Clinical Article

Bacteriology and epidemiology of hand infections

JF Greyling MBChB, (UFS), Orthopaedic Registrar
Dr E Visser, MBChB, MMed(Orth)Head of Hand Surgery, Bloemfontein
Dr E Elliot MBChB, MMed(Micro), FCPath(Micro), Dip HIV Med
University of the Free State, Bloemfontein, South Africa

Reprint requests:
Dr JF Greyling
Department of Orthopaedics
University of the Free State
National Hospital
Private Bag X20598
Bloemfontein
9301

Abstract

Infection is one of the most serious and important causes of hand swelling. Neglect or incomplete treatment of hand infections will usually lead to involvement of other parts of the hand resulting in stiffness, loss of hand function, and possibly amputation (*Figure 1*). Hand infections are common conditions that have significant morbidity. Referral is often delayed and infections present late. Hand infections should be managed by an experienced surgeon.

The aims of the investigation were: to identify the spectrum of organisms and appropriate antibiotics for hand infection; and to characterise the patterns and sites of hand infections. This information was collected against the background of a high prevalence of HIV-infected patients and increasing antibiotic resistance.

A total of 66 patients treated for hand infections over a period of six months in Pelonomi Hospital, Bloemfontein, South Africa, was prospectively recruited for the study.

Staphylococcus aureus was the commonest isolate. Results show that cloxacillin is still an effective first line antibiotic for community-acquired hand infections in the absence of immunosuppression. Alternative empiric therapy would be clindamycin – especially in the beta-lactam intolerant patient. Erythromycin also proved to have a favourable profile. HIV-positive patients were more prone to Gram-negative infections.

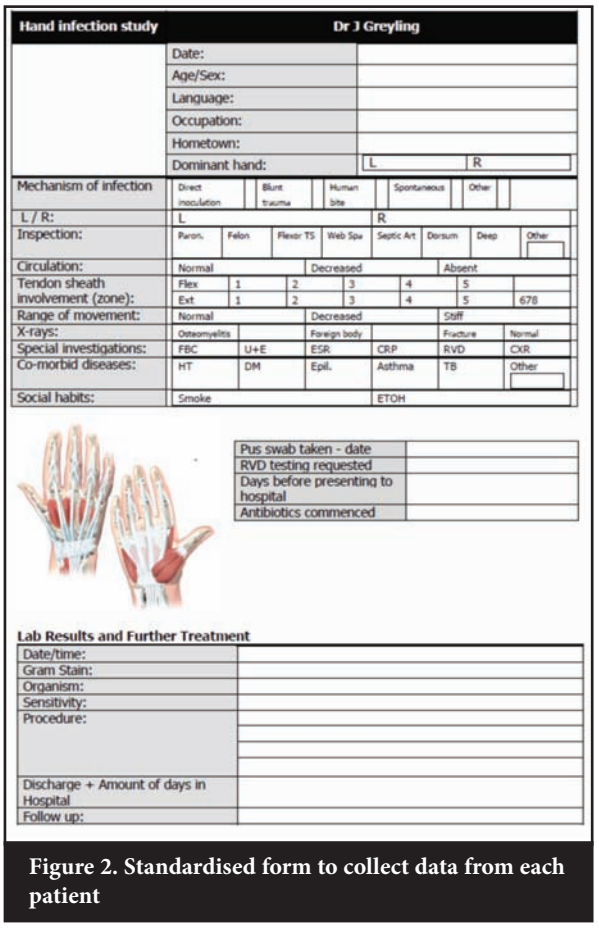
Key words: Hand, infection, bacteriology, epidemiology, antibiotics

Introduction

Hand infections are commonly seen by orthopaedic surgeons as well as emergency room and primary care physicians. Identifying the cause of the infection and starting prompt and appropriate medical or surgical treatment can prevent substantial morbidity. The most common bacteria implicated in hand infections remain *Staphylococcus aureus* and the *Streptococcus* species. Methicillin-resistant *S. aureus* infections have become a common and difficult problem best treated with empiric antibiotic therapy until the organism can be confirmed. Other organisms can be involved in specific situations that will be reviewed.

