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Hand hygiene compliance in the intensive care unit of the Onderstepoort Veterinary Hospital, South Africa

By

Dikeledi Carol Sebola

Submitted in fulfilment of the requirement for the degree

MSc

In the Faculty of Veterinary Science,

University of Pretoria

Pretoria

October 2019

Supervisor: Prof. Daniel Nenene Qekwana

Co-Supervisor: Dr. Charles Boucher

Declaration

I, **Dikeledi Carol Sebola** declare that the dissertation, which I hereby submit for the degree **MSc in Paraclinical sciences** at the University of Pretoria, is my own work and has not previously been submitted at this or any other tertiary institution.

SIGNATURE: …….

DATE: …….

Dedication

This dissertation is dedicated to my late father Petrus Mabusha Sebola, My mother Sophie Makoma Sebola and my siblings Sewela and Mahlatse “Joey” Sebola.

Acknowledgments

First and foremost, All the glory goes to the most high GOD for carrying me through this process. It has been a rollercoaster and I acknowledge I wouldn't have done it had it not been for God.

I want to extend my gratitude to my mentor and supervisor Prof. DN Qekwana for believing in me even when I didn't believe in myself at some instances. Thank you for consistently sharing your knowledge, for your guidance, continuous support, sacrifices, going extra miles for my wellbeing and the life lessons you give me all the time. To my co-supervisor, Dr Charlie Boucher, thank you for always availing yourself to assist me in this project and giving me all the necessary support when it got tough. To Dr Caroline Maslo from Netcare, I am grateful for all the light you shared with me in this research and for availing yourself, opening your doors for me to learn more and guiding me throughout the project.

Let me extend my gratitude to my great cheerleaders and supporters in this journey, my friends and fellow students tsa Prof. thank you for the continuous support and the laughter we share. My life coaches and mentors Mr Benjamin Shilakwe, Mr Lesailane, Mrs Mathebula, Pastor Mathebula and Pastor Molapo thank you for always pushing me and lending an ear whenever it got tough. I will never forget the constant prayers support.

Last but not least, my family Ya Ga Sebola. This degree was done at the most trying times, yet you showed me love, support and cheered me all the way. I am grateful and I am because of all of you. My baby cousins, you know all this is for you.

I know I have made all of you proud. Thank You

Abstract

Infection prevention and control (IPC) practices play an important role in the prevention and management of hospital-acquired infections (HAIs) in healthcare facilities and hand hygiene is the cornerstone of all IPC practices. Despite the effectiveness of IPC in the management of HAIs, its adoption in veterinary medicine has been limited. Additionally, there is paucity of data on IPC practices in veterinary medicine. Therefore, this study evaluated hand hygiene compliance among healthcare workers in the intensive care unit (ICU) at the Onderstepoort Veterinary Academic Hospital. A cross-sectional study was conducted among healthcare workers (HCWs) and visitors in the ICU. The infection control assessment tool (ICAT), focusing on the five hand hygiene moments criteria was used to evaluate compliance. The level of compliance and a 95% confidence interval was calculated for all variables. Individual bottles of alcohol-based hand rub solutions and hand-wash basins with running water, soap dispensers, and paper towels were available in the ICU. In total, 296 observations consisting of 734 hand hygiene opportunities were recorded. In addition, hand hygiene compliance was also evaluated during invasive (51.4%) and non-invasive (48.6%) procedures. Most HCWs did not sanitize stethoscopes, leashes, and cellular phones used in between patients. Additionally, the majority of them were not bare “below the elbows” because they wore jewellery. The overall hand hygiene compliance was 24.3% (178/734). The most common method of hand hygiene was hand rub (58.4%) followed by hand-wash (41.6%). Nurses had a higher (44%) level of compliance compared to students (22%) and doctors (15%). Compliance was also higher after body fluid exposure (42%) compared to after patient contact (32%), before patient contact (19%), after contact with patient surroundings (16%), and before an aseptic procedure (15%). Furthermore, nurses had the lowest compliance after body fluid exposure (14%), students had the lowest compliance before patient contact (16%) and doctors had the lowest compliance

after contact with patient surroundings (0%). The low levels of hand hygiene compliance in this study raises concerns of potential transmission of HAIs and zoonosis in the ICU. Therefore, intervention strategies are recommended to improve the compliance level in the hospital. These may include an educational campaign on the importance of adhering to hand hygiene, development and promotion of written hand hygiene protocols, and programs promoting regular hand hygiene auditing could be developed.

List of abbreviations

95% CI: Ninety-Five Percent Confidence Interval

ABFE: After Body Fluid Exposure

ACPS: After Contact with Patient Surroundings

APC: After Patient Contact

BAP: Before an Aseptic Procedure

BPC: Before Patient Contact

BSI: Bloodstream Infections

CACS: Companion Animal Clinical Studies

CRAB: Carbapenem-resistant *Acinetobacter baumannii*

CDC: Centers for Disease Control and Prevention

HAIs: Hospital Acquired Infections

HCW: Healthcare worker

ICAT: Infection Control Assessment Tool

ICP: Infection Control Practitioner

ICU: Intensive Care Unit

IPC: Infection Prevention and Control

MDR: Multidrug Resistance

MRSA: Methicillin-Resistant *Staphylococcus aureus*

OVAH: Onderstepoort Veterinary Academic Hospital

SSI: Surgical Site Infections

UTI: Urinary Tract Infections

VRE: Vancomycin-Resistant Enterococci

WHO: World Health Organization

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CHAPTER 1

1.1 Infection prevention and control

The World Health Organization (2004) defines infection prevention and control (IPC) as a scientific approach and a practical solution designed to prevent transmission of infections between patients and health workers within a particular healthcare setting through surveillance and outbreak investigation.

1.1.1 Infection Prevention and control in veterinary medicine

Infection prevention and control (IPC) practices in veterinary medicine play an important role in the management of nosocomial or hospital acquired infections (HAIs) (Iku Kisani, Awasum, Udegbunam, Nnaji, Muhammed, Melekwa & Ankwedel, 2016; Stull & Weese, 2015a). These practices aim to minimise the environmental impact of infections by managing disease outbreaks. Infection prevention and control practices are designed to protect patients, animal owners, veterinary personnel, and communities from HAIs and zoonotic diseases (Stull & Weese, 2015a; Traverse & Aceto, 2015). In addition, they help reduce the burden of hospital environment pathogens (Walther, Tedin & Lübke-Becker, 2017; Willemsen, Cobbold, Gibson, Wilks, Lawler & Reid, 2019) and overuse of antimicrobial agents by controlling the transmission of multidrug resistant (MDR) pathogens (Lonks, 2018; Willemsen *et al.*, 2019). Infection prevention and control has slowly been adopted in veterinary medicine (Stull & Weese, 2015b). However, it is the cornerstone of patient care and management in human medicine (World Health Organization, 2004).

1.2 Hospital acquired infections

1.2.1 Hospital acquired infections in veterinary medicine

Hospital-acquired infections have been reported in veterinary hospitals and they are defined as infections acquired by patients during hospitalization (Iku Kisani *et al.*, 2016;

Milton, 2015). They are associated with increased mortality, morbidity, length of hospital stays, increased antimicrobial drug prescription, and costs of treatment (Iku Kisani *et al.*, 2016; Stull & Weese, 2015a). Furthermore, HAIs in veterinary medicine can be transmitted to healthcare workers (HCWs) and patient owners leading to spread of zoonotic infections (Walther *et al.*, 2017). Moreover, organisms associated with HAIs are often MDR, leading to limited treatment options and worsening patient prognosis (Stull & Weese, 2015a; Walther *et al.*, 2017).

Organism including *Staphylococcus aureus, Staphylococcus pseudintermedius, Pseudomonas* spp.*, Klebsiella* spp.*, Enterobacteriaceae* spp., *Acinetobacter baumannii*, and *Escherichia coli* are commonly isolated HAIs in veterinary hospital (Boerlin, Eugster, Gaschen, Straub & Schawalder, 2001; Iku Kisani *et al.*, 2016; Stull & Weese, 2015b,a; Walther *et al.*, 2017; Wieler, Ewers, Guenther, Walther & Lübke-Becker, 2011). They have been reported in clinical cases such as urinary tract infections (UTI), surgical site infections (SSI), bloodstream infections (BSIs), and gastrointestinal diseases in veterinary clinical cases (Stull & Weese, 2015a,b; Traverse & Aceto, 2015).

Immunocompromised, hospitalized, geriatrics, and patients with an underlying clinical condition are at a high risk of HAIs (Walther *et al.*, 2017). Since the majority of these patients are often hospitalised in the intensive care unit (ICU), this area of the hospital has the highest burden of HAIs (Stull & Weese, 2015a; Walther *et al.*, 2017). In addition, ICU environmental surfaces have shown to harbour organisms responsible for HAIs and remains a source of infection for susceptible patients (Traverse & Aceto, 2015). Furthermore, a longer period of hospital stay has also been shown to increase the risk of HAI among these patients (Milton, 2015; Walther *et al.*, 2017).

