A review of bacteriology spectrum and antibiotic sensitivity of hand sepsis in patients treated at CHBAH

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Declaration

I, Prince Masibulele Jada declare that this Research Report is my own, unaided work. It is being submitted for the Degree of Master of Medicine in the branch of Orthopaedic Surgery at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

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(Signature of candidate)

……day of …….20…….in Johannesburg

Abstract

Hand infection is the most common condition seen at Chris Hani Baragwanath Academic Hospital Orthopaedic casualty. In 2017, 31% of orthopaedic admissions at our institution were patients with hand sepsis. Failure to adequately treat these infections results in severe loss of hand function and disability, and this leads to a significant socioeconomic impact in our population. The infected patients are usually started on empiric antibiotics (amoxicillin-clavunate (Augmentin)) on admission, and prior to surgical drainage. The purpose of this study was to identify the microbiology profile of hand infections and their antibiotic sensitivity at our institution. The laboratory results of antimicrobial sensitivity were compared with the antibiotics started empirically. The impact of associated co-morbidities on the microbiology profile was also assessed. The results showed that *Staphylococcus aureus* (*S. aureus*) is the most common cultured organism. Most organisms were sensitive to cloxacillin. The culture results in HIV infected patients did not differ to those in the uninfected population. Acquired Methicillin-Resistant *S. Aureus* remains low in our population setting.

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Nomenclature

AIDS	Acquired Immunodeficiency Syndrome
CHBAH	Chris Hani Baragwanath Academic Hospital
CIs	Confidence Intervals
Df	Degrees of freedom
HIV	Human Immunodeficiency Virus
HREC	Human Research Ethics Committee
IBM SPSS	International Business Machines Statistical Package for Social Science
MC&S	Microscopy, Culture and Sensitivity
MRSA	Methicillin-Resistant Staphylococcus Aureus
MSSA	Methicillin-Sensitive Staphylococcus Aureus
NHLS	National Health Laboratory Service
ORs	Odd Ratios
S. aureus	Staphylococcus Aureus
Wits	University of the Witwatersrand, Johannesburg
Vs	Versus

CHAPTER 1

1 Introduction and literature review

1.1 Background

Hand infections are defined as microorganism inoculation of superficial or deep spaces of the hand resulting in pus collection in the space involved. These spaces are formed by fascia and fascial septae. Superficial spaces are pulp of the finger, and dorsal subcutaneous spaces. The deep spaces include thenar, hypothenar, midpalmar and dorsal subaponeurotic spaces. Hand infections present a very difficult diagnostic and management challenge to Orthopaedic surgeons. Early and accurate diagnoses combined with appropriate management are vital for good outcomes. Adequate treatment requires an understanding of the anatomy of the hand and how this influences the behaviour of certain organisms, antibiotic treatment, management of host factors, and surgical intervention. Types of infections include superficial abscesses (paronychia, felon, etc.), deep space infections, flexor tenosynovitis, septic arthritis, osteomyelitis, bites (animal or human), mycobacterium and fungal infections[1,4].

Infections of the hand are present in all communities, but prevalence is dependent on patient factors such as immunodeficiency and exposure (occupation, intravenous drug use, foreign body inoculation, etc.)[4].

The most common causative microbes are the bacterial flora of the skin and mouth. It has been reported that 70% of hand sepsis is caused by *Staphylococcus aureus* (*S. aureus*) and *Streptococcus* species[1,9]. It was previously noted that 86% of cultures yield a single organism, however more recent studies show that 60% of all cultures have mixed organisms with *Staphylococcus* and *Streptococcus* species[2,14,15]. Immunocompromised patients present with mixed organisms of both Gram-positive and Gram-negative bacteria[3]. There has been a recent increase in the incidence of Methicillin-Resistant *Staphylococcus Aureus* (MRSA) as the offending organism in hand infections in both the hospital and community settings[4]. The incidence of MRSA infections ranges from 34% to 74% of all hand infections depending on

which part of the population the patient is from[8]. There is a high prevalence in the United States of America (70%) whereas the prevalence is low in the United Kingdom (11%) and other European countries (34%)[8]. Risk factors for the development of MRSA include prolonged hospitalisation, prolonged antibiotic therapy, previous surgical procedures, chronic illnesses, and intravenous drug use[24].

There are several aetiological factors for hand sepsis but the most common and frequent cause is neglect[3]. Bite injuries (human and other mammals) are relatively common, and they are responsible for 20 − 30% of the infections[2,3].

Superficial infections are the most common infections of the hand. These include paronychia which is a soft tissue infection of the lateral nail fold, and felon which is an abscess of the digital pulp. Paronychia presents with swelling, erythema, tenderness and abscess formation along the nail fold. This can be treated with warm soaks and oral antibiotics, but if an abscess collection is present, incision and drainage is warranted. A felon is usually associated with penetrating trauma[25]. The septal compartments of the palmar pad create a close space that can easily form an abscess and result in compartment syndrome. All superficial abscesses can be treated as outpatients with incision and drainage under local anaesthesia, oral antibiotics and wound dressings. Regular follow up for wound check is advised to identify early complications or pus recollection[3,8,24,25].

The hand is the most common site for bite injuries[20]. Human bites are less common than animal bites accounting for 2 − 3% of hand bites. These bites can be categorised as clenched fist injuries (fight bites) which result from the impact of the hand against the teeth during a fight, or occlusive bite injuries which are caused by closing of the teeth directly on tissue[20]. Human bites can result from altercations, assault, abuse or self-defence. The true incidence is likely to be underestimated because patients may not seek medical care. The clenched fist injuries usually involve the metacarpophalangeal joint because of its prominence. The teeth often penetrate the extensor mechanism and joint capsule leading to injuries of articular cartilage and bone. When the hand returns to a relaxed position, retraction of the extensor tendon removes the tendon from view in the skin wound and seals the capsular tear. This creates a closed environment ideal from bacterial growth and development of septic arthritis, tenosynovitis and subcutaneous space abscess[20].

Dog bites are responsible for 80 to 90% of bites[21]. Cat bites are the second most common and they usually occur in adult women[21]. Bite infections can present with a wide spectrum of diseases depending on the inflicting species[12]. Human bite infections are often more serious than those inflicted by animals due to the amount of bacterial flora in the human mouth, as well as the mechanism of injury[21]. In more than 50% of cases, these are associated with anaerobic bacteria[12] and triple antibiotic cover is advised to cover Gram-positive, Gram-negative and anaerobic bacteria[12].

Fungi, mycobacteria and viruses can present more indolent hand infections that can be difficult to diagnose and treat. These atypical organisms exist within a wide spectrum of presentations, from superficial to deep abscesses in immunocompromised patients[23]. These infections are commonly misdiagnosed and do not respond to standard antibiotic therapy. Having a high clinical suspicion for atypical infections is essential because a diagnosis often requires special tests and cultures[23].

A delay in presentation and inadequate treatment results in poor hand mobility and function. These infections are diagnosed clinically and require prompt treatment. The management of hand sepsis includes a combination of antimicrobial therapy, immobilisation, early surgical drainage of an abscess and early rehabilitation when oedema settles.

Best practice management of hand sepsis requires a full understanding of the unique and complex hand anatomy by the treating surgeon. It also includes early aggressive wound care and adequate antibiotic selection based on commonly cultured organisms. Immunocompromised patients may present with atypical organisms making antibiotic selection very difficult[5]. Patients with diabetes mellitus usually have mixed organisms with a predominance of Gram-negative organisms[5,6,7]. These patients present with severe extensive infections. They respond slowly to adequate treatment with some patients requiring multiple debridements and amputation to control sepsis.

Initial antibiotic selection is based on the most likely infecting organism, using local guidelines on the most prevalent organisms. *S. aureus* (most cultured organism) is sensitive to cloxacillin[7]. First generation cephalosporins have previously been used as empiric antibiotic cover for hand sepsis[7,8,9]. With the increasing prevalence of community acquired MRSA, some studies suggest the addition of vancomycin in antibiotic selection[10,11,12]. In patients with a risk of having Gram-

negative sepsis, fluoroquinolones or Amoxicillin-clavulanic acid (Augmentin) is advisable for broad spectrum cover.

As there is a wide spectrum of organisms present in different patients, it becomes difficult to select appropriate empiric antibiotics. In our clinical setting, at Chris Hani Baragwanath Academic Hospital (CHBAH), it is important that we select appropriate antibiotics as many factors result in delayed and adequate treatment. Most of our patients present late and rarely get surgical drainage within 24 hours. Some patients wait for more than 48 hours due to the huge volume of patients requiring emergency surgery. It also takes about three days to get microscopy, culture and sensitivity results from the National Health Laboratory Service (NHLS).

Currently at CHBAH, there is no standardised protocol being used for empiric antibiotic selection in patients with any type of hand sepsis. Therefore, this study will help healthcare workers group the different types of infections, and assess their microbiology spectrum and antibiotic sensitivity. The results will be used to develop a protocol on selecting the appropriate antibiotic therapy to be used to treat patients who present with hand sepsis in the hand unit at CHBAH.

1.2 Literature review

Greyling et al. conducted a prospective cross-sectional study on 66 patients with hand sepsis over six months at Pelonomi Hospital, Bloemfontein[1]. The aim of the study was to identify the spectrum of organisms and appropriate antibiotics for the treatment of hand infections; and to characterise the patterns and sites of hand infections. The authors found that *S. aureus* was the most common organism presenting in these patients (82%), followed by *Streptococcus* (9%). Nineteen (19) patients were HIV positive and 36% of these patients cultured Gram-negative organisms. Most Gram-positive organisms were sensitive to Cloxacillin (65%) and clindamycin (61%), and only 5% were sensitive to Amoxicillin-Clavulanic acid (Augmentin)[1]. The authors concluded that immunosuppression plays a role in bacteriology and antibiotic sensitivity in hand infections. The other key finding was that, cloxacillin is the adequate first line antibiotic treatment of hand infections. This study was relevant because hand infections and HIV are common in South Africa. The design was appropriate for the research question. Though they did test all the patients for HIV, that was not the main question of their study. The data was collected by different registrars in their hand unit; this decreased an element of bias.

The study sample was small to draw some conclusions especially about HIV positive patients. They did not measure viral load and CD4 count prospectively. Patients with low CD4 count and viral load are prone to multiple infections, atypical organisms etc. Those that have undetectable viral loads and high CD4 counts might not have different results to the HIV-negative patients.

Rabarin et al. presented a prospective study of 103 patients with fingertip infections. Their aim was to determine the outcome of early treatment with prophylactic antibiotics and debridement. The most common cultured organism was *S. aureus* (58.3%), followed by polymicrobial flora (16.5%) and *Streptococcus* (12.6%)[24]. All these patients were treated as outpatients with surgical drainage under local anaesthesia. There were no complications in all patients. At one month, all the patients considered themselves as cured[24]. The authors also looked at the different types of infections, where superficial hand sepsis was the most common (42. 2%). The most common site of infection was the dorsum of the hand or finger (42%), followed by flexor tenosynovitis (21%). Only 3% of the patients had radiographic evidence of osteomyelitis. None of the patients had associated foreign bodies in the hands. The authors concluded that patients with acute fingertip infections can be successfully treated in the emergency room as outpatients to reduce hospital costs. This study was in keeping with what we practice at CHBAH where all uncomplicated fingertip infections are treated in the emergency unit. Their study design was appropriate for the research question and the study tested the hypothesis. The one month follow up in this study was telephonic, this may impair on the results as there is no objective recording of post treatment findings. They had a large sample size and the conclusions drawn from the study are justifiable. A patient with a less functioning little finger may be satisfied with the treatment whereas a patient with thumb minimal dysfunction may report the problem as being too serious.

