A retrospective cohort study investigating the epidemiology of bacterial hand infections at a tertiary hospital in the Western Cape of South Africa

Ridwaan Aboobaker,* Hentas van Zyl, Marilize C Burger

Department of Orthopaedic Surgery, Tygerberg Hospital, Stellenbosch University, Cape Town, South Africa

**Corresponding author: drridwaanaboobaker@gmail.com*

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Abstract

Background

Hand infections can cause serious morbidity and financial implications to patients and healthcare systems. This retrospective cohort study investigates the epidemiology of bacterial hand infections at a tertiary institution over a year, with a secondary objective of investigating factors that modify risk for complications.

Method

Patient demographics, clinical information, microbacterial spectrum, timeframes of patient's pathway, and risk factors for complication development were investigated. Data related to antibiotic cover and any resistance to commonly used antibiotic therapy, specifically co-amoxiclav (Augmentin) and cloxacillin, was also captured. Relationships between risk factors and complications were investigated with a chi-squared or Fisher's exact test at an alpha-level of 0.05.

Results

Overall, 529 patients (mean age of 33.0 ± 15.6 years; 73% male) were included. A delay of a median of 6.0 (IQR 3.0–9.0) days between onset of symptoms and admission occurred. Complications were experienced by 23% (n = 124) patients. These patients required soft tissue cover (55%, n = 69), relook-debridement alone (34%, n = 42), or an amputation (10%, n = 13). Methicillin-sensitive *Staphylococcus aureus* (MSSA) was most frequently cultured, at 79% (n = 281) of all cultured organisms. More of the cultured organisms were sensitive to co-amoxiclav (86%, n = 305) than they were to cloxacillin (78%, n = 278). Patients with necrotising fasciitis and co-amoxiclav resistance had a statistically significant increase in complications.

Conclusion

The findings of this study highlight a high burden of hand infections as well as a high rate of complications following treatment. Furthermore, co-amoxiclav was an appropriate choice of antibiotic cover in this population. Finally, patients with necrotising fasciitis and those with co-amoxiclav-resistant infections are more at risk of complications. These findings should be taken into consideration when treating patients with hand infections.

Level of evidence: 3

Keywords: epidemiology, bacterial, hand, infections

Introduction

A hand infection can be defined as the presence of an infective organism within a hand, with or without spontaneous purulent discharge from a hand wound or surgical site.[1] Hand infections are serious conditions as they can be costly to treat, and result in a significant loss of function and, if not treated timeously and correctly, disability.[2,3] The populations at greatest risk for developing hand infections include those who are immunocompromised, diabetics, from lower socioeconomic backgrounds, and manual labourers who work with their hands and do not use protective equipment.[4]

Staphylococcus aureus is a well-known and common causal organism of hand infections, with methicillin-sensitive *Staphylococcus aureus* (MSSA) being most prevalent.[1,4-6] However, methicillin-resistant *Staphylococcus aureus* (MRSA) has recently been reported to occur more frequently in developed and urban settings, such as found in a study conducted in San Francisco which showed a high incidence of community-acquired MRSA infections, with 46% of their culture results positive for MRSA.[7]

The mainstay of treatment for hand infections includes both the use of antibiotics as well as surgical management in the majority of cases.[1] Antibiotic treatment generally consists of initial intravenous antibiotics, followed by oral antibiotics to complete the course.[8] Cloxacillin antibiotic treatment has been found in several studies in other provinces to be appropriately sufficient and effective enough to cover the causal organisms found in the South African setting, and the use of this antibiotic alone has been found to be sufficient in some previous studies.[6,8] However, the use and sensitivity of cloxacillin as well as co-amoxiclav have neither been investigated

in the majority of studies, nor in the setting of our tertiary institution, in the Western Cape. Co-amoxiclav also remains widely used in the other provinces and settings, as noted in a South African study where co-amoxiclav was shown to be the most effective antibiotic, especially in mixed organism cultures.[4]

Most patients with hand infections require operative treatment,[9] which typically includes either incision and drainage, or debridement of the affected area.[2] The most notable complications of hand infections include amputation, the need for multiple debridements, and the requirement for soft tissue cover.[8]

Factors related to complications include poorly controlled diabetes, immunocompromised hosts, those from lower socioeconomic backgrounds, those who present late, and cases with antimicrobial-resistant infections, as noted in two South African studies,[8,10] as well as a study in similar low- to middle-income countries (LMICs).[11]

Demographics and patient populations may differ from province to province in South Africa, and potential differences may exist due to many factors, including cultural and geographical differences.[12] It is also important to note that resource allocation towards healthcare and population conditions may differ between provinces;[13] therefore, exploring differences in patterns of disease, treatment and complication patterns may provide information in order to manage these conditions effectively. Findings of studies that investigate the different variables associated with hand infections may potentially be used to guide resource allocation, specific antibiotic treatment based on causal organisms, and inform future studies in order to address any gaps or inadequacies that exist in the management of hand infections.