1.2.2 Hospital acquired infections in Human medicine

In human hospitals, patients who stay longer in the hospital are also at a higher risk of developing HAIs (Glance, Stone, Mukamel & Dick, 2011) with increased mortality (Glance *et al.*, 2011), length of stay and hospital costs (Thom, Hsiao, Harris, Stine, Rasko & Johnson, 2010). Similar to veterinary medicine, organisms associated with HAIs are often MDR with high levels of treatment failure and poor patient prognosis (Mendelson & Matsoso, 2015). Organisms that have been identified in human cases include *Acinetobacter baumannii* (Eveillard, Kempf, Belmonte, Pailhoriès & Joly-Guillou, 2013; Thom *et al.*, 2010), *Staphylococcus* species (Glance *et al.*, 2011; Hughes, Tunney & Bradley, 2013), *Clostridium difficile* (Glance *et al.*, 2011), and *Pseudomonas aeruginosa.* Urinary tract infections, SSIs, and BSIs account for most HAIs in human medicine (Boev & Kiss, 2017). Patients in the ICU compared to outpatients are at a higher risk of HAIs (Choi, Kim, Jeon, Son, Yoon, Kim, Kim, Sohn, Kim & Park, 2010; Eggimann & Pittet, 2001).

1.3 Hand hygiene compliance

Effective hand hygiene, cleaning and disinfection of surfaces, patient management, surveillance, education, and training have been shown to mitigate transmission of HAIs in both human (Eggimann & Pittet, 2001; Kelcíkova, Skodova & Straka, 2012) and veterinary medicine (Anderson, 2015; Walther *et al.*, 2017). Therefore, hand hygiene compliance remains the most effective means to prevent and control infections (Nakamura, Tompkins, Braasch, Martinez Jr & Bianco, 2012; Stull & Weese, 2015a; Willemsen *et al.*, 2019).

1.3.1 Hand hygiene compliance in human hospitals

Transmission of HAIs between patients often occurs through direct contact with contaminated surfaces (Gould, Drey & Creedon, 2011; Randle, Arthur & Vaughan, 2010; World Health Organization, 2009a) or indirectly via contaminated hands or gloves of HCWs (Hughes *et al.*, 2013; World Health Organization, 2009a). Hand hygiene compliance is

regarded as the most effective IPC measure to control the transmission of HAIs from patient to patient (Gould *et al.*, 2011). Notwithstanding, hand hygiene compliance among HCWs has been reported to be low in ICU (Allegranzi & Pittet, 2009; Salama, Jamal, Al Mousa, Al-AbdulGhani & Rotimi, 2013; World Health Organization, 2009a,b) and this has been attributed to busy schedule and the high ratio of patients to HCWs (Baek, Kim, Kim, Cho, Hong & Kim, 2019).

1.3.2 Hand hygiene in veterinary medicine

Veterinary hospital staff or personnel play a significant role in the transmission of HAIs and zoonotic bacteria (Anderson, 2015; Smith, Packman & Hofmeister, 2013). However, up to now, hand hygiene compliance in veterinary hospital has received little attention (Anderson, Sargeant & Weese, 2014). Nonetheless, several studies have reported low compliance of hand hygiene in veterinary clinic (Anderson, 2015; Anderson *et al.*, 2014; Nakamura *et al.*, 2012) with factors such as lack of hand hygiene compliance after patient contact been among the contributors (Anderson *et al.*, 2014; Burgess & Morley, 2015; Canadian Committee on Antibiotic Resistance, 2008; Shea & Shaw, 2012; Stull & Weese, 2015b).

1.4 *Justification*

Infection prevention and control has been shown to be effective in reducing HAIs (Anderson, Montgomery, Weese & Prescott, 2008; Burgess & Morley, 2015; Shea & Shaw, 2012; Stull & Weese, 2015b). Effective hand hygiene, cleaning and disinfection of surfaces, patient management, surveillance, and education and training have been shown to mitigate the risk of transmission of HAIs in veterinary facilities (Anderson, 2015; Walther *et al.*, 2017).

Since most of the HAIs are MDR and this limits the choice of antimicrobials available for good patient prognosis, therefore, there is a need to limit the transmission of these organisms and reduce overuse of antimicrobials (Brink, Messina, Feldman, Richards,

Becker, Goff, Bauer, Nathwani, den Bergh & Alliance, 2016; Eagar & Naidoo, 2017; Lonks, 2018; Nathwatni & Sneddon, 2013). Moreover, Lonks (2018) suggest that implementation of both IPC and antimicrobial stewardship can lead to greater results on reducing antimicrobial resistance. In addition, IPC and antimicrobial stewardship form critical pillars of the 2018-2024 South African National AMR strategy (Eagar & Naidoo, 2017; National Department of Health, 2018).

Notwithstanding studies done on IPC in veterinary medicine in other countries (Anderson, 2015; Nakamura *et al.*, 2012; Traverse & Aceto, 2015; Walther *et al.*, 2017; Willemsen *et al.*, 2019), there are no published studies on IPC including hand hygiene compliance in veterinary medicine in South Africa. Therefore, understanding hand hygiene compliance patterns in the ICU as part of IPC is a crucial step towards minimizing the risk of HAIs. In addition, the results of this study will contribute towards the implementation of the South African Antimicrobial Resistance Strategy Framework as IPC is one of the strategic objectives as outlined by the National Department of Health (Eagar & Naidoo, 2017; Mendelson, Whitelaw, Nicol & Brink, 2012; National Department of Health, 2018).

1.5 Aim

This study aims to assess hand hygiene compliance as part of infection prevention and control measures in the ICU of the Onderstepoort Veterinary Academic Hospital (OVAH) to guide policy on infection prevention and control at OVAH.

1.6 Objective

The objective of this study was to determine hand hygiene compliance level using the Infection Control Assessment Tool (ICAT) among the healthcare workers in the ICU.

1.7 Benefits of the study

This study will contribute to ongoing research on antimicrobial stewardship program in the OVAH University of Pretoria. The information generated from this study can also be used

to guide academic curriculum development in IPC, development of IPC policies, and training courses in IPC in veterinary medicine.

1.8 Structure of the thesis

This dissertation comprises of four chapters. The first chapter provides the general background, aim, objectives, and structure of the dissertation. The second chapter is a literature review which outlines published studies on IPC, HAIs and zoonotic diseases, and hand hygiene compliance. The third chapter comprises of the methodology of the study, results, discussion, and conclusion. The last chapter will outline the key findings of the study and will make recommendations based on the results obtained in the study.

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CHAPTER 2

2.1 Hospital-acquired infections

2.1.1 Hospital acquired infection in human hospital

Hospital-acquired infections (HAIs) are common in human facilities and they are defined as infections acquired by patients during hospitalization (Salama, Jamal, Al Mousa, Al-AbdulGhani & Rotimi, 2013). They are associated with increased mortality, morbidity and have an economic burden due to extended hospital stay and increased antibiotic prescriptions (Eggimann & Pittet, 2001; Salama *et al.*, 2013). Patients with underlying illness and immunocompromised, understaffing, overcrowding, and poor patient care have been reported to increase the risk of HAIs (Anastasiades, Pratt, Rousseau, Steinberg & Joubert, 2009; Eggimann & Pittet, 2001). Most common HAIs in human hospital include surgical site infection, central line associated bloodstream infection, and ventilator associated pneumonia (Anastasiades *et al.*, 2009; Boev & Kiss, 2017; World Health Organization, 2017).

2.1.2 Hospital acquired infection in veterinary hospital

In veterinary medicine, HAIs also result in increased hospital stay, high morbidity, and high mortality (Iku Kisani, Awasum, Udegbunam, Nnaji, Muhammed, Melekwa & Ankwedel, 2016; Stull & Weese, 2015a). The most common HAIs in veterinary medicine include surgical wound infections, urinary tract infections, respiratory tract infections, and gastrointestinal infections (Boerlin, Eugster, Gaschen, Straub & Schawalder, 2001). *Staphylococcus aureus, S. pseudintermedius, Pseudomonas* spp., *Klebsiella* spp., *Enterococcus* spp, *Salmonella* spp., and *Escherichia coli* are commonly isolated pathogens in HAIs in veterinary hospital (Boerlin *et al.*, 2001; Iku Kisani *et al.*, 2016; Stull & Weese,

2015a,b; Walther, Tedin & Lübke-Becker, 2017; Wieler, Ewers, Guenther, Walther & Lübke-Becker, 2011). Additionally, organisms such as Methicillin-Resistant *Staphylococcus aureus* (MRSA) and *Salmonella* spp., have been reported as causes of zoonotic diseases among HCWs and pet owners (Stull & Weese, 2015a).