Stern et al. conducted a randomised, prospective study of 200 patients with established hand infections. The study was designed to compare the efficacy of two antibiotics (cefamandole and nafcillin) used in hand infections. The results revealed that 63.5% of the patients grew multiple organisms and 26% had anaerobic infections[2]. They noted complications in 13% of patients. About 95% of all organisms were sensitive to cefamandole whereas only 67% were sensitive to nafcillin. The authors concluded that the use of empirical antibiotics in hand sepsis is reasonable; however, other factors such as the extent of the infection and treatment delay were important in the development of complications. The study design was appropriate for the

study question; they had a good sample size to draw conclusions. The study itself did not add anything new. Their conclusion was not based on their research question. They chose specific antibiotics to look at, which does not entirely represent the true natural history of hand sepsis.

Turow et al. conducted a retrospective analysis of all patients (114) who presented in their hospital with a hand infection in 2012. The aim of their study was to identify the incidence, treatment and co-morbidities of hand infection patients and to identify factors associated with poor outcomes[26]. The median age of the patients was 31 years, and the male to female ratio was 1.6:1. Most hand infections were secondary to trauma (43%), whereas spontaneous infections accounted for 29.8%[26]. *S. aureus* was the most cultured organism (40%), followed by MRSA (25%) and *Streptococcus (*23%). Polymicrobial growth was present in 19% but there was no association with co-morbidities[26]. In their results they also found that the rate of MRSA was associated with (i) smoking, (ii) substance abuse, (iii) whether you are indigenous or not and (iv) comorbidities did not seem to play a role. This study had a good study design but their research question was inadequate. This study is relevant because associated comorbidities may impact on the clinical outcome of hand infections. Their outcome measures were not in keeping with the research question. The authors focused more on factors affecting the outcome of the infection instead of looking at different treatment options.

In a study by Glass, the author reviewed 138 patients treated from 1970 – 1980, and 81% of the patients were found to have deep hand infections. All the patients were adults with ages ranging from 18 to 63 except for one patient who was four (4) years old. The empirical antibiotics used were cephalosporins in 64% of patients, and penicillin G in 28%. The resolution of infection was eight days or longer in 57% of patients and about two weeks in 28% of patients. This study showed a correlation between delayed treatment and slower resolution of infections[3]. Other factors that delayed resolution of infection were adequacy of surgical drainage, efficacy of antibiotics and associated co-morbidities such as diabetes mellitus[3].The authors concluded that a delay of more than two and half days in presentation results in a slower resolution of symptoms. The study research question was appropriate and clear. The study addressed the hypothesis well and they had an acceptable sample size to draw conclusions. The data collected also justified the conclusions.

In a retrospective review by Hassan et al., the authors aimed to determine the incidence of community acquired MRSA hand infections in 135 patients from Scotland. The most

commonly affected sites in these patients were the finger (57%), palm of the hand (17%) and thumb (10%). The most common organism was *S. aureus* (48%), followed by *Streptococcus pyogenes* (18%). There was only one case of community acquired MRSA identified[27]. The key finding was that there are low incidences of MRSA in Scotland. This study was relevant because of the variable trends of MRSA worldwide. The research question and study design were appropriate. The data collected was justifiable for the conclusions they made. The collection of specimens was not standardised, and this may impact on the organism yield obtained.

Perovic et al. conducted a laboratory based surveillance of antimicrobial resistance[34]. They included thirteen academic centres in South Africa from June 2010 to July 2012. The aim was to obtain an in-depth understanding on recent antimicrobial resistance trends and molecular epidemiology of *Staphylococcus* bacteraemia[34]. They included *S. Aureus* from 2709 patients, and found that 46% were resistant to methicillin, with a significant decline over a 3-year period. Geographically, they found that MRSA was higher in Gauteng compared to other provinces[34]. The authors concluded that there is high prevalence of MRSA in South Africa. This was a large multicentre study. There was minimal bias. They had a good study design and the research question was relevant. They only looked at hospitalised patients. Therefore, their findings are mainly related to hospital-acquired MRSA. There were no recorded community acquired MRSA.

Fortuin-de Smidt et al. reported on cases of *S. aureus* isolated between September 2012 and September 2013 in three Gauteng academic hospitals. There were 442 cases isolated during this period, and antimicrobial testing was performed in 54% of these. MRSA was isolated in 36% of the cases. They found that a longer hospital stay, antibiotic use in the last three months, and hospitalisation in the last year were all independent predictors of MRSA[33]. They also found that HIV is the independent risk factor MRSA. This was a large local study with an adequate sample size. The study did not look specifically at hand sepsis but all systems involved. It gave an idea on the incidence of MRSA in our institutions. The study question was appropriate however HIV was not included as one of the comorbidities in their protocol. The rest of the study tests the hypothesis and bias was minimised by the collection of all MRSA cases in the study period.

Shuping et al. conducted a cross-sectional study from five South African tertiary hospitals in Gauteng and the Western Cape in 2014. The aim of their study was to determine the prevalence and risk factors for hospital acquired MRSA. The overall prevalence of MRSA in patients who were culture positive for *S. aureus* was 30.9%[35]. Their key finding was that, of the cultured *S. aureus*, MRSA is the most common in hospital-acquired infections and patients with burns, on ventilators, neonates, prolonged hospitalisation increased the risk of acquiring MRSA. The study design was a multicentred cross sectional study. The study was performed in line with the original protocol. The data collected justified the conclusions made because of the large sample size they had.

Wilson et al. conducted a retrospective review of all patients with community acquired soft tissue infections of the hand between 2004 and 2007. Of the 84 patients who were reviewed, 62 (74%) were males and 22 (26%) were females. Sixty-seven percent (67%) of the patients had no comorbidities while only 12% had associated diabetes. The common type of infection was superficial fingertip infections (36%), followed by a dorsal hand abscess (15%)[11]. The overall incidence of MRSA was found to be 60% and the incidence of Methicillin-Sensitive *Staphylococcus Aureus* (MSSA) was 20%. The key finding in this study was that, MRSA is becoming more common than MSSA in hand infections. This study was done in the USA where MRSA is more prevalent than in our population. They looked at community acquired MRSA rather than just hospital acquired which also has a high incidence in South Africa. This study is relevant as it will assist one to compare the study results with the incidence of MRSA in our setting.

In a retrospective study by Downs et al., the authors reviewed 32 patients who met the inclusion criteria. The aim of their study was to determine if there was a difference in the time taken to provide patients with the appropriate antibiotic treatment between MRSA and non-MRSA hand infections. The overall prevalence of MRSA was 34%, and these patients experienced a substantial delay (average 2.2 days) to the time of treatment with appropriate antibiotics[7]. This study showed that if MRSA is unsuspected, there is a substantial delay in starting adequate targeted treatment. The study did not look at clinical outcomes of delayed treatment however from their conclusion; debridement was the cornerstone of treatment in all these patients. Therefore, whether the delay in the initiation of appropriate antibiotics has an impact on clinical outcome or not remains unknown.

Fowler and Ilyas conducted a retrospective study on 2287 patients from 2005 – 2010, and 458 (30%) of the patients were culture positive. The purpose of this study was to define the epidemiology of adult acute infections in an urban setting with the aim of improving empiric antibiotic therapy. They also recorded associated co-morbidities (diabetes, HIV, smoking, and intravenous drug use). Paronychia was the most common infection (50%), but had the least number of positive cultures (6%). Finger abscess/flexor tenosynovitis was the second commonest infection type (31%) and had the most positive cultures (53%). MRSA was the most common cultured organism (53%), followed by MSSA (23%). Nineteen percent (19%) of the culture positives were polymicrobial[4]. The incidence of polymicrobial infections in patients with diabetes was 33% whereas in HIV positive patients it was 6%. Most of the patients with polymicrobial cultures had infections caused by human bites. They concluded that there is an increase in the incidence of MRSA in hand infections in certain areas where the organism is common. The study looked at patients who had open wounds as a predisposing factor. Even though open injuries increase the risk of hand infections, most hand infections are spontaneous or secondary to minor trauma. Any patient with an open wound in the hand or any part of the body has a higher risk of infection. The patients with open injuries were excluded in our study.

An eight-year longitudinal retrospective chart review was performed on all culture positive hand infections encountered by an urban hospital from 2005 to 2012[28]. A total of 683 culture positive patients were identified. Overall MRSA was present in 49% of the cases with an annual peak incidence of 65% in 2007. MSSA was cultured in 21% of the patients while polymicrobial organisms were cultured in 20% of the patients[28].

In a study by Mann et al., the authors reviewed 20 diabetic patients with hand infections[5]. About 35% (7 of 20) patients had amputations done to control infections or because functions of the extremities were impaired[5]. This signifies the extents and complexities of these infections in immunocompromised patients. They cultured Gram-negative bacteria in 12 of the 20 patients[5]. The key finding in this study was that neglected hand infections in diabetic patients have serious complications. Moreover, this study outlined the extent of the disease in immunocompromised patients, especially in diabetics who are very difficult to treat. Very few of these patients resolve fully without functional loss or amputations. The disease process is so severe in diabetics to an extent that if inadequately treated it progresses to life changing conditions such as necrotising fasciitis.

In a retrospective review article by McDonald et al., the authors divided hand infections into cellulitis, superficial abscesses, deep abscesses, septic arthritis and osteomyelitis[6]. The authors were considering different types of infections and their management options. Even though the treatment of these infections is similar, the complications and outcomes may differ. The authors found out that the most common organisms in hand sepsis are *S. aureus* and *Streptococcus* species, respectively[6].

Türker et al. did a retrospective analysis of hand infections treated over a period of one year. They reviewed 123 patient charts and included 94 of them. The purpose of the study was to report on patient demographics, causative organisms, clinical course and management of hand infections. The male to female ratio was 2:1 (71.3% male, 28.7% female). Infections occurred almost equally in right (46%) and left (49%) hands, and 5% of the patients had bilateral hand infections. The most frequent infection diagnosis made was deep space infections (77%)[19]. The authors concluded that early surgical and medical management are solution to the treatment of most hand infections. This study highlights that there is no single treatment for hand infections but a combination of surgery with antibiotics, as well as aggressive rehabilitation, result in improved outcomes. Though they discussed clinical management, they only looked at antibiotics and surgically drained hands. They did not discuss splinting and rehabilitation which plays a very import role in functional outcome.