Types of infections include cellulitis, superficial or deep abscesses, septic arthritis and osteomyelitis. In recent years, treatment of these infections has become challenging due to increased virulence of some organisms and drug resistance. Treatment involves a combination of proper antimicrobial therapy, immobilisation, oedema control and adequate surgical therapy. Best-practice management requires use of appropriate diagnostic tools, understanding by the surgeon of the unique and complex anatomy of the hand, and proper antibiotic selection in consultation with infectious disease specialists.[1]

Figure 1. Neglected hand infections can have disastrous consequences



Hand infection study	Dr J Greyling						
	Date:						
	Age/Sex:						
	Language:						
	Occupation:						
	Hometown:						
	Dominant hand:			L		R	
Mechanism of infection	Direct inoculation	Blunt trauma	Human bite		Spontaneous	Other	
L / R:	L				R		
Inspection:	Paron.	Felon	Flexor TS	Web Spa	Septic Art	Dorsum	Deep	Other
Circulation:	Normal			Decreased		Absent	
Tendon sheath involvement (zone):	Flex	1	2	3	4	5	
	Ext	1	2	3	4	5	678
Range of movement:	Normal			Decreased		Stiff	
X-rays:	Osteomyelitis			Foreign body		Fracture	Normal
Special investigations:	FBC	U+E	ESR	CRP		RVD	CXR
Co-morbid diseases:	HT	DM	Epil.	Asthma		TB	Other
Social habits:	Smoke			ETOH			

Pus swab taken - date	
RVD testing requested	
Days before presenting to hospital	
Antibiotics commenced	

Lab Results and Further Treatment

Date/time:	
Gram Stain:	
Organism:	
Sensitivity:	
Procedure:	
Discharge + Amount of days in Hospital	
Follow up:	

Figure 2. Standardised form to collect data from each patient

Materials and methods

A prospective, cross-sectional, analytical study was performed on 66 patients presenting with hand infections at the Pelonomi Hospital from January to June 2009.

Inclusion and exclusion criteria

All patients with active infections were included. Patients with high risk wounds, even those who required debridement in theatre (for instance fight bites), had to be excluded due to the fact that positive cultures could not be obtained.

Treatment protocols

A standardised treatment protocol was followed in managing these patients, including: incision and drainage (and relook if necessary), splinting, intravenous antibiotics, dressings, hand baths and hand therapy. Pus swabs and tissue biopsies were sent to the laboratory for microscopy, culture and sensitivity (M/C/S). A standard form was used to collect data from each patient (*Figure 2*). All laboratory reports were followed up for the identity and antibiotic susceptibility of causative organisms. All patients were counselled, and then tested for HIV if they gave consent.

Laboratory investigations done before surgery included full blood count (FBC), C-reactive protein (CRP), and erythrocyte sedimentation rate (ESR). The initial collection of data was done by the registrars rotating through hand surgery at the time of the study. The researcher reviewed all the information and laboratory data.

Statistical methods

Statistics were analysed by the Department of Biostatistics, University of the Free State. Results were summarised by frequencies and percentages (categorical variable) or percentiles (numerical variables). Subgroups were compared using relative risks or percentages. The P-value was calculated for the relative risk of HIV-positive patients acquiring Gram-negative infections vs HIV-negative patients.

Cost

Total hospital days for the patient population were calculated. This was multiplied by the average cost of a hospital bed per day.[2]

Identifying the cause of the infection and starting prompt and appropriate medical or surgical treatment can prevent substantial morbidity

Ethics statement

The study only commenced once full ethical approval had been obtained (ETOVS number: 20/09). Informed consent was collected from each participant. In case of minors, the guardian provided informed consent as well as the procurement of informed assent by the minor. HIV tests were only done after normal counselling guidelines had been met.

Results

Age

Sixty-six patients consented to participate in the study. The youngest patient was 3 years old and the oldest 72. Seven patients (10.6%) were paediatric (3–13 years), 55 (83.3%) were between the ages of 14 and 60, and four patients (6.1%) were older than 60 years (*Figures 3 and 4*).

Occupation

Manual labourers (builders, carpenters, steel workers) accounted for 16 (24.2%) cases, and 19 (28.8%) were non-manual workers (including scholars, security guard, crèche worker). Thirty-one patients (47%) were unemployed.

Mechanism of infection

Infections followed a penetrating injury in 34 patients (51.5%) and human bites in seven (10.6%). Spontaneous infection occurred in 18 (27.3%) and following blunt trauma in five (7.6%) cases.

Other causes were present in two patients (3%).