Previous exposure to antimicrobials and hospitalisation increases the risk of colonisation or infections with organisms associated with HAIs (Shoen, Rose, Ramsey, de Morais & Bermudez, 2019; Walther *et al.*, 2017). Like human patients, immunocompromised animals are at high risk of HAIs. Since the majority of immunocompromised, critical, and post-surgical cases are often hospitalised in the intensive care unit (ICU) (Smith & Witchell, 2016), this area of the hospital has the highest burden of HAIs (Stull & Weese, 2015a; Walther *et al.*, 2017). In addition, ICU environmental surfaces have shown to harbour organisms responsible for HAIs and remains a source of infection for susceptible patients (Traverse & Aceto, 2015).

2.1.3 Hospital acquired infections and multidrug resistance

Organisms isolated from HAI cases in veterinary medicine are often multidrug resistant (MDR), leading to limited treatment options and worsening patient prognosis (Stull & Weese, 2015a; Walther *et al.*, 2017). The emergence of MDR bacteria in veterinary medicine is not only a clinical concern but a public health concern as some of these organisms are zoonotic (Taylor, Latham & Woolhouse, 2001; Walther *et al.*, 2017). Therefore, veterinary personnel, students, and animal owners are at a higher risk of infection (Walther *et al.*, 2017). Furthermore, zoonotic diseases associated with MDR pathogens are likely to put financial stress on an already stressed human health system in developing countries (Molyneux, Hallaj, Keusch, McManus, Ngowi, Cleaveland, Ramos-Jimenez, Gotuzzo, Kar, Sanchez, Garba, Carabin, Bassili, Chaignat, Meslin, Abushama, Willingham & Kioy, 2011). In the absence of alternative treatment, high levels of MDR may lead to injudicious antimicrobial

use and further exacerbate the existing antimicrobial resistance problem ((Allegranzi, Nejad, Combescure, Graafmans, Attar, Donaldson & Pittet, 2011; Boerlin *et al.*, 2001; Eggimann & Pittet, 2001).

2.2 Infection prevention and control

The WHO has put together regulations on the core components of IPC practices to improve the quality and safety of health service delivery and health outcomes of the people entering those services (World Health Organization, 2017). The implementation of these measures both in human (World Health Organization, 2017) and veterinary hospitals (Stull & Weese, 2015a) have been shown to decrease the prevalence of HAIs and change antimicrobial use practices (Lonks, 2018; Pittet, Hugonnet, Harbarth, Mourouga, Sauvan, Touveneau, Perneger & others, 2000).

2.2.1 Infection prevention and control in Human medicine

Infection prevention and control practices are designed to inhibit the transmission of infections from patients to HCWs, other patients, and visitors in human hospital (Storr, Twyman, Zingg, Damani, Kilpatrick, Reilly, Price, Egger, Grayson, Kelley, Allegranzi, Caluwaerts, El-Asady, Fisher, Gastmeier, Holmes, Jayatilleke, McLaws, Mehta, Mehtar, Ndoye, Otaíza, Padoveze, Park, Parneix, Pittet, Robertson, Sesay-Kamara, Seto, Talaat, Unahalekhaka & Curiel, 2017; World Health Organization, 2004). Therefore, HCWs, patients, and visitors must adhere to these IPC guidelines regardless of whether the health status of the patient is known (Storr et al., 2017; World Health Organization, 2017). In addition, all surfaces in the hospital area must be cleaned and disinfected as computers, keyboards and mouse in an ICU have been reported to harbour organism such as *S. aureus* (Anastasiades et al., 2009).

2.2.2 Infection prevention and control in Veterinary medicine

In veterinary medicine IPC measures protect patient owners, veterinary personnel, and communities from possible HAIs of a zoonotic nature (Stull & Weese, 2015a; Traverse & Aceto, 2015). Moreover, veterinary personnel can acquire the pathogen from animal patients and transmit it beyond the hospital borders to their homes (Walther *et al.*, 2017). Source of HAIs could either be endogenous flora of patients or exogenous microorganisms in the hospital and these are transmissible through contaminated hands of healthcare workers (Boerlin *et al.*, 2001; Walther *et al.*, 2017). For example, Boerlin *et al* (2001) reported *A. baumannii* transmission from companion animal hospital to the equine clinic through the hands of students in Switzerland.

There is limited information on standardised protocols for infection control in veterinary medicine (Weese, 2004). Nonetheless, it is the responsibility of every veterinary clinic to have a formal IPC programme including an infection control practitioner (ICP) to reduce the risk of sporadic cases and outbreaks of HAIs (Canadian Committee on Antibiotic Resistance, 2008). These protocols must address areas such as animal handling, point of care, and patient environmental surrounding (Canadian Committee on Antibiotic Resistance, 2008; Guptill, 2015; Traverse & Aceto, 2015; Weese, 2004; Willemsen, Cobbold, Gibson, Wilks, Lawler & Reid, 2019) and must also be based on disease aetiology and pathogenies. Furthermore, IPC protocols must address ongoing assessment of the efficacy of IPC practices (Guptill, 2015). Every hospital staff member and patient owner visiting the hospital must also adhere to these protocols (Canadian Committee on Antibiotic Resistance, 2008).

2.3 Hand hygiene

Transmission of most organisms associated with HAIs such as MRSA is mostly through contaminated hands of healthcare workers (Nakamura, Tompkins, Braasch, Martinez Jr & Bianco, 2012). Hand washing using water and soap and disinfecting hands have been shown to reduce the transmission of HAIs and antimicrobial-resistant pathogens (Weese, 2004; Willemsen *et al.*, 2019). Therefore, hand hygiene remains the cornerstone of IPC (Nakamura *et al.*, 2012).

2.3.1 Hand hygiene in human hospital

Although healthcare workers (HCWs) compliance to hand hygiene have been reported to minimize exposure to HAIs and break the cycle of microbial transmission between computer equipment, staff, and patients (Anastasiades *et al.*, 2009). Hand hygiene compliance among HCWs in human hospitals is said to be low (Allegranzi & Pittet, 2009; Salama *et al.*, 2013). This has been attributed to lack of resources, HCWs underlying clinical conditions including skin irritation, forgetfulness, and lack of knowledge of IPC (Erasmus, Daha, Brug, Richardus, Behrendt, Vos & van Beeck, 2010; Pittet *et al.*, 2000).

In order to improve hand hygiene compliance, studies done in human hospital suggest the use of alcohol-based sanitizers as they are less irritating on the skin and require less time compared to washing hands with water and soap (Allegranzi & Pittet, 2009; Picheansathian, 2004). Picheansathian (2004) in a human hospital in Thailand, reported improvement in hand hygiene compliance when using alcohol-based sanitisers compared to other methods of hand hygiene compliance. Notwithstanding the effectiveness of alcohol-based sanitizers, mechanical hand washing with running water and soap should be used whenever possible as alcohol-based sanitizers' have been shown to be less effective against certain pathogens including spore forming bacteria (Allegranzi & Pittet, 2009).

2.3.2 Hand hygiene in veterinary hospital

Similar to human medicine, hand hygiene compliance among HCWs in veterinary medicine is reported to be low, with high implications on transmitting zoonotic pathogens (Anderson, 2015; Nakamura *et al.*, 2012; Shea & Shaw, 2012). Nakamura and colleagues in the USA reported that less than 50% of veterinary technicians and veterinary support staff regularly wash their hands between animals, and most have attributed their behaviour to the busy schedules and high workload (Nakamura *et al.*, 2012).

Alcohol-based sanitizers are recommended as the most effective method of hand hygiene compliance, however, in veterinary medicine the use of soap and water is preferable as the hands of healthcare workers are most likely to be soiled with debris (Nakamura *et al.*, 2012). Traub-Dargatz et al. (2006) in a veterinary hospital in Colorado compared the effectiveness of three hand hygiene protocols during a routine equine physical examination. The protocols used were for hand washing, alcohol-gel hand sanitizer, and for alcohol with chlorhexidine lotion. In their study, they found reduction of bacterial count on hands of HCWs when using the alcohol-gel hand sanitizer and the alcohol chlorhexidine protocols compared to hand washing with an antiseptic soap. Notwithstanding, the need for hand washing when hands are visibly soiled, the authors suggest that in situations where hand hygiene needs to be optimal and hand washing is not feasible, alcohol-gel sanitizers should be considered. Moreover, the authors recommend an adjustment of hand washing time which was mostly 15 seconds as a longer period might be optimal for reduction of bacterial load during hand washing.

2.4 Cleaning and disinfection in veterinary medicine

Environmental cleaning and disinfection are important in reducing HAIs, MDR organisms, and zoonotic infections in veterinary hospitals (Willemsen *et al.*, 2019). Moreover, Traverse and Aceto (2015) reported HAIs on surfaces such as cages, doors, stethoscopes, thermometers, and mouth gags in veterinary medicine mainly due to lack of cleaning and disinfection of these surfaces. Organisms associated with HAIs can adhere and survive on hospital surfaces for a longer period and remain sources of infection to susceptible patients (Stull & Weese, 2015a; Traverse & Aceto, 2015). Since they are not visible to the naked eye, effective cleaning and disinfection of contaminated areas is important in reducing the risk of transmission (Stull & Weese, 2015a).

