Appendix A: Subspecialist training programme in Paediatric Infectious Diseases at Red Cross War Memorial Children's Hospital and the Department of Paediatrics and Child Health, University of Cape Town

Aim

To produce competent paediatric Infectious Diseases subspecialists with expertise in clinical infectious diseases, microbiology, virology, mycology, parasitology, infectious diseases epidemiology, infection control practice, antibiotic stewardship, outbreak investigation, immunodeficiencies that predispose to infections and ID clinical research.

Specific objectives

(1) To provide training in clinical infectious diseases for paediatricians, microbiologists and virologists
(2) To provide microbiology, virology and immunology laboratory training for clinical infectious diseases registrars through a joint training forum with the Department of Clinical Laboratory Sciences at the University of Cape Town
(3) To provide training in communicable diseases epidemiology, infection control practice and public health
(4) To strengthen the research, presentation and writing experiences of trainees
(5) To develop collaborative training initiatives in paediatric infectious diseases with centres of excellence throughout Africa

The Training Unit at Red Cross War Memorial Children's Hospital

Red Cross War Memorial Children's Hospital (RCWMCH) is a tertiary referral hospital linked to the University of Cape Town. The Paediatric Infectious Diseases Unit (PIDU) at RCWMCH was the first paediatric ID training unit to be established in South Africa. Approval to train ID sub-specialists was granted by the Health Professions Council of South Africa (HPCSA) in February 2006. The first paediatrician commenced her sub-specialist training in the PIDU in April 2006 and successfully completed the exit examinations in March/April 2008. A parallel M Phil (paediatric infectious diseases) was established through the Faculty of Health Sciences, University of Cape Town, in January 2006.The first M Phil (paediatric ID) was awarded December 2010.

Colleges of Medicine of South Africa regulations[1, 2]

In accordance with regulations established by the College of Paediatricians, an affiliate of the Colleges of Medicine of South Africa (CMSA), qualified paediatricians who train in ID must complete an additional two years of training, comprising 18 months of clinical ID work and 6 months of laboratory training. A portfolio of learning template was developed by the CMSA to record progress and important milestones during the period of clinical and laboratory training. A 6-monthly review of the portfolio and learning achievements by the supervisor(s) and trainee is essential. Furthermore, successful completion of the CMSA ID sub-specialist examination is needed for sub-specialist certification (a requirement for all trainees), and for sub-specialist registration with the HPCSA. The training programme at RCWMCH complies with these requirements.

Clinical responsibilities

Each ID senior registrar (trainee) is expected to complete 18 months of training in clinical infectious diseases. This training will take place at RCWMCH.

Clinical responsibilities at RCWMCH include:

(1) Outpatient

Management of children with specialised infectious diseases and immunology problems who attend the Infectious Diseases Clinic on Monday mornings, together with the duty subspecialist.

Management of children with HIV-infection, particularly those on antiretroviral therapy and attend weekly HIV clinics at RCWMCH.

Together with the ID subspecialists provide ID consultation / antibiotic stewardship support to central/regional hospitals e. g. Groote Schuur and New Somerset hospitals, district hospitals e. g. Victoria and Mitchells Plain hospitals, and level 1 clinics in the Klipfontein sub-district.

Together with consultant staff in the PIDU provide onsite & telephonic consultation to other paediatric antiretroviral treatment sites in the Western Cape

(2) Inpatient

Together with the ID subspecialists, provide an ID consultation service to RCWMCH, including support for HIV-infected & HIV-TB co-infected children, sick children with tuberculosis including drug resistant tuberculosis and those with malaria, provide antimicrobial and infection control advice, and assist with the diagnosis and treatment of children with primary immunodeficiency diseases (PIDs)

Together with the duty ID subspecialist and attending microbiologists and virologists conduct weekly antibiotic stewardship rounds in the paediatric intensive care unit.

Together with the subspecialists conduct a problem / teaching ward round every week during which the management of patients with ID problems including issues relating to HIV infection and antiretroviral therapy are addressed.

(3) *Ad hoc* & telephonic consultation

Provide initial consultation on all urgent internal ID queries and external telephonic queries during working hours.

(4) Infection control

Attend and contribute to meetings and activities convened by the hospital infection control committee.

(5) After hours & weekends

In accordance with the practice in the Department of Paediatrics and Child Health, the ID registrar will fulfil senior registrar duties in the emergency unit of the hospital, or the neonatal service affiliated to the Department of Paediatrics and Child Health. These duties provide additional experience in a wide range of ID emergencies. Weekend cover is performed in ward B1. ID senior registrars employed through the African Paediatric Fellowship Programme are exempted from these responsibilities.