This study, therefore, aimed to explore the epidemiology of bacterial hand infections at a tertiary hospital in South Africa. Specific objectives include to describe the patient and clinical demographic, describe the microbiological profile including sensitivities to two commonly used antibiotics (co-amoxiclav and cloxacillin), describe the treatment process, evaluate the presence of complications following treatment, describe the timing of presentation of hand infections to the hospital, and timing to first surgical debridement. A secondary objective was to investigate potential risk factors associated with increased complications following hand infections.

Methods

Study design

The study followed a retrospective cohort design, investigating the epidemiology of bacterial hand infections managed at the orthopaedic surgery department of a tertiary hospital in the Western Cape of South Africa over a one-year period.

The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for reporting observational studies was used.[14]

Study population

All patients who were referred with bacterial hand infections at a tertiary hospital in the Western Cape province of South Africa who required admission were considered for inclusion. Specific inclusion criteria included patients with either acute and chronic bacterial infection involving the forearm, wrist or hand up to and including the fingertips, between 1 January 2022 and 31 December 2022 who had been admitted to the hospital. A hand infection was defined as infection with the presence of a pus collection or drainage from any area of the hand from the tips of fingers up to and including the forearm.

Patients who did not require admission, those with minimal to no information on file, and those who had absconded from the emergency department prior to being admitted to the hospital ward were excluded. Those who did not have a clinically palpable or visible collection or pus drainage were also excluded from the study.

Demographic characteristics, brief medical history and baseline clinical information of all included patients were collected from the relevant hospital files by the principal investigator, thereby reducing the potential risk of bias. Patient information was deidentified at the point of data collection. Time delays between the onset of the symptoms of infection and time to presentation, as well as total duration of treatment and length of hospital stay was calculated using the information of times and dates recorded in the patients' files. Any missing data was recorded as unknown.

Types of hand infections were subcategorised according to the anatomical location of the infection. All information regarding treatment procedures, including the number of surgical procedures, need for soft tissue cover or amputation, as well as all microscopy, culture and sensitivity results were recorded as potential exposures that could alter risk for complications. All surgical procedures for hand infections were performed as a major surgical procedure either under a local block or under general anaesthesia. Surgeries performed were exclusively debridement, soft tissue cover, or an amputation.

The presence of complications was recorded as the main outcome of interest for the secondary objective. Complications were defined as requiring 1) amputation, or 2) more than one surgical procedure, or 3) soft tissue cover due to soft tissue loss. Requiring a second procedure was always regarded as being a complication whether it was planned at the initial procedure/setting or not. While an important outcome to consider, stiffness as a complication was not included in the present study as there was not sufficient information recorded in the patient files to accurately comment on this outcome. Presence or absence of systemic involvement, defined as the presence of pyrexia, tachycardia or septic shock (mean arterial pressure < 65 mmHg in the presence of fever) was also recorded.

Data analysis plan

Data was analysed using Statistica (v.18, TIBCO software). Continuous data is described as means ± standard deviations, with 95% confidence intervals as appropriate, or medians (interquartile ranges, IQR), depending on the distribution. Categorical data are described as frequencies and counts. Associations between potential risk factors and the presence of complications were investigated using chi-squared or Fisher's exact tests as appropriate. Potential risk factors included comorbidities (smoking, substance abuse and diabetes), aetiology, injury location, complex microbiological findings or time delays to treatment (categorised as < 5 vs > 5 days from onset to treatment). Power to detect an association between the potential risk factors and the presence of complications ranged from 10–100% in this finite sample, at a pre-set alpha-level of 0.05.

Results

A total of 566 patients were considered for inclusion. Of these, 37 patients were excluded due to either not requiring admission for surgery (n = 14), having incomplete medical records (n = 10) or due to having absconded (n = 13) (*Figure 1*).