2.5 Patient management in veterinary medicine

Patient management is another key part of minimizing the incidence of HAIs in veterinary settings (Guptill, 2015; Stull & Weese, 2015a). This area of IPC must focus on patient admission, housing, diagnostic procedures, and treatment. It must deal with the assessment and handling of high-risk patients to prevent transmission of infectious agents (Guptill, 2015). Movement of animal patients between services such as between diagnostic imaging and surgery areas within the hospital must also follow strict protocol (Guptill, 2015; Stull & Weese, 2015a). In addition, isolation facilities must be available in the hospital to prevent transmission of pathogens from high-risk patients to low-risk patients (Weese, 2004).

2.6 Surveillance veterinary medicine

Early identification of HAIs and zoonotic disease cases is critical in minimizing the impact of HAIs as part of IPC in veterinary hospitals (Burgess & Morley, 2015; Milton, 2015; Walther *et al.*, 2017). Ongoing surveillance of HAIs can be useful for analysis of trends and comparisons between facilities (Canadian Committee on Antibiotic Resistance, 2008). The information generated can also be useful in evaluating the effectiveness of intervention

strategies in reducing incidences of HAIs (Stull & Weese, 2015a). In addition to patient surveillance, surveillance of environmental surfaces including critical areas and equipment used must also be done (Milton, 2015).

2.7 Education and training

2.7.1 Education and training in human medicine

Lack of knowledge in human studies has been stated as one of the factors affecting IPC compliance (Pittet *et al.*, 2000). Most healthcare facilities implementing education and training as an intervention strategy have reported improvement in IPC compliance (Allegranzi & Pittet, 2009; Salama *et al.*, 2013). Salama et al. (2013) in Kuwait observed an improvement in hand hygiene compliance of HCWs from 43% before educational campaign to 61.4% after educational campaign. However, evidence of long-term adherence or compliance to IPC linked to education and training remains a concern (Ward, 2011). Therefore, the WHO (2017) recommends ongoing educational and training as well as multimodal approaches targeting influence on human behaviour such as monitoring and feedback infrastructures for long term improvement of IPC compliance. This multimodal approach can take many forms including written information, oral instruction, e- learning and interactive training sessions (Ward, 2011; World Health Organization, 2017).

2.7.2 Education and training in veterinary medicine

Educating HCWs in veterinary medicine on IPC practices can also lead to reduction in the burden of HAIs and MDR cases (Milton, 2015; World Health Organization, 2017). Healthcare workers and animal owners must also be educated on zoonotic infections and infection control policies that minimise the risk of transmission of HAIs (Milton, 2015; Stull & Weese, 2015a). In addition, patient handling, potential animal bites, and injuries at work may further increase the risk of exposure of HCWs to zoonotic infections and animal owners

(Stull & Weese, 2015a). Therefore, it is important that HCWs and everyone entering veterinary facilities be familiar with these protocols.

2.8 The intensive care unit

2.8.1 The human intensive care unit

The ICU is where patients with infectious diseases, in critical condition and often immunosuppressed are kept (Boev & Kiss, 2017). It remains an area of the hospital with the highest risk of transmission of HAIs and antimicrobial resistance pathogens (Choi, Kim, Jeon, Son, Yoon, Kim, Kim, Sohn, Kim & Park, 2010; Eggimann & Pittet, 2001; Thom, Johnson, Strauss, Furuno, Perencevich & Harris, 2007; Walther *et al.*, 2017). Choi *et al* (2010) reported Carbapenem- resistant *Acinetobacter baumanni* (CRAB) outbreak in two ICUs on the same floor of the hospital but separated from one another. The authors conclude that the most likely cause of the spread of this pathogen could have been through the hands of HCWs. Therefore, the authors suggest strict contact precautions should be adhered to in cases of an outbreak in ICU. Furthermore, protocols addressing different IPC practices should be emphasized in the ICU to reduce the risk of HAIs and AMR (Anastasiades *et al.*, 2009; Trick, Vernon, Hayes, Nathan, Rice, Peterson, Segreti, Welbel, Solomon & Weinstein, 2003).

2.8.2 veterinary intensive care unit

Veterinary ICUs house patients with cardiovascular, neurological, respiratory systems, and other clinical conditions (Humm & Kellett-Gregory, 2016; Smith & Witchell, 2016) and similar to human hospitals, these patients are at a high risk of HAIs. Most organisms causing HAIs are acquired through contact with the environment surfaces contaminated by pathogens shed from the animal skin, saliva, urine, and faeces (Kamathewatta, Bushell, Young, Stevenson, Billman-Jacobe, Browning & Marenda, 2019). Shoen *et al* (2019) in a veterinary teaching hospital, isolated *S. pseudintermedius* on different sites of the ICU ward

and suggest that transmission could have been through the hands of HCWs. Furthermore, antimicrobial residues are often shed via urine and faeces of patients and may accumulate in the cage environment further increasing the risk of the development of antimicrobial resistance (Kamathewatta *et al.*, 2019). Therefore, frequent hand washing, hand disinfection, wearing of gloves, and effective cleaning and disinfection are highly recommended in veterinary ICU (Kamathewatta *et al.*, 2019; Shoen *et al.*, 2019).

2.9 Methods to evaluate Infection prevention and control

Monitoring and evaluation of infection control practices are important for routine management of the risk of HAIs. Therefore, regular audits in healthcare facilities must be conducted to ensure compliance with good IPC practices. These audits must include assessment of IPC protocols, the facility, infection control daily activities, and knowledge of IPC practices among HCWs (Guptill, 2015).

Observations of IPC compliance can be done directly by a trained observer on the clinic floor or through recorded video footage. Although not frequently used, video observations provide less bias compared to direct observation due to the “Hawthorne effect” (Anderson, 2015; World Health Organization, 2009). The results of the observations and audits are then compared with national standards, published literature and recommendations are made on changes needed to improve infection control in the facility (Khamis & van Knippenberg-Gordebeke, 2016; Traverse & Aceto, 2015). These recommendations must be communicated to every employee in the clinic to ensure that each worker is invested and improves on their infection control practices (Guptill, 2015; Traverse & Aceto, 2015).

2.10 Hand hygiene compliance assessment

The hand hygiene compliance in a healthcare facility can be assessed either by direct or indirect monitoring (World Health Organization, 2009). Direct monitoring includes direct observation of hand hygiene activities during patient care. Indirect monitoring involves monitoring of the consumption patterns of hand hygiene products such as soap, hand rub and automated hand rub dispensers (World Health Organization, 2009). Direct observation is considered the gold standard for assessing hand hygiene compliance (Erasmus *et al.*, 2010; Gould, Creedon, Jeanes, Drey, Chudleigh & Moralejo, 2017; World Health Organization, 2009).

During the observation, five hand hygiene moments are evaluated namely: (1) before patient contact, (2) before an aseptic procedure, (3) after body fluid exposure, (4) after touching a patient, and (5) after contact with patient surrounding (**Figure 2. 1, Table 2. 1**) (World Health Organization, 2009).

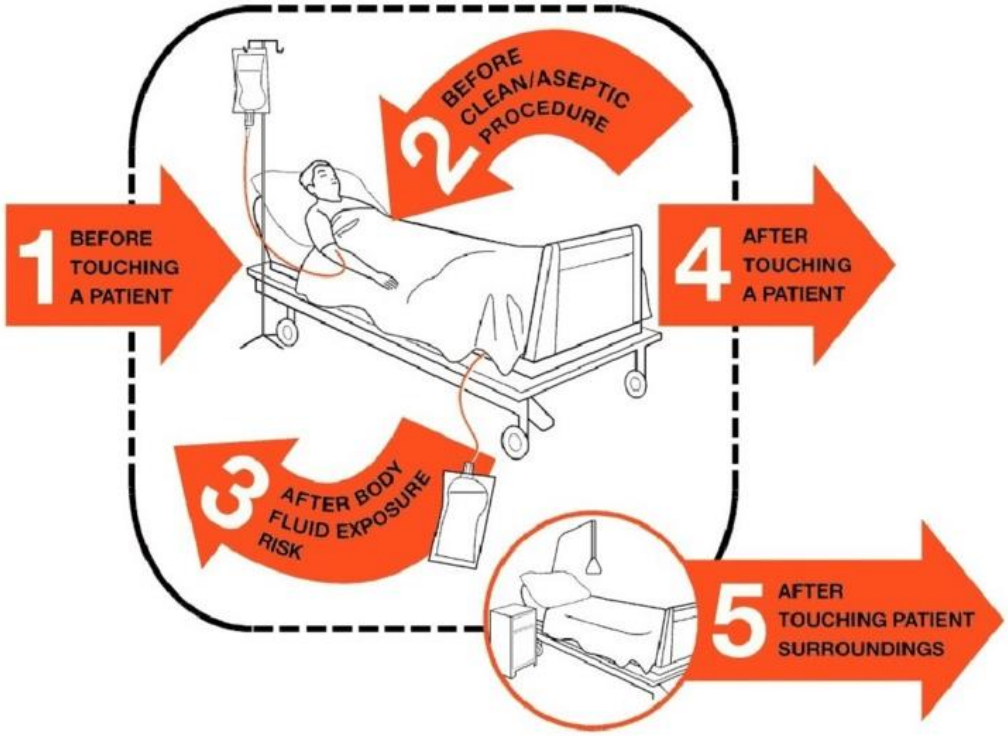

Figure 2. 1 Hand hygiene five moments by World Health Organization [1]

The World Health Organization (WHO) describes hand hygiene five moments as a crucial framework for understanding, training, measuring, and communicating hand hygiene performance in healthcare settings (World Health Organization, 2009).