Together with the subspecialists, the ID senior registrars will at times provide an after-hours Infectious Diseases consultation service to hospitals affiliated to the Department of Paediatrics and Child Health

Educational / research objectives

During the 2-year attachment the ID Registrar should participate in all educational activities convened by the PIDU at RCWMCH including:

(1) Infectious Diseases ward rounds
(2) Weekly microbiology blood culture meetings
(3) HIV and ID case review meetings
(4) Infectious Diseases Journal clubs

ID registrars are encouraged to attend other ID academic meetings, symposia & courses in particular, those hosted by the PIDU, the Institute of Infectious Diseases and Molecular Medicine (IIDMM), University of Cape Town, the Federation of Infectious Diseases Societies of Southern Africa and the Southern African HIV Clinicians Society. For example, the Federation of Infectious Diseases Societies of Southern Africa runs periodic short courses on parasitology and tropical infections for ID senior registrars who are preparing for the CMSA examinations.

In accordance with the CMSA subspecialist training regulations, ID registrars should maintain a record of clinical cases that they have managed as well as a description of the extent of their laboratory experience in the portfolio of learning. The information on clinical cases recorded in the portfolio should include folder number, age of patient, date of entry, diagnosis, specific comments relating to the learning experience of the case, and relevant references.

Opportunities to develop presentation skills exist including during ward rounds, and during clinical and journal club meetings & symposia conducted by the PIDU and the Department of Paediatrics and Child Health. ID senior registrars should also participate in undergraduate and postgraduate teaching.

Regular feedback sessions (at least at 6-monthly intervals) should be conducted by the sub-specialists attached to the unit with each trainee.

ID registrars are expected to complete an M Phil (paediatric ID) dissertation, in publication-ready format. This gives them an opportunity to develop research and writing skills. Regular meetings between the ID registrar and the project supervisors (ID subspecialists) will be held to direct the development and completion of the research project and minor dissertation in accordance with guidelines established by the Faculty of Health Sciences, University of Cape Town.

ID registrars are expected to complete the CMSA examination for the post-specialisation certificate in the subspeciality Infectious Diseases [Cert ID (SA) Paed] during their 2-year ID attachment. This will permit subspecialist registration with the HPCSA. The list of topics included at the end of this document may be used to guide preparation for this examination.

Laboratory training

Microbiology and virology training will take place in the routine NHLS microbiology and virology laboratories of the Divisions of Medical Microbiology and Virology, University of Cape Town, directed by the respective laboratory heads. Laboratory training takes place over 6 months (i. e. 4 months in routine microbiology, including 1 week in immunology, and 2 months in virology), in accordance with the HPCSA regulations. Immunology laboratory training is currently completed in the NHLS diagnostic immunology laboratory, Tygerberg Hospital. During the laboratory attachment the ID senior registrar works under direction of the laboratory specialists, integrates into existing laboratory schedules, and participates in all laboratory activities and tasks as required. During the laboratory attachment the ID senior registrar is relieved of all clinical responsibilities to ensure full participation in laboratory activities including regular bench time, attendance of departmental meetings and journal clubs, participation in antibiotic, ID and ICU ward rounds involving the laboratory staff members, phoning out culture results, assisting with queries and general clinical liaison.

I. Goal of laboratory training

To develop a basic knowledge of the diagnostic role of the microbiology, virology, and immunology laboratories in order to interface with the laboratory, collect appropriate specimens, interpret laboratory results, understand the principles and limitations of all tests,

II. Guidelines for laboratory training

During the laboratory attachment the spectrum of activities should include:

1. Bacterial identification and susceptibility testing

Procedure	**Requirements**
Specimen reception: appropriate specimens (SOPs), rejection criteria, electronic gate keeping, challenging cases	Understand principles & standard operating procedures, observe process
Perform and read Gram stain	Perform minimum 10
Reading plates (macroscopic description and identification of bacterial colonies)	Perform minimum 10
Bacterial identification: Catalase, DNAse, oxidase, etc.	Understand principles, observe at least 10
Bacterial identification: automated methods	Understand principles, observe at least 10
Antimicrobial susceptibility testing methods: Prepare and interpret E test	Perform minimum 5
Disc diffusion	Perform minimum 5
Broth dilution	Understand principles
Modified carbapenemase inactivation method (mCIM), carba NP test, or by a lateral flow assay	Understand principles
Identification of MDR organisms such as ESBL, CRE, MRSA, VRE, etc.	Understand principles
Automated susceptibility testing	Understand principles