In a retrospective study by Houshian et al., the authors reviewed 418 patients who underwent surgery for the treatment of hand infections between 1992 and 2001. The aim of the study was to delineate and update the bacteriological spectrum, characterise patterns and sites of injury, and evaluate laboratory tests and possible causes of complications in patients with bacterial hand infections. There were 296 males and 132 females of all ages enrolled in this study, of which 35% of the patients had puncture wound/laceration as the predisposing factor. The commonest infection was subcutaneous (45%) followed by flexor tenosynovitis (27%). *S. aureus* was isolated in 44% of the positive cultures whereas 11.7% of infections cultured mixed organisms. They concluded that most infections were due to neglected minor wounds[9].

Furthermore, in two literature reviews by O'Malley et al. and Wilson and Rinker, the authors showed an increased number of MRSA culture positive hand infections[10,11]. O'Malley et al. did a retrospective study of 85 patients seen over a year with acute hand infections. Wilson et al. conducted a retrospective review of all patients with community acquired soft tissue

infections of the hand between 2004 and 2007[11]. They only included community acquired MRSA. These studies showed results of 55% MRSA[10] and 60% MRSA, respectively[11]. They suggested that all patients treated for hand sepsis in an area where MRSA has a prevalence of more than 10% be covered for MRSA[11]. This study will assist in raising awareness regarding the local prevalence of MRSA, thus initiation of early therapy or empiric cover for it. Knowing the incidence of MRSA is helpful, as it takes a few days (2 – 5) to get culture results which delays making a diagnosis and the initiation of appropriate antibiotics.

A prospective, randomised study was undertaken to determine if mechanical care of early human bites alone is sufficient therapy in the compliant patient or if prophylactic antibiotics (oral versus parenteral) are indicated[12]. All patients presented within 24 hours, had no active infection, bites did not penetrate the joint capsule and had no tendon injury. They randomised patients into three groups where one group received a placebo, one group received intravenous antibiotics and the last group received oral antibiotics. All the groups received mechanical debridement in the emergency unit. Forty-six percent (46%) of the patients in the placebo group developed infection, whereas none of the other patients in the remaining groups had an infection. They concluded that patients with uncomplicated human bites will do well if treated with mechanical debridement and empiric antibiotics[12].

In a systematic review of eight randomised controlled trials, Meideros et al. showed that hand and wrist bites are independent risk factors for infection[22]. The objective of this review was to determine if the use of prophylactic antibiotics in mammalian bites is effective in preventing bite wound infection. They found that antibiotic prophylaxis reduced infection from 28% to 2%[22]. The key finding was that antibiotic prophylaxis is due to mammalian bite injuries. This empiric cover must be initiated early and coupled with debridement to reduce the rate of infection. This study will help give an idea of which antibiotics to use for adequate empiric cover for different mammalian bites.

Uriel et al. studied 106 patients with human bites of the hand from 1976 to 1983. The authors managed 100 patients successfully as outpatients, and they were all debrided and given antibiotics. The main determining factor for a good outcome was early presentation and treatment[13].

A retrospective cohort study by Duma et al. looked at 39 patients treated between June 2013 and October 2014. The aim of this study was to determine if HIV infection is associated with

an increased risk for the development of early complications following human bites to the hand. They found that 41% of the patients were HIV positive of which 44% had a CD4 count less than 350 cells/mm^3. Only 25% of the HIV positive patients were on anti-retroviral therapy. Complications occurred in 88% of HIV positive patients compared to 80% of HIV negative patients. Amputation was performed in 25% of HIV-positive patients *vs* 6.7% in HIV-negative patients. They noted that most cases of amputation were due to delayed presentation rather than HIV disease[18]. The key finding in this study was that HIV infection alone does not lead to complicated hand sepsis. There are various factors that also contribute to the development of complications.

Pang et al. conducted a retrospective review of medical records of patients treated between 2001 and 2006 with pyogenic tenosynovitis[30]. The aim was to assess the clinical factors that affect the outcome of pyogenic flexor tenosynovitis. In this study there were 47 males and 37 females. Of the 75 patients reviewed, 17% of them had an amputation. Most patients (67 %) were affected on the dominant hand, and the most common associated comorbidity was diabetes with 35% of patients involved. The most commonly cultured organism was *S. aureus* (43%) and 23% of patients had no organisms cultured. The comorbidities that were associated with a higher risk of amputation included diabetes mellitus (rate of amputation, 39%), peripheral vascular disease (rate of amputation, 71%), and renal failure (rate of amputation, 64%) [30].

Kour et al. carried out a prospective study during a six-month period on all patients who had hand infections and diabetes mellitus. There were 15 men and 10 women. All the patients were adults between the ages of 32 and 80 with 80% of the patients aged 60 years or younger. Three patients were diagnosed to have diabetes mellitus after their admission for uncontrolled sepsis in the hand. In 64% of the patients, the site of infection was in a digit, of which 36% involved the finger pulp, 4% involved the nail, and 24% in the rest of the digit. Twenty-four of 25 patients needed surgery on admission. In 22 of 24 patients, the initial surgery performed was for drainage and debridement. There were 2 patients who needed primary amputation surgery. In 4 patients who had initial drainage surgery, a repeat procedure was necessary to further debride the wound with 1 patient needing amputation of the digit. Of the 3 patients who had amputation, 2 patients had digit amputation and 1 patient had a forearm amputation. The presence of vascular and neurologic changes in hands had no correlation with the occurrence of the hand infection, nor did these changes affect the outcome of the infection. Forty-eight

percent (48%) of patients cultured *S. aureus*, 48% had multiple organisms and 64% cultured Gram-negative organisms[29].

1.3 Problem statement

There is a high prevalence of hand sepsis, both in developed and developing countries. The increase in resistance to antibiotics is well documented in the literature due to overzealous use. In developing countries, there is an increased incidence of community acquired MRSA in the hand. Therefore, this study will help with identifying the most prevalent organisms and their antibiotic sensitivity in different types of hand sepsis in our setting.

1.4 Study Aim and Objectives

The aim of this study is to identify the microbiology profile and antibiotic sensitivity of patients with hand sepsis treated at CHBAH.

The objectives of this study are to:

- Compare the antibiotics started empirically in the emergency department to those given following the availability of laboratory results of cultured organism sensitivity.
- Assess the most prevalent organism in hand sepsis
- Assess the effect of co-morbidities on the prevalence of hand sepsis.
- Help formulate guidelines and protocols on the most appropriate empirical intervention to be used on patient admission. The results will be used as a guide.

CHAPTER 2

2 Methodology

2.1 Research Question

Is MSSA the most common organism in patients with hand infections treated at CHBAH, Orthopaedic Department hands unit?

2.2 Research Design

This was a prospective cross-sectional study done on patients with hand sepsis who were treated at CHBAH, Orthopaedic department, hands unit.

2.3 Materials and Methods

Selection Criteria:

- **Patient Inclusion criteria**
    - Patients who provided written informed consent to form part of the study
    - Male or female patients ≥ 18 years of age
    - Patients with spontaneous hand sepsis, bites (human or animal)
    - Patients with recorded microscopy, culture and sensitivity on the National Health Laboratory Service (NHLS) database
    - Patients with all types of hand infections including osteomyelitis and septic arthritis
- **Patient Exclusion criteria**
    - Patients with post trauma hand infections
    - Patients with no recorded specimens
    - Patients with septic hardware and surgical site infection

2.4 Sample

All patients who were admitted with hand infections were enrolled. These patients were then selected purposefully post admission the following day. There were 150 patients enrolled in the study. The final number of patients with adequate information for data analysis was 103.

2.5 Data Collection

Data were collected by the principal researcher (Dr Jada) on a daily basis after patients were admitted to CHBAH and were awaiting incision and drainage. Informed consent was obtained from each patient prior to his/her inclusion in the study (see Appendix D), and patients were kept anonymous. The types of data collected were categorical data which included the following variables: antibiotic sensitivity, antibiotic resistance, antibiotics initiated on admission, gender, associated diagnosis, comorbidities, hand dominance and HIV status.

The data were captured on the collection sheet as shown in Appendix A. All data were collected after admission before patients went for a first debridement. No specific tests were carried out. Patient results were followed up after debridement was done and specimens collected. Patient results were followed up to two weeks after the specimen was entered into the NHLS system. NHLS TrakCare Web Results Viewer was used to collect the patient results and complete data collection.

2.6 Data Analysis

In this study; frequencies, percentages, cross tabulations and graphical display for descriptive analyses were used. The Chi-Squared ($\chi 2$) test was used to compare patient's HIV status, comorbidities, diagnosis, antibiotic sensitivity and their association with patient's cultured organism.

Logistic regression models were used to analyse the association between the patients' cultured organisms and antibiotics sensitivities. Unadjusted and adjusted odds ratios (ORs), (95% confidence intervals (CIs)) were determined. *P*–values < 0.05 were considered statistically significant. All the calculations and analyses were carried out using the IBM Statistical Package for Social Sciences (SPSS) Software, version 23.

2.7 Limitations

Limitations for this study are as follows:

- Dependence on other colleagues for patient diagnosis. This may result in an incorrect diagnosis matched with different organisms resulting in the under reporting or over reporting of results. Unfortunately, these patients are treated initially by the doctor on call and operated on by junior medical doctors who might not write clear diagnosis on the file.

- Patients who were enrolled in the study but the treating surgeon did not take their specimens in theatre. This decreased the study population sample size.

- Patients with deep hand infections were treated in theatre whereas patients with superficial hand infections were treated in the minor procedure room. As a result, most of the patients included in the study had deep, and not superficial, hand infections. These patients were treated as outpatients under local anaesthesia. Most of the patients did not have specimens sent to the laboratory. The doctor on duty would treat these patients as they arrived and after which they were discharged immediately.

2.8 Ethical considerations

The study was approved by the Human Research Ethics Committee (HREC), (Medical), Faculty of Health Sciences, University of the Witwatersrand (Clearance certificate no. **M170610**, see Appendix B). Clearance from the Hospital's CEO was also obtained (see Appendix C). The participant consent form and the study information sheet are shown in Appendix D and E, respectively.

CHAPTER 3

3 Results

3.1 Research Question

Is MSSA the most common organism in patients with hand infections treated at CHBAH, Orthopaedic department, hands unit?

This study's outcome reports on one or more of the following variables namely the microbiology profile, antibiotic sensitivity, antibiotic resistance, and antibiotics initiated on admission. The cofounding variables were gender, associated diagnosis, comorbidities, hand dominance and HIV status.

In this study 103 patients were examined, and most of these patients were young and middle aged males.