[1] https://www.researchgate.net/figure/Five-moments-of-hand-hygiene-by-World-Health-Organisation-WHO_fig2_318391092 (Accessed 15/10/2019)

Table 2. 1 Definitions of the hand hygiene five moments

MOMENT	When and why
BEFORE PATIENT CONTACT	Healthcare workers must wash their hands before touching a patient to remove any potential pathogens that were picked up from previous patients. Even if the healthcare worker does not touch the patient directly, they may encounter a patient's clothing or personal objects with harmful microorganisms.
BEFORE AN ASEPTIC PROCEDURE	This moment occurs before any clean or aseptic procedure within a patient zone. A clean procedure may include opening a venous access line, giving an injection, or performing wound care. Importantly, hand hygiene required at this moment aims at preventing hospital-acquired infections. Some procedures on clean sites require glove use. In this case, hand hygiene is required before putting on gloves because gloves alone may not entirely prevent contamination and after removal of the gloves.
AFTER CONTACT BODY FLUID EXPOSURE	Hand hygiene is required instantly after a procedure associated with a risk to expose hands to body fluids. It must take place before any next hand-to-surface exposure, even within the same patient zone. This hand hygiene action may reduce the risk of colonization or infection of healthcare workers with infectious agents that may occur even without visible soiling. Additionally, it may reduce the risk of transmission of microorganisms from a "colonized" to a "clean" body site within the same patient.
AFTER PATIENT CONTACT	Hand hygiene should happen when leaving the patient zone after a care sequence, before touching an object in the area outside the patient zone and before a subsequent hand exposure to any surface in the health-care area. hand hygiene minimizes the risk of dissemination to the health-care environment, substantially reduces contamination of HCWs' hands with the flora from one patient to the other patient and protects the HCWs themselves.
AFTER CONTACT WITH PATIENT SURROUNDING	This moment occurs after hand exposure to any surface in the patient zone, and before a subsequent hand exposure to any surface in the health-care area, even if a patient is not touched.

2.10.1 Infection Control Assessment tool (ICAT)

International organisations such as World Health Organization (WHO) and Centres for Disease Control and Prevention (CDC) have developed standards and guidelines for preventing HAIs in human hospitals (National Department of Health, 2013; Salama *et al.*, 2013). In South Africa, the Infection Control Assessment Tool (ICAT) developed by the Department of Health is used to identify, control, and prevent HAIs (National Department of Health, 2013). This tool was used in human medicine. However, this has not been adopted in veterinary medicine.

The ICAT is adaptable for use in large and small healthcare facilities (Huskins, Ross-Degnan & Goldmann, 2011; National Department of Health, 2013). The tool can be used to strengthen IPC activities by identifying weaknesses in existing IPC programme (National Department of Health, 2013). The ICAT comprises of 22 modules and observational checklists that offer a simple and practical approach for assessing IPC practices (National Department of Health, 2013).

In view of this, it is not surprising that most IPC studies in South Africa have been done in human medicine. Mehtar et al. (2007) reported that only 3.6% of staff in the dental clinic knew of the existing IPC policy. While Naidoo and Seevnarain (2012) in KwaZulu Natal reported poor practices of IPC in South African hospitals and dental care. These studies concluded that there was a lack of knowledge of IPC in clinical practice and this could contribute to the transmission of HAIs and increased MDR pathogens in healthcare facilities. In South Africa, there are no similar studies on the knowledge of IPC among veterinary HCWs.

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CHAPTER 3

Hand hygiene compliance in the intensive care unit of the Onderstepoort Veterinary Academic Hospital.

Dikeledi Carol Sebola[1], Charles Boucher[2], Caroline Maslo[3], Daniel Nenene Qekwana[1]

1. Department of Paraclinical Sciences, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, South Africa
2. Department of Companion Animal Clinical Studies, Faculty of Veterinary Science, University of Pretoria, Onderstepoort, South Africa
3. Netcare Limited, 76 Maude Street, Cnr West, Sandton, 2196, South Africa

Under review at BMC: Antimicrobial Resistance and Infection Control
DOI:10.21203/rs.2.17130/v1

3.1 Abstract

Background: Hand hygiene compliance remains the cornerstone of infection prevention and control (IPC) in healthcare facilities. However, there is a paucity of information on the level of IPC in veterinary health care facilities in South Africa. Therefore, this study evaluated hand hygiene compliance of healthcare workers and visitors in the intensive care unit (ICU) at the Onderstepoort Veterinary Academic Hospital (OVAH).

Method: A cross-sectional study was conducted among healthcare workers (HCWs) and visitors in the ICU using the infection control assessment tool (ICAT) as stipulated by the South African National Department of Health. Direct observations using the “five hand hygiene moments” criteria as set out by the World Health Organization (WHO) were also recorded. The level of compliance and a 95% confidence interval were calculated for all variables.

Results: Individual bottles of alcohol-based hand rub solution and handwash basins with running water, soap dispensers, and paper towels were easily accessible and available at

all times in the ICU. In total, 296 observations consisting of 734 hand hygiene opportunities were recorded. Hand hygiene compliance was also evaluated during invasive (51.4%) and non-invasive (48.6%) procedures. The overall hand hygiene compliance was 24.3% (178/734). Most HCWs did not sanitize stethoscopes, leashes, and cellular phones used between patients. Additionally, the majority of HCWs wore jewellery below the elbows. The most common method of hand hygiene was hand rub (58.4%), followed by hand-wash (41.6%). Nurses had a higher (44%) level of compliance compared to students (22%) and clinicians (15%). Compliance was also higher after body fluid exposure (42%) compared to after patient contact (32%), before patient contact (19%), after contact with patient surroundings (16%), and before an aseptic procedure (15%).

Conclusion: Hand hygiene compliance in this study was low, raising concerns of potential transmission of hospital-acquired infections (HAIs) and zoonoses in the ICU. Therefore, it is essential that educational programs be developed to address the low level of hand hygiene in this study.

Keyword: Infection prevention and control, nosocomial, hospital-acquired infection, hand hygiene, compliance, intensive care unit, healthcare workers, veterinary, zoonoses

3.2 Introduction

Transmission of most hospital-acquired infections (HAIs) occur via contaminated hands of healthcare workers (Allegranzi & Pittet, 2009; Gould, Creedon, Jeanes, Drey, Chudleigh & Moralejo, 2017; Nakamura, Tompkins, Braasch, Martinez Jr & Bianco, 2012; World Health Organization, 2009a). Their hands may become contaminated during routine procedures such as lifting of patients, taking of temperatures, as well as by touching contaminated surfaces and fomites including stethoscopes (Milton, 2015; Traverse & Aceto, 2015). Hand hygiene therefore remains the most effective means to prevent and control infection in healthcare facilities (Allegranzi & Pittet, 2009; Boyce, Chartier, Chraiti, Cookson, Damani, Dharan & others, 2006; Nakamura *et al.*, 2012; Salama, Jamal, Al Mousa, Al-AbdulGhani & Rotimi, 2013).

Adequate hand-washing and proper hand disinfection have been shown to reduce the risk of transmission of HAIs, zoonotic diseases, and antimicrobial-resistant pathogens (Lonks, 2018; Stull & Weese, 2015; Walther, Tedin & Lübke-Becker, 2017). Notwithstanding the advantages of hand hygiene, the overall level of compliance in healthcare units remains low (Erasmus, Daha, Brug, Richardus, Behrendt, Vos & van Beeck, 2010). This has been attributed to factors such as high workload, lack of resources, forgetfulness, lack of knowledge and training in hand hygiene practices, and avoidance due to underlying clinical conditions of HCWs including skin irritation (Anderson, 2015; Shea & Shaw, 2012; Stull & Weese, 2015).