2. Specimen processing

Procedure	**Requirements**
Sterile specimen collection	Understand principles
Automated blood culture systems	Understand principles
Process positive blood culture bottle	Perform minimum 5

Process sputum specimen (smear, Bartlett score, inoculate plates)	Perform minimum 5
Process CSF specimen (Gram, cell count, inoculate plates)	Perform minimum 5
Process stool specimen (Wet prep, iodine stain, auramine stain, inoculate plates)	Perform minimum 5
Process urine specimen (microscopy cell count, inoculate plates)	Perform minimum 5
Process pus swabs (Gram, inoculate plates)	Perform minimum 5
Process fungal cultures (inoculate plates; macroscopic description of colonies; microscopy)	Perform minimum 5
Interpretation of microbiological results and collaboration / clinical ward rounds	Understand principles, observe / join interactions with clinical staff / combined ward rounds

3. TB specimen preparation and processing

Procedure	**Requirements**
Ziehl Neelsen stain and microscopy	Perform minimum 5
Auramine stain and microscopy	Perform minimum 5
Process specimen for culture (including decontamination). Understand the differences between solid and liquid TB cultures and understand the principles of automated TB culture	Understand principles, observe at least 5
Process specimen for molecular testing (GeneXpert, line probe assay)	Understand principles, observe at least 5
Interpret results of TB molecular tests	Understand principles, observe at least 10
TB phenotypic sensitivity testing	Understand principles, observe at least 5
Identification of non-tuberculous mycobacteria (phenotypic appearance and PCR testing)	Understand principles

4. Understanding molecular biology methods

Procedure	**Requirements**
Nucleic Acid Extraction Manual (manual and automated)	Understand principles, observe at least 5
Preparation of master mixes	Understand principles, observe at least 5
Use of thermal cyclers	Understand principles, observe at least 5
Gel Electrophoresis	Understand principles, observe at least 5
Real-Time PCR	Understand principles, observe at least 5
Sequence analysis	Understand principles
HIV drug resistance testing & basic interpretation	Understand principles, interpret a minimum of 5
Molecular typing of organisms	Understand principles
Multiplex PCR	Understand principles

5. Serology

Procedure	**Requirements**

Syphilis serology – perform and interpret RPR, immunofluorescent assays, TPAB, VDRL	Perform minimum 5
Automated ELISA - indications, interpretation of results	Understand principles, observe at least 5
Manual ELISA – indications, interpretation of results	Understand principles, observe at least 5
IgG avidity assays	Understand principles
Rapid tests - immuno-chromatographic	Understand principles
Rapid tests - particle agglutination	Understand principles

6. Virology

Procedure	**Requirements**
Automated PCR testing e. g. HIV, HBV & others	Understand principles, interpretation of results, observe at least 5
Automated viral load testing e. g. HIV, CMV HIV	Understand principles, interpretation of results, observe at least 5
Automated / manual serology testing e. g. HIV, Hepatitis	Understand principles, interpretation of results, observe at least 5
Drug resistance testing e. g. HIV	Understand principles, interpretation of results
Genotyping e. g. HCV	Understand principles, interpretation of results

7. Immunology laboratory

Procedure	**Requirements**
Lymphocyte subset analysis	Understand principles, observe at least 5
Total immunoglobulins and subclasses	Understand principles
Neutrophil burst test	Understand principles
Total complement, individual component assay	Understand principles
Genetic testing for primary immune deficiencies	Understand principles

8. Laboratory safety and management

Procedure
Biosafety levels, safe handling of samples from a patient with suspected or proven viral haemorrhagic fever
Decontamination of environment following a spill
Safe handling of sharps, human material, hazardous waste
Quality assurance and laboratory accreditation

9. Infection control and prevention

Procedure
Investigation of an outbreak / unusual cluster of cases
Transmission based precautions, hand hygiene
Principles of disinfection and sterilization
Visit sterilization unit
Visit hospital kitchen / milk kitchen
Antibiotic stewardship / analysis of bacterial susceptibility surveillance data

List of clinical topics

This is not an exhaustive list but it covers important clinical topics, and may be used to guide preparation for the CMSA examination for the post-specialisation certificate in the sub-speciality Infectious Diseases [Cert ID (SA) Paed].