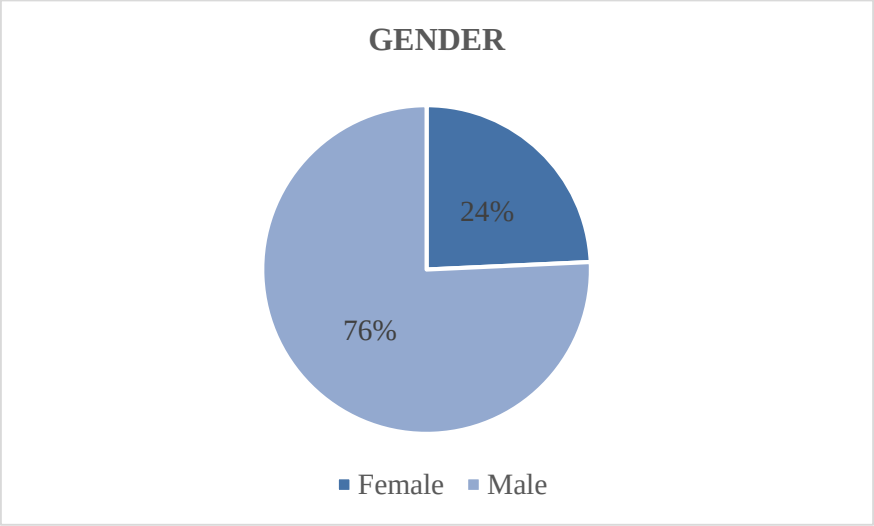

Figure 3.1 A pie chart showing the percentage of male and female patients included in the study.

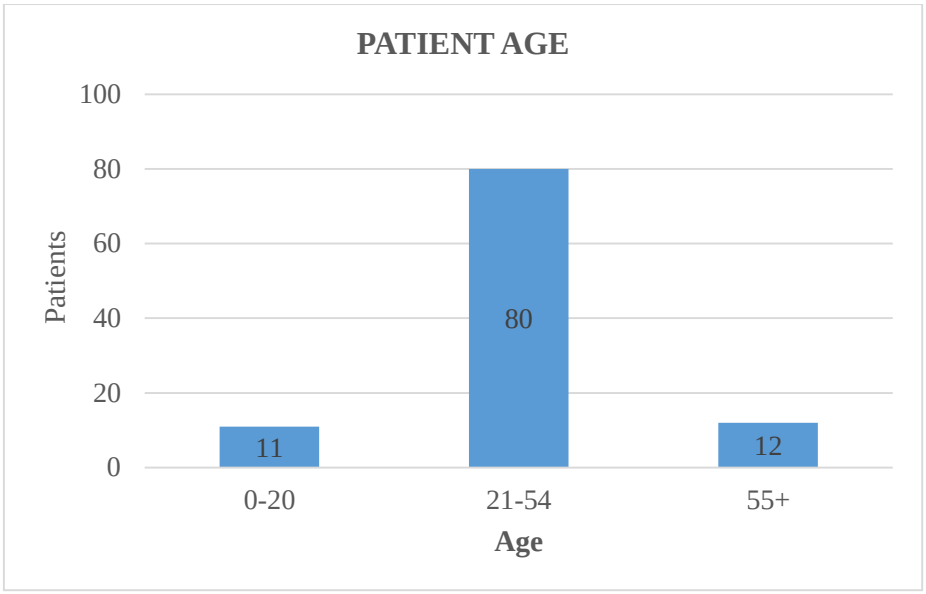

Figure 3.2 A bar graph showing age groups of patients.

Of the 103 patients examined, 33% were diagnosed with a webspace abscess, followed by a deep finger abscess (excluding tenosynovitis) (28%) and tenosynovitis (20%), respectively (refer to Figure 3.3). Bites (human or dog) were diagnosed in 7% of the patients.

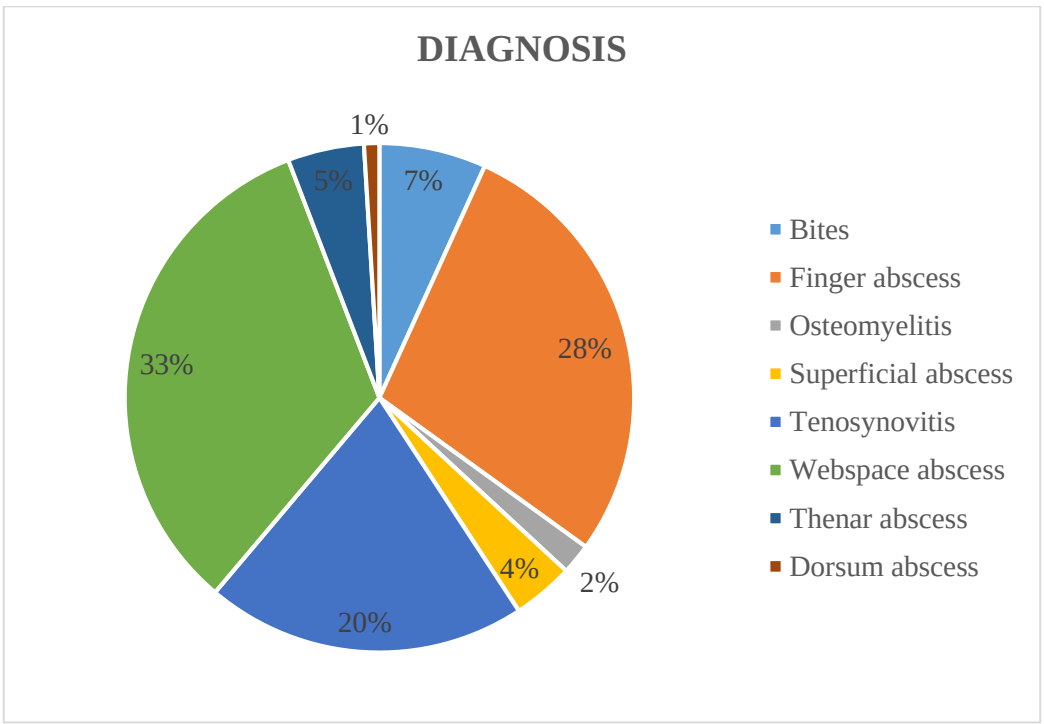

Figure 3.3 A pie chart showing the diagnosis of patients.

Figure 3.4 A patient with a deep middle finger abscess.

Figure 3.5 A patient with a second webspace abscess.

In the 103 patients examined, the most common cultured organism was *S. aureus* (68%), followed by patients who had multiple organisms (12%). Eleven percent (11%) of the patients had negative cultures after five days of culturing.

Although *S. aureus* was the most common cultured organisms in patients included in the study, MRSA was found to be present in only 2% of the patients.

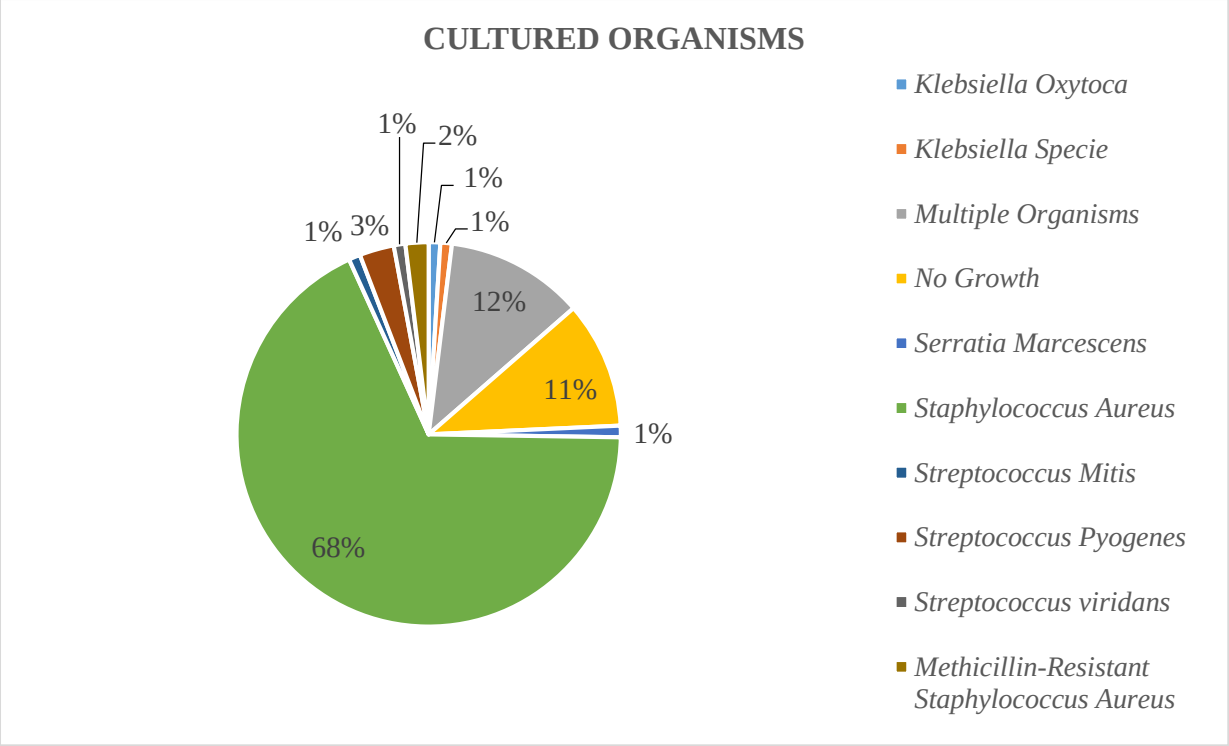

Figure 3.6 A pie chart showing cultured organisms.

The most prominent diagnosis made in patients who cultured *S. aureus* (68%) was a webspace abscess (25%), while the most prominent diagnosis made in patients who cultured multiple organisms (12%) was a deep finger abscess (5%). In eleven percent (11%) of the patients with negative cultures, 4% of these patients had a prominent diagnosis of a deep finger abscess. Additionally, one patient with MRSA was diagnosed with osteomyelitis (see Figure 3.7 below) and the other with tenosynovitis.

Figure 3.7 A patient with an amputated thumb secondary to osteomyelitis.

Table 3.1 Diagnosis Group *vs* Cultured Organisms.

			Cultured Organisms Group			
			Methicillin-Resistant Staphylococcus Aureus	Multiple Organisms	No Growth	Staphylococcus Aureus
Diagnosis	Bites	Count	0	2	3	2
		% Diagnosis	0.0%	1.9%	2.9%	1.9%
	Dorsum abscess	Count	0	0	0	1
		% Diagnosis	0.0%	0.0%	0.0%	1.9%
	Finger abscess	Count	0	5	4	20
		% Diagnosis	0.0%	4.9%	3.9%	19.4%
	Osteomyelitis	Count	1	1	0	0
		% Diagnosis	1%	1%	0.0%	0.0%
	Superficial abscess	Count	0	0	1	2
		% Diagnosis	0.0%	0.0%	1%	1.9%
	Tenosynovitis	Count	1	3	2	15
		% Diagnosis	1%	2.9%	1.9%	14.6%
	Thenar abscess	Count	0	0	0	4
		%Diagnosis	0.0%	0.0%	0.0%	3.9%
	Webspace abscess	Count	0	1	1	26
		% Diagnosis	0.0%	1%	1%	25.2%
Total		Count	2	12	11	70
		% Diagnosis	1.9%	11.7%	10.7%	68.0%

Apart from the above-mentioned diagnoses made, 7% of the patients examined were hypertensive, while 5% were diabetic and hypertensive. Eighty-two percent (82%) of the patients did not have any co-morbidities.

