambassadors should probably be chosen amongst senior medical staff. Negligence in hand hygiene is correlated with level of education and years in practice (Maury *et al.* 2000) with senior doctors performing much worse than younger nurses. Therefore, senior doctors are probably best to set a good example.

The multimodal approach

The effective percentage of prevention of HAI that is achievable by introduction of hand hygiene policies is difficult to evaluate in an evidence-based manner. In developing countries community settings where personal hygiene is still regarded as low, introduction of hand washing practices was shown on a meta-analysis level to reduce risks of diarrhoeal diseases by 42–47% and thereby potentially save a million lives every year (Curtis and Cairncross 2003). The effective impact of hand hygiene in reduction of medical infections is far more difficult to assess. Historically, the figural 'overnight' implementation of hand hygiene policies by Semmelweis led to a 2/3 drop in puerperal fever mortality rates (Manor *et al.* 2016). The trial Semmelweis performed was done in two obstetric departments with about 3500 patients each. The scale of this clinical trial is still very impressive particularly considering the absence of many confounding factors of other hygienic measures that would be present in today's settings. In the 1960s, an investigation was performed on *S. aureus* transmission between infants that had been handled by nurses who washed vs. nurses who did not wash their hands in between infant contacts. The trial revealed that hand washing by the nursing staff clearly reduced transmission of *S. aureus* between patients (Mortimer *et al.* 1962). Still, some have questioned the absence of strictly evidence-based outcomes in the field of hand hygiene set by current research standards (Chou *et al.* 2012). However, the above mentioned trial setups would currently be inacceptable. Supported by the historical evidence performing double blinded randomised trials in which the only investigated variable would be the fact that surgeons would operate with or without having washed their hands would be unthinkable and unethical. Further, with the historical development and advances made in infection control it is also likely that it is the 'package' that comes with introduction of better hand hygiene compliance that provides largest benefit rather than the act of hand hygiene alone. Increasing hand hygiene in clinical practice is therefore part of a multimodal approach towards infection control that should target patient, care provider and environmental control to be successful.

Conclusions

Hospital acquired infections and zoonotic diseases are a reality that accompanies our lives as animal healthcare workers in the care of our patients. A simple act of hand hygiene can help in reducing the burden these infections put on the outcomes of our patients and ourselves.

It is of such great importance and so easy to perform, yet we fail to do it enough. In many ways, it is all in our hands.

Use your head – clean your hands: Clean Hands Save Horses.

Author's declaration of interests

No conflicts of interest have been declared.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's website:

Supplementary Item 1: Clean Hands Save Lives: presurgical hand asepsis protocol poster.

Supplementary Item 2: Clean Hands Save Lives: hygienic hand sanitation protocol poster.

Supplementary Item 3: Clean Hands Save Lives: hygienic hand sanitation protocol poster (alternative poster).