The final sample, therefore, included 529 patients with a mean age of 33.0 ± 15.6 years (95% CI 31.6–34.3) *(Table I),* the majority being males (79%, n = 385), and the right hand being mostly involved (59%, n = 312). The most common comorbidity was smoking (40%, n = 213). A total of 16% (n = 85) of patients were substance abusers, which included either methamphetamines, methaqualone, marijuana, heroin and/or cocaine. Retroviral

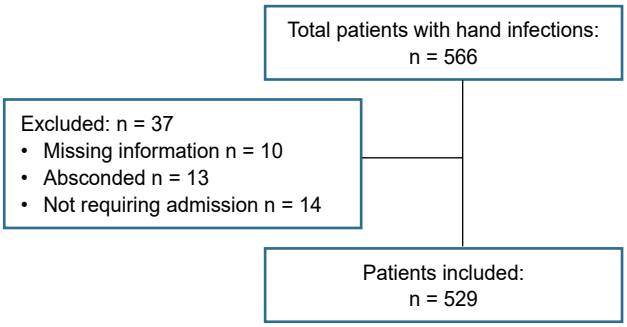

Figure 1. Flow diagram leading to remaining final patient inclusion in the study

Table I: Demographic characteristics of all patients admitted for the treatment of hand sepsis

Characteristic	n = 529
Age (years)	33.0 ± 15.6 (95% CI 31.6–34.3)
Sex (male/female)	72.8 (385) / 27.2 (144)
Affected hand (right/left)	58.8 (311) / 41.2 (218)
Smoker (yes/no/unknown)	40.2 (213) / 56.1 (297) / 3.7 (19)
Diabetes (yes/no)	5.9 (31) / 94.1 (498)
Substance abuser (yes/no)	16.1 (85) / 83.9 (444)
RVD status (unknown/negative/reactive)	82.2 (435) / 5.9 (31) / 11.9(63)
Other comorbidities (yes/no)	13.4 (71) / 86.6 (458)

Data is described as mean ± standard deviation (95% confidence interval) or as frequency (count). RVD: retroviral disease

Table II: Clinical characteristics of all patients treated for hand sepsis

Clinical variable	n = 529
Time to presentation (days)	6.0 (3.0–9.0)
< 5 days / > 5days	40.2 (214) / 59.2 (315)
Delay between presentation and surgery (days)	2.0 (1.9–2.3)
Length of stay (days)	4.0 (3.0–7.0)
Mechanism of sepsis (spontaneous/preceding trauma)	48.6 (257) / 51.4 (272)
Complication (yes/no)	23.4 (124) / 76.4 (405)
Systemic involvement	2.6 (14)
Type of complication	n = 124
Soft tissue cover	55.2 (69)
Amputation	10.4 (13)
> 1 surgery required	100.0 (124)
Relook debridement	33.6 (42)
Microbiological profile of cultured organisms	n = 356
Staphylococcus aureus	68.7 (281)
Other	18.3 (75)
Negative cultures	
No bacteria cultured	13.0 (53)
Antibiotic sensitivities	
Co-amoxiclav	85.6 (305)
Cloxacillin	78.1 (278)

Data is described as median (interquartile range) of a frequency (count).

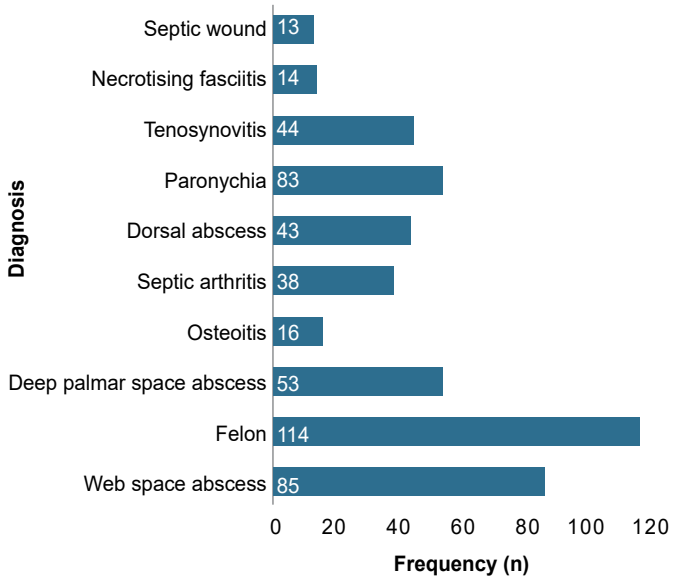

Figure 2. Frequency of specific diagnoses of subtype of hand sepsis with the absolute number of patients in each category indicated in each bar

disease (RVD) status was unknown in the majority of cases, given that testing was not routinely performed.