Direct observation is the preferred method of evaluating hand hygiene compliance in healthcare facilities (Erasmus *et al.*, 2010; Gould, Drey & Creedon, 2011; World Health Organization, 2009a) and this is done based on the “hand hygiene five moments” as defined by the World Health Organization (WHO) (World Health Organization, 2009a). This method has been applied in some form in both veterinary (Anderson, Sargeant & Weese, 2014; Anderson & Weese, 2012; Kelcíkova, Skodova & Straka, 2012; Shea & Shaw, 2012; Smith,

Packman & Hofmeister, 2013) and human healthcare facilities (Randle, Arthur & Vaughan, 2010; Salama *et al.*, 2013). In South Africa, studies on hand hygiene compliance have been done in human healthcare facilities (Matuka, Binta, Carman & Singh, 2018; Mehtar, Shisana, Mosala & Dunbar, 2007). There are however no published studies on the level of hand hygiene compliance in veterinary health facilities in South Africa. This study aims to evaluate the level of hand hygiene compliance among healthcare workers in the intensive care unit (ICU) at the Onderstepoort Veterinary Academic Hospital (OVAH). The authors hypothesized that the level of hand hygiene compliance among HCWs in the ICU at the OVAH was low, similar to that reported in other studies (Erasmus *et al.*, 2010; Shea & Shaw, 2012).

3.3 Methods

3.3.1 Study design

A cross-sectional study on hand hygiene compliance was conducted among healthcare workers (HCWs) and visitors at the OVAH between January and March of 2019. The HCWs evaluated were clinicians, veterinary nurses, and students (veterinary and nursing).

The OVAH is located north of Pretoria in the City of Tshwane Municipality; it is part of the only veterinary faculty in South Africa, which is part of the University of Pretoria. This study was performed within the Companion Animal Clinical Studies (CACS) Department, which forms one of the five departments within the Faculty. This department is further divided into small animal surgery, small animal medicine, and outpatients. All patients from these sections that require critical care are referred to the same ICU, excluding those with contagious infectious diseases like canine parvovirus, which are admitted to a separated isolation ward. There are three duty shifts in the ICU: morning (08h00 to 12h00), afternoon (12h00 to 20h00) and night shifts (20h00 to 08h00).

3.3.2 Data collection

3.3.2.1 Facility check

The facility was audited using a facility checklist for washing supplies and alcohol hand antiseptic outlined in the infection control assessment tool (ICAT) (National Department of Health, 2013). The questions in the checklist covered the number of cots and cages, number of animals admitted, presence, number, and distribution of hand hygiene facilities such as hand washing basin, alcohol-based hand rub, and the type of soap available for use, if any.

3.3.2.2 Observation checklist

Health care workers were observed by the researcher during their routine patient care in the morning, afternoon, and night shifts. The day of data collection was randomised and the HCWs were not made aware of the scheduled date for observation. The duration of observation was at least two hours per shift. Direct observation of hand hygiene was conducted using ICAT using hand hygiene module and observation checklist for hand hygiene practices (National Department of Health, 2013; World Health Organization, 2009a).

The five moments of hand hygiene within the patient zone were evaluated, namely: (1) before patient contact, (2) before an aseptic procedure, (3) after contact with body fluids, (4) after patient contact, and (5) after contact with patient surroundings (World Health Organization, 2009a). The information was recorded manually on paper and entered into Epi Info™ software (Centers for Disease Control and Prevention, 2018) at the end of each observation sessions.

The ICAT was pre-tested in the ICU before the commencement of the project and modifications were made to improve the quality and relevance of the questions to the veterinary ICU setting. In addition, the observer was trained on how to conduct observations.

3.3.3 Data management and data analysis

The dataset was assessed for missing data such as incomplete entry of observed moments and inconsistencies such as improbable values, none being identified. For each opportunity, the outcome was coded as a binary, 1-complied or 0-not. The hand hygiene compliance as a proportion was calculated by dividing the number of hand hygiene actions by the total number of opportunities (World Health Organization, 2009a). In addition, 95% confidence intervals were calculated for all variables in the dataset.

3.3.4 Ethics approval

The study was approved by the Research Ethics Committee of the University of Pretoria (Project number: REC034-18). Permission was also secured from the Director of the hospital and the Head of the Department of CACS.

3.4 Results

3.4.1 Facility audit

The ICU has 21 fixed cages positioned two storeys against the wall and three freestanding cots on wheels. When the need arises, more portable cages are added. On average, there were six HCWs per shift. During the study, an average of 11 dogs per day were housed in ICU with two being in critical condition. In addition, on average, two cats per day were housed in ICU.

Individual bottles of alcohol-based hand rub solutions with 0.5% chlorhexidine gluconate and 70% alcohol were distributed throughout the ICU allowing easy access by HCWs. Some were mounted on the outside of cages and cots; one for every three cages and one for each cot and others were on the benches and medicine tables in the ICU.

Three hand-wash basins each equipped with running water, antiseptic soap dispensers, and one paper towel were placed near all the three doors in the ICU (two entrances and one to the duty room).

Information on IPC, including the wearing of protective clothing, was displayed on each cage depending on the condition or clinical diagnosis of the patient. In addition, English posters in picture and text showing the five moments of hand hygiene were displayed above each hand-washing basin. However, there was no formal training program on hand hygiene for HCWs within the ICU.

Morning and night shifts are regarded as busy compared to the afternoon shift. During all the shifts, there was at least one ICU sister on duty. The morning shift was manned by student nurses, while the afternoon and evening shifts were manned by student veterinarians. During the afternoon shift, veterinary students and veterinary clinicians visited the ICU to attend to their cases.

3.4.2 General observation

Healthcare workers were responsible for taking patients for walks outside the building to allow them to urinate and defecate. During this process, no hand hygiene was applied before using a leash or touching a patient. Similarly, no hand hygiene was practiced before or after contact with the patient, especially at times when patients needed/vocalised for attention. No hand hygiene was performed by the majority of students before or after patient contact or with environmental fomites, including stethoscopes, telephone, cellphones, thermometers, medicine cabinet, drugs and intravenous infusion pumps. The majority of veterinary students were not 'bare below the elbow' as they were wearing wristwatches and rings. However, most HWCs, seemed to adhere to the hand hygiene instructions given on IPC when dealing with infectious disease cases such as haemorrhagic, gastroenteritis, urinary tract infections, and multidrug resistant *Pseudomonas aeruginosa.* Most HCWs did not perform any hand hygiene before putting on or after removing gloves.

3.4.3 Hand hygiene compliance

There were 296 total observations made in the ICU. A total of 734 hand hygiene opportunities were recorded during the study. A hand hygiene opportunity existed whenever one of the moments for hand hygiene was present and a hand hygiene action was expected. Therefore, there was an opportunity for the observer to assess compliance.

The types of patient procedures included invasive (51.4% (152/ 296), CI: 45.7- 57.0) and non- invasive (48.7% (144/ 296), CI: 43.0- 54.3). Invasive procedures are procedures which access to the body is gained via an incision, percutaneous puncture, and needles. Additionally, intramuscular, and subcutaneous injections, catheterisation, use of thermometer, and feeding tubes were also classified as invasive procedures. Non-invasive were those with no break in the skin or enters internal body cavity.

Hand rub (58.4%; CI: 51.1- 65.4) was the preferred method of hand hygiene compared to hand-wash (41.6%; CI: 34.6-48.9). Among the HCWs, 77.6% of opportunities assessed were from students, 12.3% from nurses, and 9.4% from clinicians **(Table 3.1).** Visitors had 0.5% opportunities **(Table3.1)**.

The overall hand hygiene compliance in ICU was calculated to be 24.3% **(Table 3.1).** Hand hygiene compliance was higher among nurses (44.0%) compared to students (22.3%), clinicians (15.9%) and visitors (0%). The morning shift had the highest (35.3%) level of compliance compared to afternoon (13.9%) and night (23.4%) shifts. Hand hygiene compliance among HCWs was higher after body fluid exposure (41.7%) and after patient contact (32.2%). Lower hand hygiene compliance was observed before patient contact (18.8%), before an aseptic procedure (15.4%), and after contact with the patient's surroundings (15.8%).

Table 3. 1: Levels of hand hygiene compliance among healthcare workers and visitors in the intensive care unit between January and March 2019.

	Opportunities	**Hand hygiene compliance**	
Variable	**% (n/N)**	**% (n/N)**	**95% CI[a]**
Ward	734	24.3 (178/734)	21.29- 27.48
Healthcare workers			
Clinician	9.4 (69/734)	15.9 (11/69)	9.14- 26.33
Nurses	12.3 (91/734)	44.0 (40/91)	34.21- 54.19
Students	77.7 (570/734)	22.3 (127/570)	19.06- 25.88
Visitors (Patient owners)	0.5 (4/734)	0 (0/4)	0.00-48.99
Time of day			
Morning	28.2 (207/734)	35.3 (73/207)	29.08- 41.99
Afternoon	26.4 (194/734)	13.9 (27/194)	9.75- 19.49
Night	45.3 (333/734)	23.4 (78/333)	19.19- 28.26
Type of opportunity			
Before patient contact	39.2 (288/734)	18.8 (54/288)	14.66- 23.66
After patient contact	36.8 (270/734)	32.2 (87/270)	26.93- 38.01
Before an aseptic procedure	3.5 (26/734)	15.4 (4/26)	6.15- 33.53
After contact with the surrounding	15.5 (114/734)	15.8 (18/114)	10.23- 23.58
After body fluid exposure	4.9 (36/734)	41.7 (15/36)	27.14- 57.80

[a]95 percent confidence interval

Nurses had the lowest compliance after body fluid exposure (14.3%) and the highest compliance was before an aseptic procedure (100.0%). Students had the lowest compliance before patient contact (15.6%) and the highest was before an aseptic procedure (46.2%). Clinicians had the lowest compliance after contact with patients' surrounding (0.00%) and the highest was after patient contact (33.3%) **(Table 3.2).**

Table 3. 2: Level of hand hygiene compliance among healthcare workers based on the five hand hygiene moments.