1. Basic immunology concepts
    a. Development of the immune system from fetus to adulthood
    b. Anatomical organisation of the immune system
    c. Innate and acquired (T & B cell) immunity
    d. Diagnosis and treatment of primary and secondary immunodeficiencies
    e. Investigating the child with recurrent infection
    f. Immunity to specific infections including HIV, TB, viral infections & acute bacterial infection
    g. Immunity following immunisation

2. Congenital Infections
    a. Congenital syphilis
    b. Viral causes of congenital infections including rubella, herpes, CMV and varicella-zoster
    c. Uncommon congenital infections such as toxoplasmosis and TB
3. HIV/AIDS
    a. The virus
    b. Pathogenesis
    c. Mother-to-child transmission and interventions to prevent MTCT
    d. Diagnosis and interpretation of laboratory assays
    e. Disease spectrum
    f. TB/HIV co-infection
    g. Management / treatment
    h. Diagnosis & management of HIV drug resistance
    i. Opportunistic infections
    j. Prevention, including circumcision, pre-exposure prophylaxis, post-exposure prophylaxis and vaccination

4. Tuberculosis
    a. Pathogenesis
    b. Disease spectrum
    c. Epidemiology and molecular epidemiology
    d. Diagnosis (specimens, microscopy, culture, PCR, immune, other)
    e. Management of drug-susceptible and drug-resistant TB including INH mono-resistant TB, MDR-TB and XDR-TB
    f. Prevention, including existing & newer vaccine strategies, and optimal infection control practice

5. Neonatal infections

6. Immunisation
    a. EPI and non-EPI vaccines
    b. EPI disease eradication and elimination
    c. Vaccines for neglected diseases e.g. malaria
    d. Vaccine adverse events

e. Vaccine development: vaccine types, immunological responses, phase I to IV trials
f. Immunisation for immunocompromised individuals e.g. children with asplenia, children with PIDs, children requiring / receiving long-term immunosuppressive therapy, post-haematopoietic stem cell transplantation and children requiring solid organ transplantation, and other special groups e.g. pregnant women, adolescents and preterm babies
g. Immunisation of travellers

7. Hospital-acquired infections & infection control measures
    a. Definitions and surveillance of hospital-acquired infections
    b. Hospital infection control policy and practice
    c. Antibiotic policy and practice including antibiotic stewardship
    d. Sterilisation and disinfection
    e. Waste disposal
    f. Prevention of transmission of communicable disease in health settings (eg TB, meningococcus, varicella, measles etc)

8. Exanthems of childhood and common skin infections

9. Fever
    a. Pathogenesis of fever
    b. Inflammatory and acute-phase response
    c. Approach to fever of unknown origin
    d. Autoinflammatory disorders (defects affecting the inflammasome & non-inflammasome-related conditions) and other diseases that mimic infections in children such as malignancy and auto-immune diseases

10. Malaria
    a. Pathogenesis
    b. Spectrum of disease
    c. Diagnosis (microscopy, antigen tests etc)
    d. Management including newer therapeutic options
    e. Control and prevention, including prophylaxis regimens, environmental control and vaccines
    f. HIV/Malaria co-infection
    g. Malaria in pregnancy and neonatal period

11. Selective parasitic infections
    a. Schistosomiasis
    b. Trypanosomiasis
    c. Cysticercosis
    d. Toxoplasmosis
    e. Helminthic infections
    f. Hydatid disease

12. Fungal infections
    a. Diagnostic approaches
    b. Management of fungal infections including Candida species, Aspergillus species, Cryptococcus neoformans and Pneumocystis jiroveci

13. Gastrointestinal infections
    a. Rotavirus diarrhoea
    b. Cholera
    c. Giardiasis

d. Amebiasis
e. Viral hepatitides including A, B, C, D and E
f. Peritonitis and other intra-abdominal infections
g. Food poisoning

14. Selective other infections
    a. Viral haemorrhagic fevers (Marburg fever, Ebola viral infection, Crimean-Congo haemorrhagic fever, etc)
    b. Prion diseases
    c. Typhoid fever
    d. Brucellosis
    e. Bordetella pertussis
    f. Rickettsial infection including SA tick bite fever
    g. Leptospirosis
    h. Herpes virus infections
    i. Mycoplasma, chlamydial and ureaplasma infections
    j. Measles
    k. Rubella
    l. Varicella
    m. CMV infection
    n. RSV infection
    o. SARS-CoV-2 infection / COVID-19
    p. Enterovirus infection
    q. Diphtheria
    r. Tetanus
    s. Rheumatic fever
    t. Cardiovascular infections
    u. Infections of bones and joints
    v. Meningitis and other central nervous system infections
    w. Bloodstream infection
    x. Urinary tract infections
    y. Upper and lower respiratory tract infections
    z. Skin and soft tissue infections
    aa. Infections related to trauma, including burns, animal bites and human bites
    bb. Sepsis syndrome
    cc. Infections of the reproductive organs
    dd. Sexually transmitted infections
    ee. Infections of the eye
    ff. Emerging infections