There was a slightly higher frequency of having a history of preceding trauma than spontaneous onset hand sepsis. The median number of days from onset of symptoms to presentation to admission to hospital was 6.0 (IQR 3.0–9.0) days, with a further delay of 2.0 (IQR 1.9–2.3) days to surgery. The median length of stay was 4.0 (IQR 3.0–7.0) days (*Table II*).

A total of 23% (n = 124) of cases experienced at least one complication (*Table II*), and a small number of patients 3% (n = 14) had documented evidence of systemic involvement. All patients with complications required more than one surgery, which finally resulted in the need for an amputation 10% (n = 13), requiring soft tissue cover 55% (n = 69), or the need for relook debridement alone 34% (n = 42).

The most common types of hand infections were felon (22%, n = 114) and web space abscesses (16%, n = 85) (*Figure 2)*.

A total of 412 patients had specimens sent for microbiological culture at the first debridement. Of these, an organism was successfully cultured in 86% (n = 356) of samples, and MSSA was cultured in 79% (n = 281) of specimens. Another organism, different from MSSA, was observed in 18% (n = 75) of all specimens, and MRSA was cultured in less than 1% (n = 3) of samples.

Of a total of 356 cases which had a positive culture, the majority of cases (86%, n = 305) were sensitive to co-amoxiclav. Following closely behind in sensitivity was cloxacillin, with 78% (n = 278) cases being sensitive, and the remainder of positive cultures being resistant (*Table II*).

No difference in the risk of developing complications was observed in diabetic patients (p = 0.103), smokers (p = 0.054), those with spontaneous onset hand infections (p = 0.151), substance users (p = 0.272) or those who presented to the hospital at ≥ 5 days from the first onset of symptoms (p = 0.088) (*Table III*). Similarly, the location of the infection, and causal bacteria had no association with the risk of developing complications (*Table III*).

An increased risk for developing complications (p < 0.001) was observed in patients with necrotising fasciitis (79%, n = 11) versus those without (30%, n = 113). Similarly, patients with co-amoxiclav-resistant infections had a higher risk (p = 0.002) of developing complications (49%, n = 25) compared to those with co-amoxiclav-sensitive infections (23%, n = 70) (*Table III*). More of the cultured organisms were sensitive to co-amoxiclav (86%, n = 305) than they were to cloxacillin (78%, n = 278) (*Table III*).

Table III: Association between clinical characteristics or microbiological findings and the risk of complication

Risk factor	Complication		p-value
	Yes % (n)	No % (n)	
Diabetes			
Yes	36 (11)	65 (20)	0.103
No	23 (113)	77 (385)	
Smoking status			
Yes	29 (61)	71 (152)	0.054
No	20 (58)	81 (239)	
Unknown	26 (5)	74 (14)	
Substance abuser			
Yes	19 (16)	81 (69)	0.272
No	26 (108)	76 (336)	
Time to presentation			
< 5 days	20 (42)	80 (172)	0.088
> 5 days	26 (82)	74 (233)	
Onset aetiology			
Spontaneous	26 (67)	74 (189)	0.151
Preceding trauma	20.9 (57)	79 (216)	
Necrotising fasciitis			
Yes	79 (11)	21 (3)	< 0.001
No	30 (113)	78 (402)	
Tenosynovitis			
Yes	30 (13)	70.5 (31)	0.318
No	23 (111)	77.1 (374)	
Felon			
Yes	173 (18)	83 (86)	0.099
No	25 (106)	75 (319)	
Web space abscess			
Yes	21 (18)	79 (66)	0.635
No	24 (106)	76 (339)	
MSSA			
Yes	24 (66)	76 (215)	0.051
No	36 (27)	64 (48)	
Co-amoxiclav-resistant			
Yes	49 (25)	51 (26)	0.002
No	23 (70)	77 (235)	

Data presented as frequency (count). MSSA: methicillin-sensitive *Staphylococcus aureus*