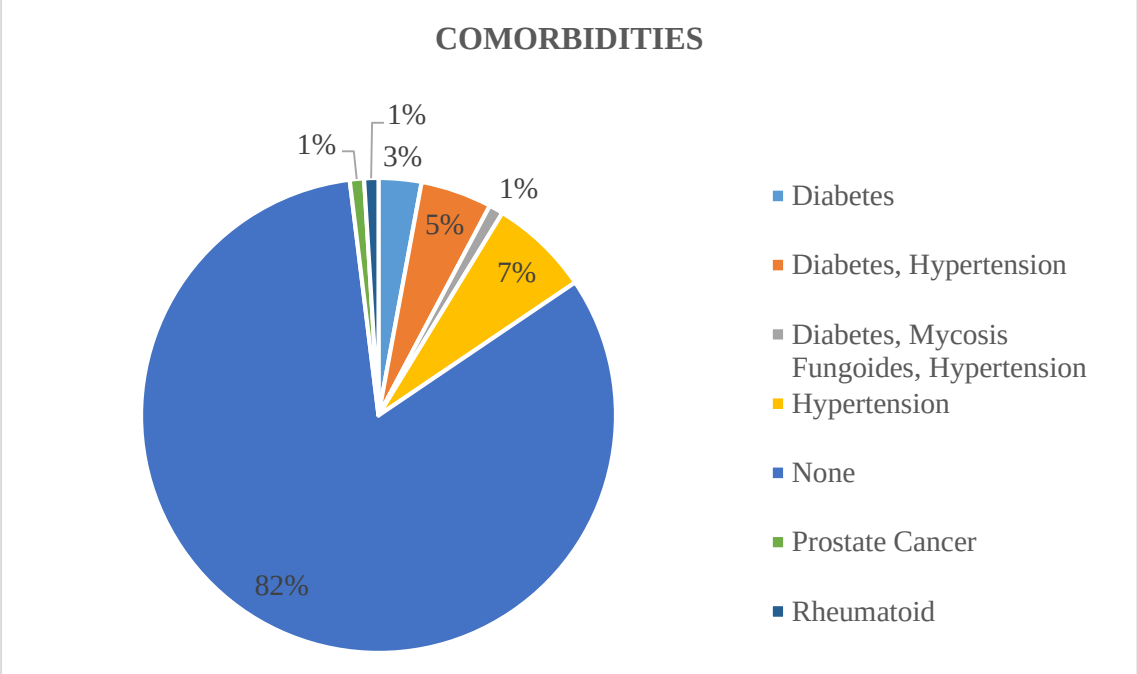

Figure 3.8 A pie chart showing patients' co-morbidities.

In 12% of the patients who cultured multiple organisms, 4% were found to be diabetic and/or hypertensive and the remaining eight did not have any co-morbidities. In 68% of the patients who cultured *S. aureus*, 9% were diabetic and/or hypertensive, 1% had rheumatoid arthritis and the remaining 58% did not have any co-morbidities. Furthermore, there were no comorbidities present in the patients who cultured positive for MRSA (refer to Table 3.2 below).

Table 3.2 Comorbidities *vs* Cultured Organisms.

			Cultured Organisms Group			
			Methicillin-Resistant Staphylococcus Aureus	Multiple Organisms	No Growth	Staphylococcus Aureus
Comorbidities	Diabetes	Count	0	1	0	2
		% Comorbidities	0.0%	1%	0.0%	1.9%
	Diabetes, Hypertension	Count	0	3	0	2
		% Comorbidities	0.0%	2.9%	0.0%	1.9%
	Hypertension	Count	0	0	2	5
		% Comorbidities	0.0%	0.0%	1.9%	4.9%
	None	Count	2	8	9	60
		% Comorbidities	1.9%	7.7%	8.7%	58.2%
	Rheumatoid	Count	0	0	0	1
		% Comorbidities	0.0%	0.0%	0.0%	1%
	Total	Count	2	12	11	70
		% Comorbidities	1.9%	11.7%	10.7%	68.0%

From this study 10% of the patients were HIV positive and 33% were HIV negative. The HIV status in 57% of the patients was unknown as patients were not tested for HIV during the study (see Figure 3.9 below).

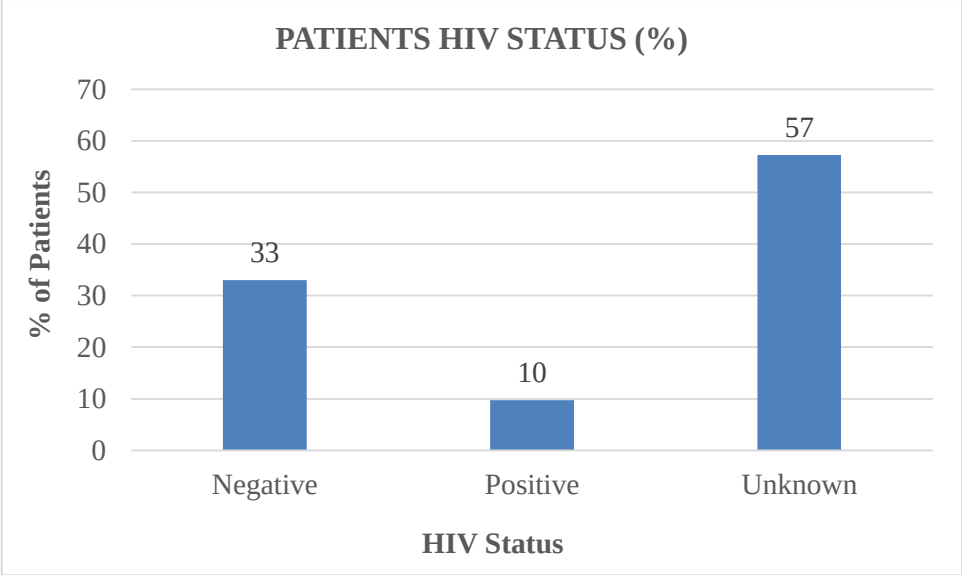

Figure 3.9 A bar graph showing patients' HIV status.

Seven percent (7%) of the HIV positive-patients cultured *S. aureus* and the remaining 3% cultured multiple organisms. None of the HIV-positive patients had MRSA and negative cultures.

In HIV-negative patients, 22% cultured positive for *S. aureus*, 4% cultured multiple organisms, and 2% had negative cultures. Moreover, 1% of these patients cultured MRSA. There was no statistically significant association found between the patient's HIV status and the patients' cultured organism ($p = 0.94$). The table below shows the relationship between cultured organisms and the patient's HIV status.

Table 3.3 Chi-Square Test between Patient HIV Status and Cultured Organism.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	16.535[a]	27	0.942
Likelihood Ratio	18.584	27	0.885
N of Valid Cases	103		

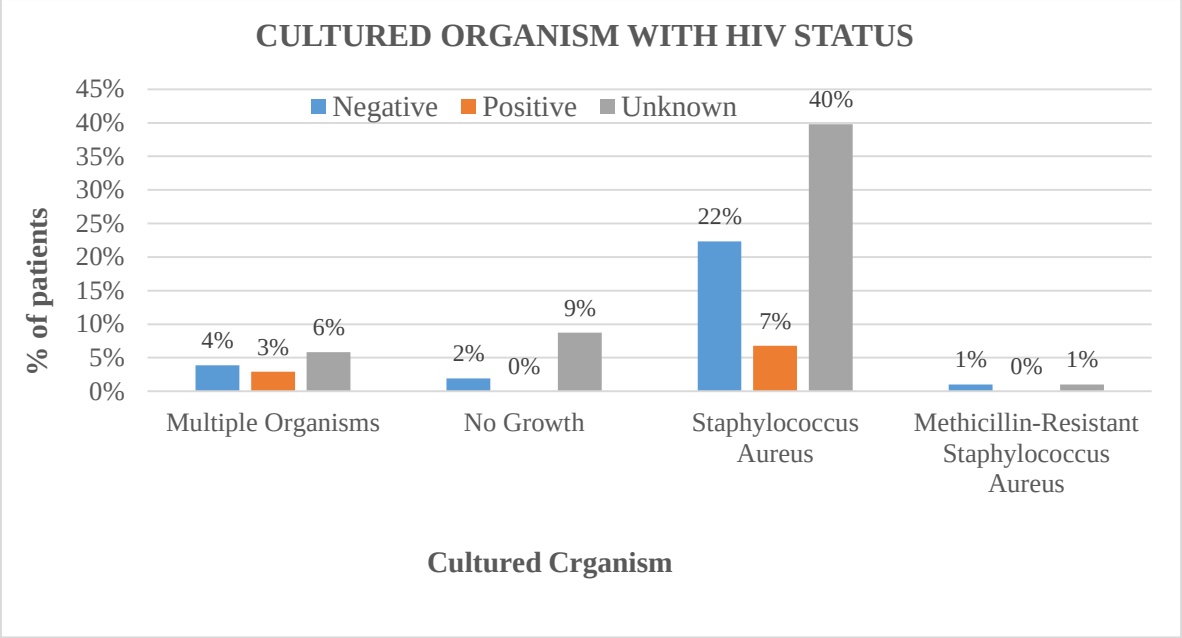

Figure 3.10 A bar graph showing patients' cultured organisms and their HIV status.

A binomial logistic regression was performed to ascertain the effects of cultured organism (*S. aureus*) on the likelihood of patient sensitivity to cloxacillin. The logistic regression model showed the results are statistically significant, chi-squared $\chi 2 = 43.014$, $p < 0.0005$. Patients who cultured positive for *S. aureus* had a 7.14 times higher odds to be sensitive to cloxacillin than patients who cultured positive for any other organism/s.

Table 3.4 Cultured Organism *vs* Antibiotic Sensitivity.

Cultured Organism		**Antibiotic**		
		Cloxacillin	Amoxicillin-Clavunic acid	Ampicillin, Penicillin
Staphylococcus Aureus	Count sensitivity	66	0	1
	% sensitivity	64%	0%	1%
	count Resistance	1	0	50
	% Resistance	1%	0%	49%
Multiple Organisms	Count sensitivity	5	1	2
	% sensitivity	5%	1%	2%
	count Resistance	2	4	4
	% Resistance	2%	5%	4%

Fifty-nine percent (59%) of the patients were started on amoxicillin-clavunate followed by cloxacillin (39%). Of the 59% patients who were started on amoxicillin-clavunate, only 3% were sensitive to it, and 49% were cloxacillin sensitive. In 39% of the patients who started on cloxacillin, 29% were sensitive to this antibiotic. Overall, there is an association between the type of antibiotic given on admission and antibiotic sensitivity (p = 0.001).