Type of HCW	Moments of hand hygiene				
	BPC[b]	APC[c]	ACPS[d]	BAP[e]	ABFE[f]
Nurses	43.6 (17/39)	48.6 (17/35)	25.00 (3/12)	100.0 (2/2)	14.3 (1/7)
Students	15.6 (35/ 225)	29.7 (63/212)	16.48 (15/91)	46.2 (13/26)	33.3 (1/3)
Doctors	9.1 (2/22)	33.3 (7/21)	0.00 (0/11)	12.5 (1/8)	12.5 (2/16)

[b]Before patient contact; [c]After patient contact; [d]After contact with patient surrounding; [e]Before an aseptic procedure; [f]After body fluid exposure

3.5 Discussions

The aim of this study was to evaluate the level of hand hygiene compliance among healthcare workers and visitors in the ICU at the Onderstepoort Veterinary Academic Hospital.

Alcohol hand rub was the preferred method of hand hygiene in this study. In contrast, Nakamura and colleagues (2012) in a small animal private practice in the United States reported more (85%) handwashing with soap than alcohol-based hand rubs (11.6%) or chlorhexidine/betadine solution (3.8%). Alcohol-based rub is the preferred method as it is faster, more effective, and better tolerated by the skin (World Health Organization, 2009a). In addition, it has a broad spectrum of action and is able to kill most microorganisms in a hospital setting (Allegranzi & Pittet, 2009; Nakamura *et al.*, 2012). A human study by Eggimann and Pittet (2001) in Switzerland, reported a decrease in the prevalence of HAIs and Multidrug-Resistant *Staphylococcus aureus* (MRSA) after the introduction of alcohol-based sanitizers. Notwithstanding the effectiveness of alcohol-based sanitizers, mechanical hand washing with running water and antiseptic soap should also be used in veterinary medicine as animals are more likely to be soiled with debris. Moreover, mechanical hand washing has been shown to be more effective against spore-forming bacteria and in the presence of organic matter (Allegranzi & Pittet, 2009).

Most students in this study wore wristwatches and used personal cellphones during the care of patients. This is concerning as the wearing of jewellery, use of cellphones, and other personal equipment while treating a patient has been shown to increase risks of transmission of both HAIs and zoonotic infections (Anderson *et al.*, 2014; Milton, 2015; Willemsen, Cobbold, Gibson, Wilks, Lawler & Reid, 2019). Trick *et al* (2003) in human medicine showed a greater frequency of pathogens present on hands with jewellery compared to those without, regardless of the method of hand hygiene applied. Health care

workers may also transport pathogens from healthcare facilities and introduce infections into their homes (Anderson *et al.*, 2014; Nakamura *et al.*, 2012).

The majority of HCWs in this study did not perform hand hygiene before putting on or after removing gloves. The use of gloves is recommended in infection control but should not be a substitute for hand hygiene (National Department of Health, 2013), which should therefore be performed prior to donning and after glove removal (National Department of Health, 2013; Smith *et al.*, 2013). Hands could additionally be contaminated in the process of removing gloves, gloves could tear, or they may have microscopic defects resulting in contamination.

3.5.1 Overall compliance

The overall hand hygiene compliance in the OVAH ICU was similar to the 20.6% reported by Shea and Shaw (2012) in a small animal veterinary hospital in the United States of America. Similarly, low (30%- 40%) hand hygiene compliance in the human ICU have been reported in the Netherlands. In contrast, in a human study in the United Kingdom (UK), Randle *et a*l (2010) reported a higher (67.8%) hand hygiene compliance in the ICU. The overall low level of hand hygiene compliance in the current study could be attributed to time constraints between patients (Erasmus *et al.*, 2010), a lack of perceived importance of hand hygiene (Anderson, 2015), and low levels of hand hygiene compliance in the five moments observed in this study. The low compliance level in the current study is concerning as hand hygiene compliance has been shown to decrease cases of HAIs and minimise exposure to zoonotic disease (Matuka *et al.*, 2018; Shea & Shaw, 2012). Therefore, it is imperative that ongoing educational programs and surveillance be implemented for sustained changes in behaviour (Anderson *et al.*, 2014; Salama *et al.*, 2013; Shea & Shaw, 2012; World Health Organization, 2009a) and improvement in hand hygiene compliance (Lau, Tang, Mak & Leung, 2014; Nakamura *et al.*, 2012; Shea & Shaw, 2012).

3.5.2 Compliance based on the type of healthcare worker and time of day

We observed lower compliance among doctors when compared to nurses and students with nurses having the highest level of compliance. Similarly, Salama and colleagues (2013) in a human hospital in Kuwait reported lower compliance in doctors (38.4%) compared to nurses (50.0%). Our results and results of others suggest that nurses are more adherent to and knowledgeable about hand hygiene compared to other HCWs (Lau *et al.*, 2014; Salama *et al.*, 2013). Furthermore, hand hygiene compliance was higher in the morning compared with that during other shifts. This could be because nurses worked mostly in the morning shift and had higher level of compliance compared to other healthcare workers. In addition, the higher number of HCWs present in the morning shift compared to other shifts could have reduced the ratio of patient to HCW allowing more time and better implementation of hand hygiene. In view of these findings we recommend the implementation of intervention strategies including education, feedback sessions, and monitoring of non-compliant doctors and students in order to improve compliance. Moreover, we recommend that the OVAH places a greater emphasis on the importance of compliance to hand hygiene and other IPC practices in the ICU through the current curriculum of both veterinary and veterinary nursing students.

3.5.3 Type of moment

We observed low hand hygiene compliance after contact with the environmental fomites such as medicine, drugs cabinets, drips, cages, cots, doors, telephones, bedding and leashes. In contrast, Randle Arthur, and Vaughan (2010) in a human hospital in the United Kingdom reported a high (50%) compliance after contact with patient surroundings. The patient's surroundings have been shown to harbour various microorganisms including those that cause HAIs (Traverse & Aceto, 2015). Anastasiades *et al* (2009) in South Africa isolated *Staphylococcus aureus* from the computer mouse and keyboards used in the

human ICU. Similarly, hand hygiene compliance in the current study was low after contact with surrounding and environmental fomites. In addition, studies have reported low hand hygiene compliance during activities that pose a low risk to HCWs when compared to patients, suggesting that HCWs perform hand hygiene for their own protection and not for that of patients' (Salama *et al.*, 2013; World Health Organization, 2009a,b). This hypothesis is substantiated by the low level of compliance before an aseptic procedure (15.4%), before patient contact (18.8%) compared to high compliance after patient contact (32.2%), and after body fluid exposure (41.7%). This is most likely due to the hands of HCWs often being visibly soiled, sticky or gritty after these moments (Allegranzi & Pittet, 2009). Therefore, it is recommended that hand hygiene be performed anytime when in contact with patients and patients surrounding (Allegranzi & Pittet, 2009; Anderson, 2015; World Health Organization, 2009a). Moreover, interventions must be moment specific due to the variation in compliance based on the type of moment.

Based on the five moments of hand hygiene, nurses had the lowest compliance after body fluid contact, students had the lowest compliance before contact with a patient, and doctors had the lowest compliance after contact with patient surroundings and before patient contact. Compliance during the five moments in our study was significantly different between the three groups of HCWs. These findings suggest that the type of moment, as well as the type of HCW should be considered when developing hand hygiene intervention strategies.

3.6 Limitations

To our knowledge, this is the first study in veterinary medicine in South Africa that used the ICAT tool to assess hand hygiene compliance. Therefore, the comparison to other studies is largely based on human studies which uses a similar system. The presence of the assessor in the ICU could have resulted in higher than normal levels of hand hygiene compliance. However, the assessor was discreet about the assessment questions and never communicated with the HCWs about the content of the assessment. The HCWs

assessed in this study were not inclusive of other ICU workers such as kennel cleaners and cleaning staff members which are also capable of transmitting HAI pathogens. Nonetheless, the results in this study provide a useful indication of hand hygiene compliance level in the ICU at OVAH.

3.7 Conclusions

The low level of hand hygiene compliance in this study is concerning because of the possible risk of transmission of HAIs and zoonotic diseases via the hands of healthcare workers. This is likely to result in increased incidence and transmission of antimicrobial resistant pathogens within the ICU, posing risks of infection to immunosuppressed patients.