Discussion

The aim of this study was to explore the epidemiology of bacterial hand infections at a tertiary hospital in South Africa. This hospital serves a patient population from both urban and rural areas in the Western Cape of South Africa, including regional and district referral hospitals. The majority of the patients served in this institution are from a low- to middle-socioeconomic status group.[11] The populations at greatest risk for developing hand infections include those who are immunocompromised, diabetics, from lower socioeconomic backgrounds, and manual labourers who work with their hands, but do not use protective equipment.[4] A large proportion of South Africans, as well as patients served by the institution investigated in the present study, fall within these high-risk categories.[12]

The first main finding of this study, set within the Western Cape province of South Africa, a province with an unemployment rate of 25.6% as published in 2024 by Statistics South Africa,[13] was that a high burden of hand infections was observed. This finding was in agreement with the results of a previous study from a different tertiary hospital, also located within the Western Cape, where approximately 650 patients with hand infections were treated in the period of a single year.[10] Similar high rates of hand infections have also been reported elsewhere in South Africa, with approximately 100 patients reported within the period of a year in a public healthcare facility located in KwaZulu-Natal,[8] and 513 hand infections reported in a Northern Cape healthcare institution.[6] A similar high frequency of hand infections was also reported in a study conducted at a hospital in the developing city of Karachi, Pakistan, a primarily LMIC population, where 271 patients were admitted in a 12-month period.[11] In contrast, much lower frequencies of hand infections have been observed in high income countries such as Denmark, with approximately 400 patients over a ten-year period,[1] or Philadelphia, United states of America (USA) with approximately 800 patients over a ten-year period.[7] While these disparities might be as a result of smaller hospital drainage areas in high-income countries vs LMICs, it is likely also an effect of the differences in the total healthcare systems and networks between these countries.[7]

In the present study, hand infections were found to be more common in males, even though the Western Cape has a larger proportion of females than males,[13] but this finding is in keeping with existing literature.[8,15] A possible explanation for this observation could be that more men may be involved in manual activities, risking hand injuries. Certain diagnoses of hand infection such as felon, web space abscess and paronychia were also more common, compared to less common, but more severe, types of hand infection such as necrotising fasciitis. Similar distributions were previously observed in other South African investigations,[6,8] other LMICs,[11] studies from high income European countries, and in this study.[1,3,5]

In keeping with the majority of other studies on hand infection,[1,5] the most common organism cultured in the present study was MSSA, with less than 1% of cultures positive for MRSA.[1,5] Similar distributions were observed in different South African studies, with a study performed in KwaZulu-Natal finding 82% being MSSA, while a Kimberley study reported MSSA as being present in 91% of patients.[4,6] In the latter two studies, less than 1% and approximately 6% of samples, respectively, cultured for MRSA.[4,6] In contrast, a ten-year longitudinal investigation from the USA reported MRSA to be most commonly cultured from hand infections in urban centres.[7] These findings highlight the importance of antibiotic stewardship, as well as potential differences in hosts between these countries.[6]

A large proportion of the study participants were smokers (40%). However, no significant association between smoking and increased risk of developing complications was observed in the present study. This finding could imply that smoking may not be involved in the risk of developing early complications following hand infections. However, smoking is known to slow down tissue healing,[16] and a recent systematic review reported an increased risk of developing orthopaedic complications such as postoperative infections and non-union, as well as an increased fracture risk.[17] This could be due to the effect smoking has on wound healing and peripheral blood circulation.[16] This, in turn, may delay immune cells and systemic antibiotic therapy from reaching the target site of infection in adequate concentrations to exert its bactericidal/bacteriostatic effect. However, it can be argued that measuring smoking as a single, binary variable in a relatively small cohort

of patients who experienced complications can be limited in how smoking should be interpreted to influence risk. Historic smoking, number of years being exposed to smoke and the quantity of smoking should all ideally be considered. Given the known biological pathway of smoking resulting in complications following orthopaedic injuries, the current findings should be interpreted with caution, and future studies should aim to investigate the role of this behaviour in larger samples. While not statistically significant in this study, most likely due to the small sample size of the subgroup, diabetes is also known to be associated with increased risk of suffering complications following orthopaedic injuries.[8,10] Similar to smoking, the presence of diabetes is also known to delay wound healing and has also previously been associated with the presence of severe infections, especially when blood glucose is not effectively controlled.[8] In addition, blood glucose also tends to rise in the presence of infection, subsequently compounding the problem.[5] This finding should therefore also be interpreted with caution, and future studies with larger sample sizes should aim to investigate diabetes as a potential risk factor for complications following hand infections.