Table 3.5 Chi-Square Test between Patient Cultured Organism and Antibiotic Sensitivity.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	71.938[a]	40	0.001
Likelihood Ratio	27.501	40	0.933
N of Valid Cases	103		

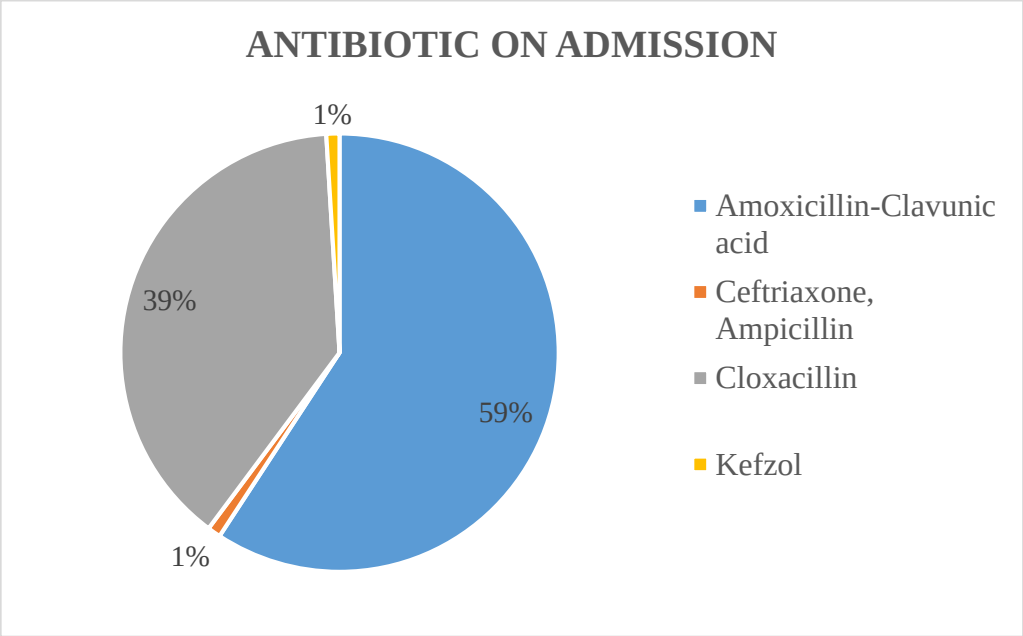

Figure 3.11 A pie chart showing antibiotics given on admission.

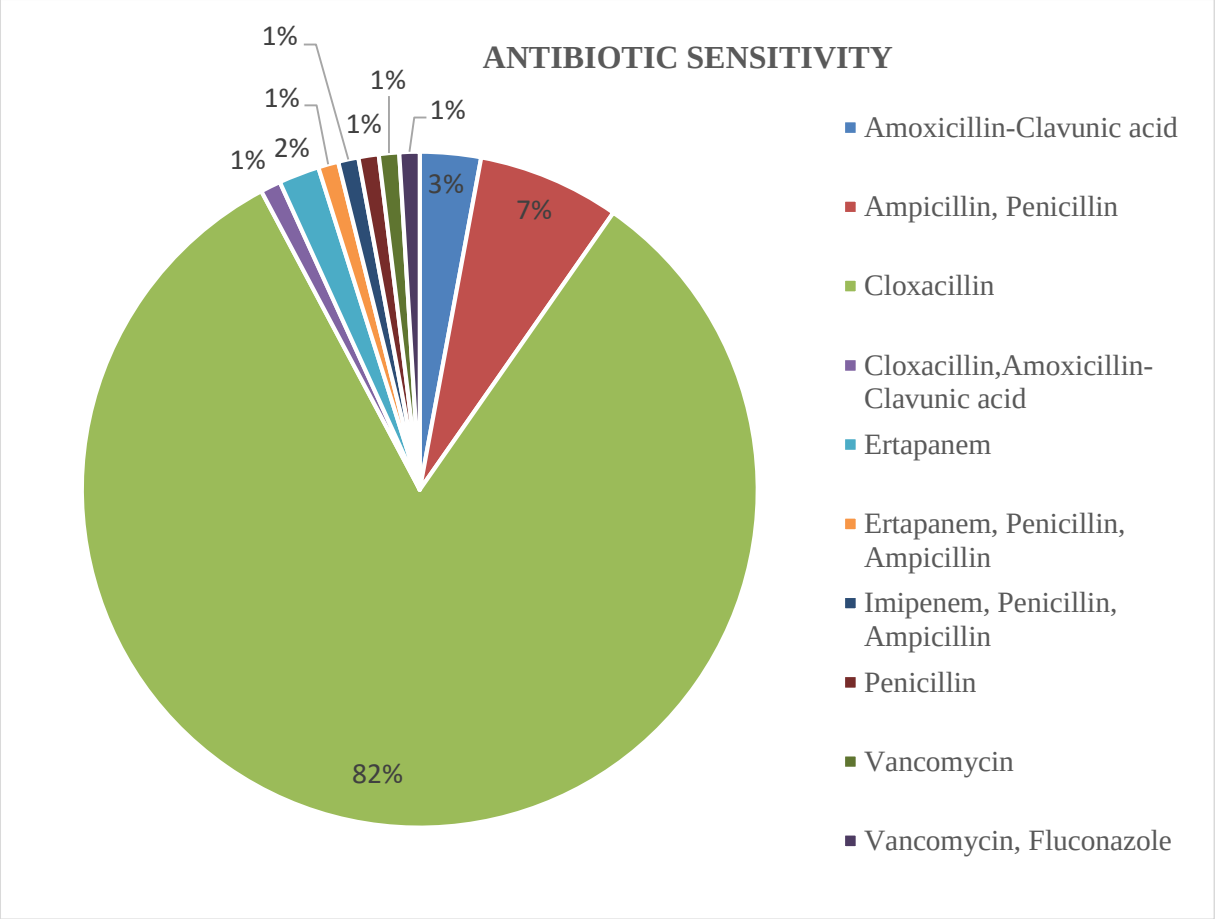

Figure 3.12 A pie chart showing antibiotic sensitivities.

Diagnoses made for the right and left hand were 65% and 33%, respectively. An overlap among the affected side was infrequent, as only 2% of the patients were diagnosed with bilateral hand infections. Most patients (54%) who were right handed were affected on the right hand. Overall there is no correlation between the patient's hand dominance and the side affected (p = 0.53).

Table 3.6 Chi-Square Test between Patient Hand Dominance and Side Affected.

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.264[a]	2	0.532
Likelihood Ratio	1.007	2	0.604
N of Valid Cases	103		

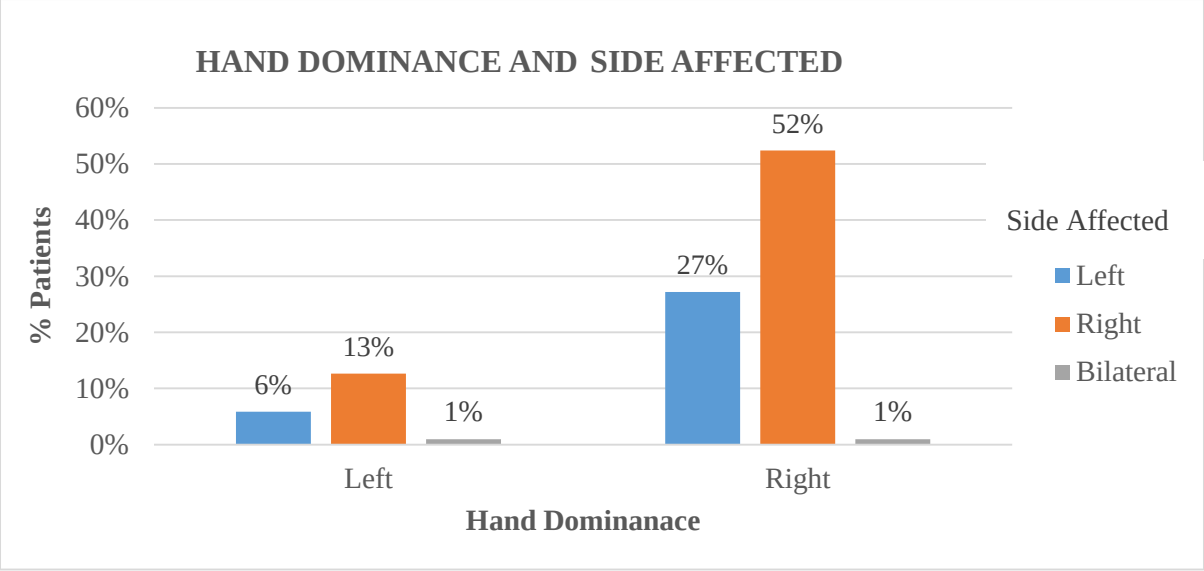

Figure 3.13 A bar graph showing patients' hand dominance and side affected.

CHAPTER 4

4 Discussion

The human hand is adapted to allow us to manipulate and interact with our environment. This special function of the hand makes us susceptible to injury and infection which results in the destruction of its anatomy and function. The loss of sensation, stiffness, chronic pain and loss of limb, or part of a limb, are some of the common complications resulting from the inadequate treatment of an injury, infection or late presentation. In this study we reviewed 103 patients with recorded microscopy culture and sensitivity.

4.1 Demographics:

In this study, most of the patients were young, middle aged males (76%). These demographics, male predominance and age group are in keeping with those reported in the global literature where more males are affected than females[10,19,30]. Although patients with open lacerations were excluded from this study, other studies have shown that the common predisposing factor to hand infections is trauma, either from puncture wounds or large lacerations[9,26]. Some studies have shown no difference in the side affected[19] and the risk of hand sepsis whereas, in this study it was shown that the right hand (52%) was more affected than the left, especially in right hand dominant patients (Figure 3.13). Kaisha et al. showed that hand dominance has no influence on the causes and pattern of injury. In non-traumatic cases, a spontaneous infection has not been shown to be associated with hand dominance however; a study by Fortuin-de Smidt et al. showed that young males under the age of 24 years are at a highest risk of occupational injuries in the hand. These findings may reflect the length of job experience and the hazardous nature of the job[33]. The majority of patients in our study were between the age of 21 − 54 (78%). This is in keeping with the working age of the majority of people who are at an increased risk of occupational injury, therefore exposing them to microorganism inoculation and infection.

4.2 Empiric antibiotics

All our patients were started on empiric antibiotic therapy in the emergency department on admission. Amoxicillin-clavunate was used in 59% of patients, whereas 39% were given cloxacillin intravenously. Cefazolin was used in 1% of patients as well as ceftriaxone and ampicillin. During the study period, cloxacillin was not available from the pharmacy for about three months. This may be a reason as to why there was more amoxicillin-clavunate used than cloxacillin. Another reason may be that most junior doctors who are rotating in different specialities, in addition to orthopaedics, often use Augmentin as the antibiotic prophylaxis of choice. Since there is no standardised protocol in the unit for empiric antibiotic treatment in hand sepsis, this results in doctors using antibiotics that they are familiar with. Augmentin has both Gram-positive and Gram-negative cover which makes it eligible for empiric use in hand sepsis.

Most patients included in our study had deep space infections, followed by those with bites and superficial infections. They all needed surgical drainage in an operating theatre. Meideros et al. found that patients with mammalian bite injuries who present early are free of infection, but the use of antibiotics and surgical debridement is still the choice of treatment[22]. None of our patients received empiric antibiotics for MRSA. The suggestion by O'Malley et al.[11], that all patients with hand sepsis in an area where community acquired MRSA prevalence is more than 10% did not apply to our setting. The local studies done showed a significantly low rate of MRSA[1,18]. In all our patients, antibiotics were started on the day of admission. Glass et al. showed a correlation of delayed treatment and slower resolution of infection. Stern et al. concluded that use of empirical antibiotics in hand sepsis is reasonable[2].