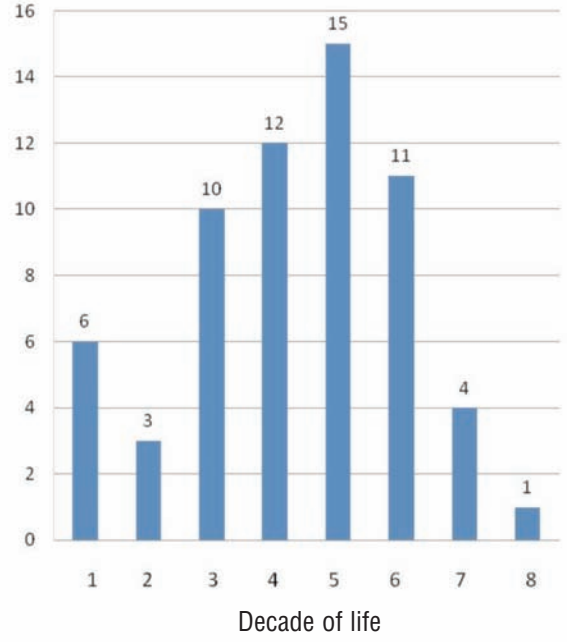


Figure 3: Age distribution of patients
51 Males (77.3%) and 15 females (22.7%) were included in the study

Figure 4. Children accounted for about 10% of the patient population

Infection types

The most common site of infection was the dorsum of the hand or finger (28 patients, 42%), while 14 (21%) had flexor tenosynovitis. Less common were web space infections (eight cases, 12%), felons and deep palmar space infections (six cases, 9%).The different types of infection found are shown in *Table I*.

X-ray findings

Most X-rays (63 patients, 95%) were normal; two patients (3%) had severely neglected hand infections with radiological osteitis and one (1.5%) had a fracture. No foreign bodies were seen.

One could question the cost efficiency of routine X-rays in hand infections but they are recommended for medico-legal reasons.

Table I: Types of Infection

Infection site	Frequency
Dorsal hand or finger	28 (42.2%)
Flexor tenosynovitis	14 (21.2%)
Web space infection	8 (12.1%)
Deep palmar space infections	6 (9.1%)
Felon	6 (9.1%)
Paronychium	3 (4.6%)
Septic arthritis	1 (1.5%)

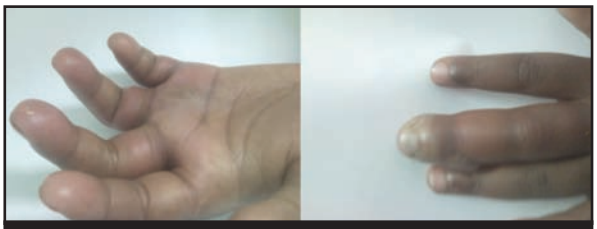


Figure 5. Flexor tensosynovitis accounted for 21.2% of cases, and paronychium for 4.6%

Laboratory results

Full blood count

Many patients (37, 56%) had low haemoglobin (N 12.1–16.3 women, 14.3–18.3 men). There are several possible explanations, including malnutrition and chronic infection,[3] which may warrant further investigation.

The white cell count (WBC) was elevated in 58%, erythrocyte sedimentation rate (ESR) in 56% and C-reactive protein (CRP) in 92% of patients.

HIV

All the patients were counselled and blood was taken for Elisa testing for HIV antibodies if consent was obtained. Fifty-four (82%) of the total of 66 patients were tested. Of these, 19 (35%) tested positive. CD4 counts were not performed routinely. The estimated HIV prevalence in the South Africa population in 2008 among men aged 30–34 years was 25.8% and among women aged 25–29 years, was 32.7%.[4] The incidence of sero-positive results was only slightly higher in the hand infection cohort than this normal (young) population but since the whole group was not tested no firm relationship could be established.

HIV-positive patients were significantly more susceptible to Gram-negative infections

Of the 16 patients in whom more than one organism was cultured, seven patients were in the HIV-positive group – making the HIV-positive patients 5.2 times more likely to have more than one pathogen in this study.

Organisms

Eighty-two organisms were cultured from the 66 patients, with more than one organism in 16 cases (24.2%).

Staphylococcus aureus was by far the commonest organism cultured (54 patients, 82%), followed by *Streptococcus pyogenes* (six patients, 9%) and coagulase negative *Staphylococcus* (five patients, 5.6%).