Hand hygiene compliance was lower among doctors, during the night shift, before patient contact and after contact with patient surroundings, and before aseptic procedures. Interventions should therefore be considered to improve hand hygiene compliance in the hospital. These may include regular educational campaigns on the importance of adhering to hand hygiene, development and promotion of written hand hygiene protocols, and programs promoting regular hand hygiene monitoring could be developed. These interventions should be moment and HCW specific.

3.8 References

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CHAPTER 4

4.1 Summary, discussions, and conclusions

This chapter summarizes the key findings of the study, provides conclusions and recommendations for future research on hand hygiene compliance at the veterinary academic hospital. The initial objective of this study was to assess hand hygiene compliance level based on the five hand hygiene moments in the intensive care unit (ICU) of Onderstepoort Veterinary Academic Hospital. In this study two assessments were done using the ICAT (National Department of Health, 2013), first was the facility audit and second was the direct observation of HCWs during their routine patient care as well as patient owners (National Department of Health, 2013; World Health Organization, 2004, 2009a). The study hypothesized that the level of hand hygiene compliance among HCWs in the ICU at the OVAH was low, similar to the level reported in other studies (Erasmus, Daha, Brug, Richardus, Behrendt, Vos & van Beeck, 2010; Shea & Shaw, 2012).

In general healthcare workers in this study had a low hand hygiene compliance when using instruments between patients. In addition, hand hygiene compliance was low between touching the environment such as the medicine cabinet, telephone, the drip machine, leashes, handling the cots or cages, feeding utensils and handling patients. The use of personal phones and the wearing of wristwatches when attending patients was also common among healthcare workers in this study. These observations are concerning because the environment has been shown to harbour most of the HAI organisms in both veterinary (Traverse & Aceto, 2015) and human medicine (Allegranzi & Pittet, 2009). Therefore, these practices are likely to increase the risk of transmission of HAIs in the ICU at the OVAH. In addition, HCWs can take home pathogens from the facility and introduce infections into their homes (Canadian Committee on Antibiotic Resistance, 2008; Trick, Vernon, Hayes, Nathan, Rice, Peterson, Segreti, Welbel, Solomon & Weinstein, 2003;

Weese, 2004). Since the findings of this study suggest that hand hygiene compliance among HCWs is low, we recommend education and training programmes on infection prevention and control (IPC) and general hand hygiene compliance be introduced in the ICU. Furthermore, continuous education programs must also be implemented to maintain a high standard of IPC and hand hygiene compliance in the hospital. The use of cellphones and wearing of jewellery must not be allowed in the ICU and were possible disinfects must be made available for cleaning of all instruments used by HCWs during patient care and management to facilitate timely control of transmission of pathogens.

Alcohol-based sanitisers and hand washing basins with running water, liquid soap and paper towel were available in the ICU. Alcohol-based hand rub compared to handwashing was the preferred method of hand hygiene compliance in this study. This is not surprising as the bottles of hand sanitiser were easily accessible in the ICU compared to the washing basins. Studies in human hospitals have also reported alcohol-based sanitiser as the preferred method of hand hygiene by healthcare workers because it is faster, more effective, better tolerated by the skin, and able to kill most microorganisms that are not visible to the eye in a hospital setting (Boyce, Chartier, Chraiti, Cookson, Damani, Dharan & others, 2006; Boyce & Pittet, 2002; Canadian Committee on Antibiotic Resistance, 2008; Picheansathian, 2004; Trick *et al.*, 2003; World Health Organization, 2009a). In view of this, our study recommends that the use of alcohol-based hand sanitizers in the ICU at the OVAH must be continued. However, were the hands of HCWs are visibly contaminated with dirt, handwashing with running water and soap must be considered as this method have been shown to be more effective in veterinary hospitals (Canadian Committee on Antibiotic Resistance, 2008).

Hand hygiene compliance

Hand hygiene compliance in this study was low similar to other studies (Erasmus *et al.*, 2010; Randle, Arthur & Vaughan, 2010; Shea & Shaw, 2012). Low compliance in this study could be attributed to the general low compliance observed in all the five moments of hand hygiene assessed in this study. It is also possible that low compliance is due to high workload, lack of resources, underlying clinical conditions including, skin irritation, forgetfulness, and time constraints between patients as reported in human studies (Anderson, 2015; Erasmus *et al.*, 2010; Shea & Shaw, 2012; Weese, 2004), however, further research will be needed to investigate this hypothesis. The most likely cause of low compliance in this study could have been lack of formal training program on hand hygiene compliance among HCWs within the ICU at the time of the study.

Similar to studies in both human (Erasmus *et al.*, 2010; Pittet *et al.*, 2000; Salama, Jamal, Al Mousa, Al-AbdulGhani & Rotimi, 2013) and veterinary medicine (Anderson, 2015; Nakamura, Tompkins, Braasch, Martinez Jr & Bianco, 2012; Shea & Shaw, 2012), hand hygiene compliance was low among doctors compared to other healthcare workers with highest level of compliance observed among nurses. This could be due to the fact that infection control is emphasized in veterinary nurses' curriculum compared to doctors' curriculum. Therefore, as reported in other studies, nurses are more likely to have high knowledge on IPC practices and are adherent to IPC practices (Lau, Tang, Mak & Leung, 2014; Pittet *et al.*, 2000; Salama *et al.*, 2013). The results further emphasise the need to include IPC education and training of other HCWs working in the OVAH ICU. In addition, ICP among veterinary nurses in the current study must be selected to champion IPC.

Type of hand hygiene moment

Compliance was low before patient contact, before an aseptic procedure, and after contact with patient surrounding. In addition, hand hygiene compliance in each moment differed with the type of HCW assessed. For example, nurses had the lowest compliance after body fluid exposure, students had the lowest compliance before patient contact, and doctors had the lowest compliance after contact with patient surroundings. The WHO and other studies reported that low compliance among healthcare workers is mostly observed in moments that put patients on risk of infections while protecting themselves (Salama *et al.*, 2013; World Health Organization, 2009b). The results suggest that intervention strategies to improve hand hygiene compliance must consider both the type of hand hygiene moment and HCWs.

Conclusions

Continuous intervention strategies to improve knowledge on IPC practices amongst HCWs in the hospital must be implemented to improve the low levels of compliance observed. These interventions may include educational programmes, feedback sessions, and regular monitoring of hand hygiene compliance. Recurriculation of the undergraduate syllabus must also be undertaken to incorporate IPC in undergraduate training. Furthermore, development and promotion of written hand hygiene protocols and programs promoting hand hygiene should be considered at the OVAH.

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ANNEXURES

This section includes the modified checklists that were used in this study for Facility checklist and hand hygiene observation checklist (Table 5.1) derived from the World Health Organisations (World Health Organization, 2009).

Annexure A: **Facility Checklist**

Facility: Ward/area: Date: Time of day:

FACILITY CHECKLIST FOR ALCOHOL HAND ANTISEPTIC

For each hand washing station, write the answer in the space provided. For multiple choice questions, mark the answer that best describes the current situation by putting an "X" through the circle in front of the appropriate response(s).

1. How many cots/ cages are there in the ward/area? _____Cots _____Cages

2. How many patients are there in the ward/area? _____

2.2Number of high-risk patients _____

3. How many health care workers are there in the ward/area currently? (Please include nursing officers, doctors, nurse, students etc.)_____

4. Is alcohol hand antiseptic currently available in the ward/area?

☐ No (end of survey)

☐ Yes

5. If YES, how many bottles are there? (not empty) _____

6. Is the antiseptic easily accessible to everyone working in the ward?

☐ No

☐ Yes

7. Is there a hand washing station in the ward or area?

☐ No (stop, go to a different ward or area)

☐ Yes

8. If YES, what type of hand washing station is it?

☐ Regular bowl, tank, or container with water

☐ Sink with running water tap

☐ Station with gravity-flow running water

9. Is there running water currently available at the station?

☐ No

☐ Yes

10. Is there soap available at the station?

- ☐ No (go to question 6)
- ☐ Yes

11. If soap is available, what kind of soap is it?

- ☐ Bar without rack
- ☐ Bar with rack
- ☐ Liquid soap in a container (plastic bottle or on the wall)

12. Are there paper towels available to dry hands?

- ☐ No
- ☐ Yes

Annexure B: Hand hygiene Observation checklist

Table 5. 1: Hand hygiene observation checklist

For each observation, choose the answer that best describes the situation by marking the applicable box with an "X" in the appropriate column

Ward: ICU **Date** **Time of day:**

Type of health worker					Type of patient contact		Type of hand hygiene before patient contact			Type of hand hygiene after patient contact			Type of hand hygiene after contact with patient surroundings (cages)			Type of hand hygiene after body fluid exposure			Type of hand hygiene before an aseptic procedure			Comments
	Dr	Nurse	Student	Other	Invasive	Non-Invasive	Wash	Alcohol rub	None	Wash	Alcohol rub	None	Wash	Alcohol rub	None	Wash	Alcohol rub	None	Wash	Alcohol rub	None	
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