4.3 Diagnosis

Patients with hand injuries are dressed and splinted when they are admitted. Therefore, the diagnoses were recorded based on the admitting doctor's notes**.** Hand sepsis is a clinical diagnosis; therefore, admission notes were assumed to be accurate with little margin for a misdiagnosis. Postoperative notes were also reviewed to assess if there were any different findings intraoperatively.

In this study, the most common diagnoses were webspace abscess (33%), deep finger abscess (28%) and pyogenic tenosynovitis (20%). The literature shows that the most common hand infections are superficial infections[1,4,9,11,24]. Fowler et al. showed that the most common deep infections are finger abscess and tenosynovitis[4]. These two diagnoses may be difficult to differentiate preoperatively if there are no obvious clinical signs of Kanavel. In this study, operative notes were reviewed to determine the involvement of the flexor tendon sheath. This helps to differentiate between a deep finger abscess and tenosynovitis. Greyling et al. also found a finger abscess (42.2%) and flexor tenosynovitis (21.2%) to be the two most common types of hand infections whereas, Houshian et al. found that flexor tenosynovitis was the most common deep infection (27%)

Human bite injuries occurred in 7% of the patients. Kennedy et al. stated that 90% of bite injuries are secondary to dog bites while human bites account for only 2 – 3%[20]. In our setting we see quite a higher number of human bite injuries compared to animal bites. The contributing factor may be due to the higher domestic violence rate which results in fight bites. Patients with human bite injuries present late when an infection has established because they underestimate the extent of the injury.

There was one case of osteomyelitis with extensive tissue loss. This patient had a delayed presentation of ten days and needed multiple debridements with subsequent tendon involvement and circumferential loss of skin cover. Many factors contribute to a delayed presentation in the clinical setting. These factors include the affordability of transport, a lack of education, and a lack of adequately trained staff in the primary health care sector. Furthermore, most studies have shown that a delay in the treatment of hand sepsis increases the risk of complications like amputation, stiffness, and contractures[2,3,13,18].

4.4 Culture Organisms

In this study, 89% of patients had positive cultures whereas 11% yielded no organisms after five days in culture media. In patients with negative cultures, the most common diagnosis was a finger abscess (36%) followed by a human bite (27%). Even though a human bite usually has a delayed presentation, the patients who present early, especially after a fight bite, are taken to theatre without any evidence of infection. This results in negative cultures as the specimens

were taken before the inoculation with microorganisms. The negative cultures may also be due to the inability to test for *Eikenella Corrodens* which does not grow well in selective media. This organism is isolated in about 17 − 30% of cases with human bite injuries[20]. Goldstein et al. showed that *Eikenella Corrodens* failed to grow on selective media even if supplemented with 5% blood[37]. They suggested that this organism needs special media to grow[37]. This implies that the laboratory has to be informed when this organism is suspected because they do not routinely test for it. Human bite injuries are known to have severe complications secondary to delayed presentation[12,13]. This study confirms that early presentation and aggressive management of bite injuries of the hand is important to prevent serious complications. None of our patients with bite injuries had any complications.

Houshian et al. reviewed the bacteriologic spectrum, patterns, and sites of injury in 418 patients with hand infections[10]. In contrast to our study, they defined hand infection as purulent drainage from the surgical incision, an organism obtained on culture of the wound, or spontaneous wound dehiscence with secretion of pus. The authors found positive bacterial cultures in 89% of the patients who underwent incision and drainage[10].

In our study, 68% of patients cultured *S. aureus* as a single organism which is comparable to the results obtained from other local studies[1,18]. This was followed by polymicrobial flora (12%) and no growth (11%). The presence of negative cultures does not exclude the presence of infection. This is because some patients may have received antibiotics from a local hospital prior to the collection of specimens resulting in false negative cultures. The specimen also takes long (sometimes 12 hours) before they get to laboratory after collection, so this may also give false negative results. The use of pus swab sticks is also not as accurate as collection of pus fluid in a container to get more accurate results. Therefore, the collection method used in theatre may also affect the accuracy of the results. Hassan et al. found that the most common organism in hand sepsis was *S. aureus* (48%)[27]. Most of the African and European studies showed that MSSA is still the most common organism cultured in hand sepsis irrespective of the types of infection [1,9,18,26,27]. In contrast, there has been an increase in MRSA associated with hand sepsis in the United States of America (USA) [4,10,11,29,30].

In South Africa, there is high incidence of hospital acquired MRSA[34,35] but it has not been associated with increased MRSA in hand infections[1,18]. In our study there were two patients who cultured positive for MRSA. This patient had osteomyelitis and had an amputation of the digit. This may have been due to the delayed treatment of the patient with appropriate antibiotic cover since we do not routinely cover for MRSA empirically. Downs et al. showed that patients with MRSA had a delay of about two days before receiving appropriate antibiotics[7].

It is well documented that a delay in appropriate treatment of a hand infection has a higher risk of serious complications[2,3]. This study's antibiotic sensitivity results showed that 64% of *S. aureus* was sensitive to cloxacillin (4% was not tested for antimicrobial sensitivity). None of the *S. aureus* was tested against Augmentin for sensitivity. Greying et al. showed that only 5% of organisms were sensitive to Augmentin[1]. Due to financial constraints, sensitivity testing is performed only on the most commonly used antibiotic targeted against a specific organism. Despite the use of Augmentin in our patients, there were no documented complications.

The culture of polymicrobial organisms in this series was not associated with any co-morbidities. These organisms include anaerobes, Gram-negative and Gram-positive bacteria. There was no clear relationship between comorbidities and multiple organisms. Human bite injuries are associated with polymicrobial cultures[4,9] but in this study, an association was not found. The majority of the patients had no comorbidities (82%) whereas 9% of patients had associated diabetes mellitus. No clear conclusions can be drawn from these results as only 6% of patients had conditions that compromised the immune system (excluding Human Immunodeficiency Virus (HIV) infection).

The culture and sensitivity results in patients with diabetes mellitus did not differ to those of the healthy population. These results may be affected by the percentage of glycated haemoglobin (HBA1c) which is a marker of plasma glucose concentrations over three months. Ince et al. retrospectively studied 34 diabetic patients who were treated for hand infections from 2008 to 2014. Patients who had an HbA1c level greater than 10% had significantly higher amputation rates[17]. Similarly, Mann et al. reviewed 20 diabetic patients with hand infections and reported that all of the patients had amputations done to control the overwhelming sepsis or due to a non-functional extremity. Even though our study did not show an association

between diabetes and the extent of hand infection, it has been well documented that infections in patients with diabetes should be aggressively treated.

Kour et al. found that two of twenty-five diabetic patients who had hand sepsis required primary amputation whereas only one patient required amputation at a later stage. Pang et al. found that the risk factors affecting amputation in hand sepsis include: poorly controlled diabetes, peripheral vascular disease, renal failure, and polymicrobial flora[30]. Poorly controlled diabetes leads to multi-organ damage; and therefore these patients have multiple comorbidities.

In this study only 10% of patients were HIV positive, 33% were HIV negative, and, 57% had an unknown status. According to Statistics South Africa, 18% of the adult population aged 15 − 49 years is infected with HIV. Furthermore, this is the age group where most patients are commonly affected by hand infections. In this study a relationship between hand sepsis and HIV co-infection could not be established as most patients who presented with hand sepsis at CHBAH were not tested for HIV.

The mass roll out of anti-retroviral drugs in South Africa has significantly improved the outcomes of complications associated with HIV infection. The impact of viral suppression has reduced the development of Acquired Immunodeficiency Syndrome (AIDS) in a number of people. Therefore, these patients can be treated in a similar way to patients not infected with HIV. There is no large series on HIV and outcome of hand infections however, in a study by Duma et al. the authors showed there was no difference in the outcome of hand infections between HIV positive and HIV negative individuals. Other factors not considered in this study include CD4 counts and viral load. Currently there is no evidence to alter the general management of hand sepsis in HIV infected individuals.

4.5 Recommendations

Based on the results obtained from this study the following recommendations are made:

- A retrospective study is needed to determine whether the patients contracted hospital-acquired organisms after the initial results. As community-acquired MRSA is rare in our population, it would be interesting to compare our patients'

findings to those who had specimens taken a second time during their hospital stay. Our patients had specimen taken on day of surgery (admission day or following day). My recommendation is to culture 48 hrs after admission and see if there is a difference in MRSA prevalence.

- A prospective study on HIV infected individuals and its impact on hand sepsis is needed to establish if there is a relationship between HIV and hand sepsis. This study will enable the investigator to test all patients enrolled and check their immune status.
- All patients treated in the minor procedure room should have their specimens taken for microscopy, culture and sensitivity to investigate the microbiology profile of superficial abscesses microbiology profile.
- A follow up study on these patients with hands sepsis is needed to assess their recovery period and functional outcome as some patients require a second debridement.

CHAPTER 5

5 Conclusion

Hand infection is the most common presenting condition to orthopaedic surgeons. It mostly occurs in young adults and the middle-aged population. This has a huge socioeconomic impact if hand infections are inadequately treated. In our population at CHBAH, MSSA is still the most common presenting organism despite the worldwide increase in the prevalence of MRSA. Cloxacillin is still the antibiotic of choice for *S. aureus* cover in hand infections.

In this study, the most common infections in the hand were webspace abscesses, tenosynovitis, and other deep finger infections. Most of the patients had no co-morbidities, and an association between hand sepsis and HIV-infection could not be established.

The early use of appropriate antibiotics and surgical debridement of bite injuries reduces the rate of subsequent infections and complications. Following the results of the study, the current management of these hand sepsis patients in the unit is consistent with international and local literature. Therefore, there was no new evidence that warranted change on current protocols.