Just over 23% of patients in the present study experienced one or more complication from their hand infection, which is slightly lower than what was observed in the KwaZulu-Natal study published in in 2020,[8] but slightly higher than Pakistan[11] and European studies,[18] respectively. Factors associated with increased risk included the cultured organism, raised blood markers of infection and presence of diabetes, as well as having multiple injuries on the hands, and raised C-reactive protein positive bacterial cultures.[18] While the present study did not find a significant difference in risk of complications in patients who presented after five days following onset of symptoms, delayed presentation has previously been associated with a complicated course of treatment.[19] Interestingly, presentation to a general practitioner for treatment before presenting to a hospital has also been associated with an increased risk of complications.[8] Increased travel distance and lack of transport to healthcare facilities are widely cited as prohibitive to obtaining care in South Africa.[20] Similarly, following the hierarchy of the healthcare system in South Africa by first presenting to a local clinic or general practitioner for conservative treatment, before being referred to a secondary or tertiary institution for surgical care, might actually increase the risk of complication. By the training of staff at primary healthcare facilities to recognise the urgency and to even potentially perform the initial debridement procedures might reduce the incidence of complications.

Co-amoxiclav was routinely used in the present study setting as the empiric antibiotic cover for all patients who present to the institution. Patients presenting with organisms sensitive to co-amoxiclav were less likely to experience complications, which is expected, given that the treatment is effective against the organism causing the infection. There are many alternatives to the antibiotic choice that would have good coverage for MSSA, such as cloxacillin, erythromycin/azithromycin, clindamycin and vancomycin, which could be potential treatment considerations.[6] However, in this study setting, it was noted that co-amoxiclav was the correct choice of antibiotic empiric protocol as compared to cloxacillin, with most cases being sensitive to co-amoxiclav.

As in any clinical environment, complications result in increased morbidity as well as increased cost to the healthcare system. Indeed, a previous investigation quantifying the average cost of hand infections to the healthcare system concluded that the cost of treatment increases drastically, as expected, with any surgical interventions needing to be performed.[15] Studies with large sample sizes highlighting potential risk factors that could be utilised in mitigation strategies to prevent complications can help reduce the morbidity as well as costs associated with complications following hand infections.

A limitation of the study was the HIV status of patients not being readily available, which limits the conclusions that can be drawn from causal organisms in hand infections from HIV-positive compared to HIV-negative patients. Smoking and diabetes, two known risk factors for complications, were measured only as binary variables, which limits the depth of the conclusion that can be drawn from the findings. In addition, the present study reported only on early complications measured in hospital, and important long-term outcomes, such as stiffness, were not measured. This study, with an arguably large sample size and high number of complications, remained underpowered to detect many expected risk factors that might predispose to risk. This highlights that collaborative work should be undertaken to truly investigate, in large enough samples, the effect of many risk factors on hand infections. The present study provides direction for these future investigations.

Conclusion

In conclusion, we report a high burden of hand infections with a high number of early complications, over a 12-month period. Clinicians should be aware of an increased risk of complications, especially in patients with necrotising fasciitis and those infections which are resistant to the treating antibiotic. Co-amoxiclav was the most appropriate antibiotic for this population group, which is contrary to many other institutions, and thus highlights the fact that different institutions should examine their own populations to determine whether their antibiotic protocol is appropriate.

Ethics statement

The authors declare that this submission is in accordance with the principles laid down by the Responsible Research Publication Position Statements as developed at the 2nd World Conference on Research Integrity in Singapore, 2010.
Prior to commencement of the study, ethical approval was obtained from Stellenbosch University Health Research Ethics Committee (HREC): HREC Ref: S22/10/220. Given the retrospective nature of this work, a waiver of informed consent was obtained. All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008.

Declaration

The authors declare authorship of this article and that they have followed sound scientific research practice. This research is original and does not transgress plagiarism policies.

Author contributions

RA: conceptualisation of the research question, study design, methodology, data collection, manuscript preparation, editing and finalisation of manuscript, approval of final version
HvZ: study design, methodology, manuscript editing, approval of final version
MCB: study design, methodology, statistical analysis, manuscript preparation and editing, approval of final version

ORCID

Aboobaker R https://orcid.org/0009-0002-9314-9711
van Zyl H https://orcid.org/0000-0002-1479-0854
Burger MC https://orcid.org/0000-0003-2831-4960

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