A total of 13 Gram-negative organisms was cultured. Seven of the 19 HIV-positive patients (36.8%) had Gram-negative infections, compared to 4 of 35 (11.4%) HIV-negative patients and two of the 12 patients (16.6%) not tested for HIV.

HIV-positive patients were significantly more susceptible to Gram-negative infections than HIV-negative patients (p=0.0283), in agreement with previous studies.[3]

A full breakdown is given in *Table II*.

Table II: Organisms cultured

Organism	(n)	Percentage (organisms) (n=82)	Percentage (patients) (n=66)
Staphylococcus aureus	54	66%	82%
Streptococcus pyogenes	6	7.3%	9.1%
Coagulase negative *Staphylococcus*	5	6.1%	5.6%
Escherichia coli	2	2.4%	3%
Klebsiella oxytoca	1	1.2%	1.5%
Proteus mirabilis	1	1.2%	1.5%
Serratia marcescens	3	3.7%	4.5%
Citrobacter freundii	1	1.2%	1.5%
Enterobacter cloacae	2	2.4%	3%
Enterococcus faecalis	1	1.2%	1.5%
Neisseria gonorrhoea	1	1.2%	1.5%
Methicillin-resistant *Staphylococcus aureus*	1	1.2%	1.5%
Streptococcus viridans	2	2.4%	3%
Acinetobacter baumannii	1	1.2%	1.5%
Klebsiella pneumonia	1	1.2%	1.5%

Antibiotic sensitivity

Selection of an appropriate empirical antibiotic is based on knowledge of likely pathogens and other investigations such as the Gram stain. Antibiotics should be used that have appropriate antibacterial activity, good bioavailability and should be administered in sufficiently high doses.[5]

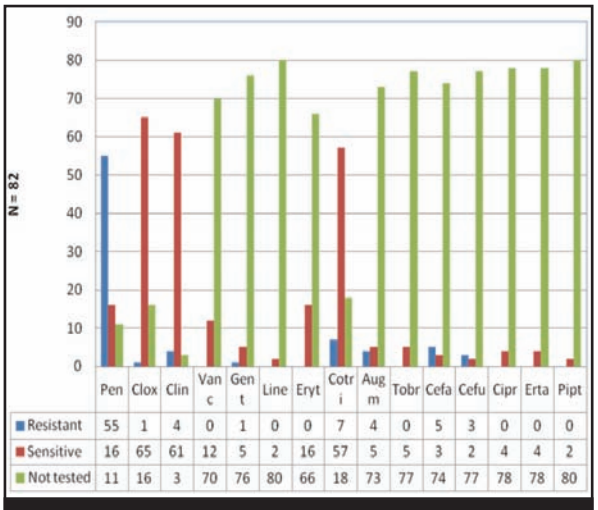


Figure 6: Antibiotic sensitivity

A marked resistance was discovered against penicillin-ampicillin. Most Gram-positive organisms, including all *Staphylococcus aureus* infections, but excluding the one hospital-acquired MRSA, were sensitive to cloxacillin, and it appears that this should still be the cornerstone of empirical antibiotic treatment.

Clindamycin also appeared useful, especially in penicillin-allergic patients.

In the HIV-positive group, eight of 19 patients (42.1%) cultured organisms resistant to cloxacillin. Sensitivity of organisms other than *Staphylococcus aureus* was variable, with only one sensitive to cloxacillin, and is summarised in *Figure 6*.

Cost

In 2008/09, the average cost per Patient Day Equivalent (PDE) in South Africa for all district hospitals was R1 096. The cost per PDE in the district hospitals in the Free State was R1 214 in 2008/09.[2] In our study, the mean stay in hospital was 4.9 days. The total hospital days for the study group amounted to 325, at a total estimated cost of R394 550 over the six-month period. It should also be stated that most hand infections are drained in theatre, which would increase costs considerably. Additional costs are those of work days lost and future disability.

Discussion

The human hand is adapted to allow us to manipulate and interact with our environment. This renders it susceptible to injury and subsequent infection. Any collection of pus in a hand destroys its intricate anatomy and function. Functions that are lost include loss of sensation, stiffness, swelling, chronic pain, chronic osteomyelitis, and may lead to amputation.