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7 Appendices

7.1 Appendix A: Data Collection Sheet

1. Name Of Patient								
2. Hospital Number								
3.Age								
4.Sex								
5.Comorbidities	MALE			FEMALE				
6. Diagnosis								
7. Hand dominance								
8. HIV Status	Right		Left					
9.NHL Specimen number	Positive		Negative		Unknown			
10. Cultured organisms								
10. Antibiotic Sensitivity								
11. Antibiotic on admission								

7.2 Appendix B: HREC Clearance Certificate

R14/49 Drs PM Jada and N Chauke

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M170610

NAME: (Principal Investigator)	Drs PM Jada and N Chauke
DEPARTMENT:	School of Clinical Medicine Department of Surgery Division of Orthopaedic Surgery Charlotte Maxeke Johannesburg Academic Hospital
PROJECT TITLE:	A review of the bacteriology spectrum and antibiotic sensitivity of hand sepsis in patients treated at Chris Hani Baragwanath Academic Hospital
DATE CONSIDERED:	30/06/2017
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Dr T Sefeane
APPROVED BY:	Professor PE Cleaton-Jones, Chairperson, HREC (Medical)
DATE OF APPROVAL:	04/10/2017

This clearance certificate is valid for 5 years from date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on 3rd floor, Phillip V Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
I/We fully understand the conditions under which I am/we are authorised to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated from the research protocol as approved, I/we undertake to resubmit to the Committee. **I agree to submit a yearly progress report**. The date for annual re-certification will be one year after the date of convened meeting where the study was initially reviewed. in this case, the study was initially reviewed in **June** and will therefore be due in the month of **June** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

25/05/2018
Date

PLEASE QUOTE THE PROTOCOL NUMBER IN ALL ENQUIRIES

7.3 Appendix C: CHBAH Permission to Conduct Research

GAUTENG PROVINCE
HEALTH
REPUBLIC OF SOUTH AFRICA

MEDICAL ADVISORY COMMITTEE
CHRIS HANI BARAGWANATH ACADEMIC HOSPITAL

PERMISSION TO CONDUCT RESEARCH

Date: 4 May 2017

TITLE OF PROJECT: A review of bacteriology spectrum and antibiotic sensitivity of hand sepsis in patients treated at Chris Hani Baragwanath Academic Hospital

UNIVERSITY: Witwatersrand

Principal Investigator: PM Jada

Department: Orthopaedics

Supervisor (If relevant): T Sefeane

Permission Head Department (where research conducted): Yes

Date of start of proposed study: May 2017
Date of completion of data collection: Dec 2018

The Medical Advisory Committee recommends that the said research be conducted at Chris Hani Baragwanath Hospital. The CEO /management of Chris Hani Baragwanath Hospital is accordingly informed and the study is subject to:-

- Permission having been granted by the Human Research Ethics Committee of the University of the Witwatersrand.
- the Hospital will not incur extra costs as a result of the research being conducted on its patients within the hospital
- the MAC will be informed of any serious adverse events as soon as they occur
- permission is granted for the duration of the Ethics Committee approval.

.....
Recommended
(On behalf of the MAC)
Date: 04 May 2017

.....
Approved/Not Approved
Hospital Management
Date: 08/05/17

Received by: MOTLO 4187
Date: 19/05/2017

7.4 Appendix D: Participation Consent Form

Participant Consent Form

Study title: A review of bacteriology spectrum and antibiotic sensitivity of hand sepsis in patients treated at Chris Hani Baragwanath Academic Hospital.

1. I have been given a Participant Information Sheet which explains the nature and processes involved in this study
2. I was given time to read it, or had it read to me, in the language I best understand
3. I was given time to ask any questions I wanted to and found any answers given to me to be satisfactory
4. I believe I fully understand why the study is being conducted and what the intended outcomes will be
5. I understand that there will be no immediate benefit to me, should I agree to participate, nor will I receive any payment; conversely, participation will not cost me anything
6. I have been given a range of contact details, repeated below, should I require further information at a later stage, or have any cause for concern over any aspect of the treatment I receive
7. I understand that, even if I initially consent to take part in the study, I may subsequently withdraw at any time and would not be required to give reasons; if that happened, any data collected about me for the purposes of the study would immediately be destroyed.

On the basis of the foregoing information, I, _____ (please print name) freely consent to participate in the study.

Signature or identifying mark: _____ Date: _____

Contact Details

Principal Investigator:
Dr Prince Jada
072 384 2006
princejada@gmail.com

Supervisors' details:

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083 291 8648
tatolos@me.com

Dr N Chauke

082 965 7359

drshiminyetani@hotmail.com

Ethical approval

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg. The Chairperson of this Committee is Professor Peter Cleaton-Jones, who may be contacted on telephone number 011 717 2301, or by e-mail on Peter.Cleaton-Jones1@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700 / 2656 / 1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za, Rhulani.Mkansi@wits.ac.za and Lebo.Moeng@wits.ac.za Rhulani.Mkansi@wits.ac.za and Lebo.Moeng@wits.ac.za

7.5 Appendix E: Study Information Sheet

Participant Information Sheet

Research title

A review of bacteriology spectrum and antibiotic sensitivity of hand sepsis in patients treated at Chris Hani Baragwanath Academic Hospital.

Introduction

My name is Prince Masibulele Jada, I am a medical doctor in the Department of Orthopaedic Surgery. I am studying towards a Masters degree at the University of the Witwatersrand, Johannesburg. The project described below forms part of my Masters studies. We continue to do research to answer certain questions and to improve the treatment of patients in future. In this research I would like to know the best treatment I can provide to patients with similar hand problem as you are presently experiencing, in order to improve outcomes.

Invitation to Participate

I would like to invite you to participate in this research, which looks at what caused the infection in your hand, as well as the best treatment method of it. I will be looking for the cause of the infection by sending a specimen of the pus from your hand to the laboratory for testing and identification. Then the laboratory will tell us what it ~~is~~ contains and help me to determine what treatment is best for it.

What is involved in the study?

I will be looking into your results from the laboratory and some medical information from your file. I need your permission to look into your file for this information. Nothing else is expected from you if permission is granted. I will be doing this research in all patients who are admitted with a hand infection for the next 6 months. There are no extra or different procedures and medications needed, besides the usual ones that we would provide irrespective of the study.

Risks/Benefits

There are no direct risks or benefits of this study to you at this moment. It will help though in future, if you or any other patients have a similar infection, to treat it adequately and better.

Participation

To be part of this study, it is important for you to understand what ~~is~~ it is about and on that basis, I hope you will sign a Consent Form, granting me permission to review your records. You are free to refuse to participate in the study, or to withdraw even after you have signed the Consent Form. You will not be required to give your reasons in either case and any data collected about you for the purposes of the study would immediately be destroyed. The treatment you will receive will not change, whether you participate or not. There is no payment for participation, nor is there any cost to you. My contact details are shown below. You can contact me at any time, if you want to withdraw from the study, or if you simply require more information.

Confidentiality

No names will be used in this research. I will use the laboratory number and hospital number. Then I will randomly give a number to all patients from 1 to 100. All the information will be reviewed by me and I will store it in my password protected personal computer. I will be the only one who has access to the hospital numbers and lab numbers. The results of the research will not have any patient numbers. It will only report on percentages of the findings. At the end of the study, I will produce a report, which may even be published. You may see a copy of this report on request. Again, individuals will not be identified in the report.

Contact Details

Dr Prince Jada (Principal Investigator)
072 384 2006
princejada@gmail.com

Supervisors' details:
Dr T Sefeane
083 291 8648
tatolos@me.com

Dr N Chauke
082 965 7359
drshiminyetani@hotmail.com

Ethical approval

This study has been approved by the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg. The Chairperson of this Committee is Professor Peter Cleaton-Jones, who may be contacted on telephone number 011 717 2301, or by e-mail on Peter.Cleaton-Jones1@wits.ac.za. The telephone numbers for the Committee secretariat are 011 717 2700/2656/1234 and the e-mail addresses are Zanele.Ndlovu@wits.ac.za, Rhulani.Mkansi@wits.ac.za and Lebo.Moeng@wits.ac.za

Thank you for reading this document and considering my request.

7.6 Appendix F: Frequency Tables

Age Group

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	0-20	11	10.7	10.7	10.7
	21-54	80	77.7	77.7	88.3
	55+	12	11.7	11.7	100.0
	Total	103	100.0	100.0	

Sex

	Frequency	Percent	Valid Percent	Cumulative Percent
Female	25	24.3	24.3	24.3
Male	78	75.7	75.7	100.0
Total	103	100.0	100.0	

HIV Status

	Frequency	Percent	Valid Percent	Cumulative Percent
Negative	34	33.0	33.0	33.0
Positive	10	9.7	9.7	42.7
unknown	1	1.0	1.0	43.7
Unknown	58	56.3	56.3	100.0
Total	103	100.0	100.0	

Hand Dominance

	Frequency	Percent	Valid Percent	Cumulative Percent
Left	20	19.4	19.4	19.4
Right	83	80.6	80.6	100.0
Total	103	100.0	100.0	

Side Affected

	Frequency	Percent	Valid Percent	Cumulative Percent
Bilateral	2	1.9	1.9	1.9
Left	34	33.0	33.0	35.0
Right	67	65.0	65.0	100.0
Total	103	100.0	100.0	

Diagnosis

	Frequency	Percent	Valid Percent	Cumulative Percent
Bites	7	6.8	6.8	6.8
Dorsum abscess	1	1.0	1.0	7.8
Finger abscess	29	28.2	28.2	35.9
Osteomyelitis	2	1.9	1.9	37.9
Superficial abscess	4	3.9	3.9	41.7
Tenosynovitis	21	20.4	20.4	62.1
Thenar abscess	5	4.9	4.9	67.0
Webspace abscess	34	33.0	33.0	100.0
Total	103	100.0	100.0	

Comorbidities

	Frequency	Percent	Valid Percent	Cumulative Percent
Diabetes	3	2.9	2.9	2.9
Diabetes, Hypertension	5	4.9	4.9	7.8
Diabetes, Mycosis Fungoides, Hypertension	1	1.0	1.0	8.7
Hypertension	7	6.8	6.8	15.5
None	85	82.5	82.5	98.1
Prostate Cancer	1	1.0	1.0	99.0
Rheumatoid	1	1.0	1.0	100.0
Total	103	100.0	100.0	

Cultured Organisms

	Frequency	Percent	Valid Percent	Cumulative Percent
Klebsiella Oxytoca	1	1.0	1.0	1.0
Klebsiella Specie	1	1.0	1.0	1.9
Methicillin-Resistant *Staphylococcus Aureus*	2	1.9	1.9	3.9
Multiple Organisms	12	11.7	11.7	15.5
No Growth	11	10.7	10.7	26.2
Serratia Marcescens	1	1.0	1.0	27.2
Staphylococcus Aureus	70	68.0	68.0	95.1
Streptococcus Mitis	1	1.0	1.0	96.1
Streptococcus Pyogenes	3	2.9	2.9	99.0
Streptococcus Viridans	1	1.0	1.0	100.0
Total	103	100.0	100.0	

Antibiotic Sensitivity

	Frequency	Percent	Valid Percent	Cumulative Percent
	14	13.6	13.6	13.6
Amoxicillin-Clavunic acid	3	2.9	2.9	16.5
Ampicillin, Penicillin	7	6.8	6.8	23.3
Cloxacillin	71	68.9	68.9	92.2
Cloxacillin,Amoxicillin-Clavunic acid	1	1.0	1.0	93.2
Ertapanem	2	1.9	1.9	95.1
Ertapanem, Penicillin, Ampicillin	1	1.0	1.0	96.1
Imipenem, Penicillin, Ampicillin	1	1.0	1.0	97.1
Penicillin	1	1.0	1.0	98.1
Vancomycin	1	1.0	1.0	99.0
Vancomycin, Fluconazole	1	1.0	1.0	100.0
Total	103	100.0	100.0	

Antibiotic on Admission Group

	Frequency	Percent	Valid Percent	Cumulative Percent
Amoxicillin-Clavunic acid	61	59.2	59.2	59.2
Ceftriaxone, Ampicillin	1	1.0	1.0	60.2
Cloxacillin	40	38.8	38.8	99.0
Kefzol	1	1.0	1.0	100.0
Total	103	100.0	100.0	