Table III: Non-*Staphylococcus aureus* sensitivity

Serratia marcescens	Gentamicin, tobramycin, ciprofloxacin
Klebsiella oxytoca	Co-amoxyclav, gentamicin, tobramycin
Escherichia coli	Cefazolin, tobramycin
Enterobacter cloacae	Gentamicin, ciprofloxacin, cotrimoxazole
Citrobacter freundii	Cotrimoxazole, cefuroxime
Acinetobacter baumannii	None
Enterococcus feacalis	Pen/Ampicillin
Coagulase negative *Staphylococcus*	Cloxacillin
MRSA	Vancomycin
Neisseria gonorrhoea	Tetracycline, ciprofloxacin

The sensory function of the hand is a very important aspect in how we experience our world, and the fingers have the most nerve endings per area than any other part of the body. This is why hand infections should be treated promptly and aggressively to avoid complications. It is a concern that referrals are often delayed and hand infections are often neglected.[6]

The presence of pus in a hand requires timely and adequate drainage; otherwise antibiotics would be rendered ineffective. Although antibiotics are not the cornerstone of treatment of hand infections they are an essential component, and a major part of this study was concerned with the bacteriology and antibiotic susceptibility of hand infections in these changing times.

South Africa has the highest prevalence of HIV-positive individuals in the world. This influences our daily practices and hand infections are no exception. There was a statistically significant difference between infecting organisms in HIV-positive and -negative individuals in this series of cases. This is in accordance with other studies from other parts of the world.[3] It may be advisable to enquire or test for HIV when treating severe hand infections. Nevertheless, most community-acquired hand infections were still caused by *Staphylococcus aureus* sensitive to cloxacillin. This is evidence that in immunocompetent patients there is usually not a need for more expensive empirical antibiotics. Erythromycin was also effective in the 16 cases where it was tested for.

During the course of the study, it became apparent, that in our institution, bacterial culture and sensitivity usually take too long to influence the early treatment. Microscopy and Gram stain, however, can be obtained relatively soon and can be a valuable tool to help select empirical antibiotics.

CRP was the most accurate predictor for the presence of a hand infection. A hand infection remains a clinical diagnosis; however this inflammatory marker may be used in monitoring treatment progress in more severe infections.

One limitation of the study was that the patients were tested for HIV, but the CD4 count was not measured prospectively, and this could not be corrected later. It was also not determined whether the patient was clinically immunosuppressed or not. This shortcoming may be addressed in follow-up studies. The patients were also not followed up to draw conclusions about the morbidity of hand infections.

Conclusion

Hand infections are common conditions that can have significant morbidity.[7]

Immunosuppression seems to play a role in the bacteriology, number of different organisms cultured and the antibiotic susceptibility. In immunosuppressed patients a simple hand infection can rapidly become a serious health problem.[8] Cloxacillin seems to be an adequate first-line treatment for acute community-acquired bacterial hand infections in immunocompetent patients in our institution (human bites and farm yard injuries excluded).

The authors did not receive grants or outside funding in support of their research or preparation of this manuscript. They did not receive payments or other benefits or a commitment or agreement to provide such benefits from a commercial entity. No commercial entity paid or directed, or agreed to pay or direct, any benefits to a research fund, foundation, educational institution, or other charitable or non-profit organisation with which the authors are affiliated or associated.

References

1. McDonald LS, Bavaro MF, Hofmeister EP, Kroonen LT. Hand infections. *J Hand Surg Am.* 2011 Aug;36(8):1403-12.
2. http://www.hst.org.za/news/20041962
3. Gonzalez MH, Nikoleit J, Weinzweig N, *et al*. Upper extremity infections in patients with the Human Immunodeficiency Virus. *J Hand Surg* 1998;23A:348.
4. Human Sciences Research Council. 'South African National HIV Prevalence, HIV Incidence, Behavior and Communication Survey, 2008'.
5. Wagenlehner FME, Naber KG. Emergence of antibiotic resistance and prudent use of antibiotic therapy in nosocomially acquired urinary tract infections. *Int. Journal of Infectious Dis.* 2004;23(suppl 1):24-29.
6. Shields C, Patzakis MJ, Meyers MH *et al*. Hand infections secondary to human bites. *J Trauma* 1975;15:235-36.
7. Nathan R, Taras JS. Common infections in the hand. In: Hunter JM, Mackin E, Callahan AD, eds. *Rehabilitation of the Hand: Surgery and Therapy*. 4th ed. St. Louis: Mosby, 1995:251-60.
8. Bishop A. Infections. In: Manske P, ed. *Hand surgery update*. American Society for Surgery of the Hand. Rosemont, IL: American Academy of Orthopedic Surgeons, 1996:395-404.