15. Antimicrobial therapy and stewardship
    a. Mechanisms of action of antibiotics
    b. Mechanisms of resistance
    c. Pharmacokinetic characteristics of antibiotics
    d. Interpretation of MIC results
    e. Managing antibiotic resistant infections
    f. Antibiotics for immunocompromised children
    g. Anti-TB drugs
    h. Antivirals including antiretrovirals
    i. Antifungals
    j. Treatment of parasitic infections
    k. Principles and practice of antibiotic stewardship

16. Other treatment modalities in infections
    a. Pro- and pre-biotics

   b. Immunoglobulin replacement therapy – intravenous and subcutaneous administration
   c. Bone marrow transplantation
   d. Biological agents (biologics) such as monoclonal antibodies, cytokines, interferons, interleukins and colony-stimulating factors in the treatment of infectious diseases
   e. Exchange transfusion
   f. Immunomodulators

17. 'Para-infectious' diseases
   a. Necrotising enterocolitis
   b. Reye syndrome
   c. Kawasaki syndrome
   d. Guillain-Barre syndrome
   e. Multisystem inflammatory syndrome in children (MIS-C)
   f. Chronic fatigue syndrome / Myalgic encephalomyelitis
   g. Long COVID-19

18. Infections in ICU & oncology service
   a. Ventilator-associated pneumonia
   b. Infections associated with indwelling catheters & other devices

19. Infection in immunocompromised children
   a. Infections in immunocompromised patients
   b. Approach to febrile neutropenic child
   c. Infections in patients with acute leukaemia and lymphomas
   d. Infections in haematopoietic stem cell transplant recipients
   e. Infections in solid organ transplant recipients

20. Travel medicine
   a. Preventative measures
   b. Approach to the ill traveller with suspected infection: diagnosis and treatment

21. Sexually transmitted diseases in children and adolescents

22. Current issues / emerging infectious diseases, e.g.
   a. Influenza immunisation
   b. local arboviral diseases
   c. Avian Influenza
   d. Poliomyelitis eradication
   e. Zika virus infection
   f. Potential bioterror agents

23. Public health principles applicable to infectious diseases
   a. Outbreak investigation
   b. Notifiable diseases
   c. Tropical public health
   d. Environmental control issues, including surveillance

24. Research methods & epidemiology applicable to infectious diseases
   a. Protocol development
   b. Study design
   c. Descriptive statistical concepts
   d. Inferential statistical methods
   e. Evaluation of diagnostic tests

f. Principles of clinical trials
g. Systematic review and meta-analysis methodology
h. Critical assessment of the medical literature including randomised control trials and systematic reviews

25. Laboratory topics
    a. Routine laboratory investigations: principles and applications
    b. Antimicrobial resistance testing: methodologies and results interpretation
    c. Advanced methodologies for detecting infectious agents

Expectations of ID trainees

Clinical and laboratory training • Completion of all training components • Lead a minimum of four ID / antimicrobial stewardship ward rounds during the second year of training • Successful completion of the Colleges of Medicine of South Africa Cert ID(SA) (Paed) examination
MPhil research project • Completion of research protocol within 6 months of commencement of ID training • Finalisation of departmental research committee and human research ethics committee review of protocol within 9 months of commencement of ID training • Completion of data collection and database entry within 20 months of commencement of ID training • Completion of data analysis and publication-ready manuscript and MPhil dissertation within 36 months of commencement of ID training
Presentation experience & critical analysis • Present a minimum of two clinical cases per year of ID training at the Friday departmental case discussion meeting • Present a minimum of one ID talk (case-based or review) during the 2-year training period at the Wednesday departmental academic meeting • Present a minimum of one ID case with detailed analysis of the case and relevant literature to the ID unit per year of training • Present a minimum of three journal articles at ID journal club meetings per year of ID training
Development of writing skills & publication experience • Complete and publish a minimum of one case report or review on an ID topic in a peer-review journal OR complete the development of a clinical guideline / policy for the paediatric ID unit during the 2-year training period • Submit the publication-ready manuscript arising from your MPhil (paediatric ID) project to a peer-review journal within 3 months of submitting your MPhil dissertation to the dissertation committee of the Faculty of Health Sciences, University of Cape Town

Recommended reading resources

I. Reference books

1. **Mandell, Bennett & Dolin:** Mandell, Douglas and Bennett's Principles and Practice of Infectious Diseases
2. **Long, Pickering and Prober:** Principles and Practice of Pediatric Infectious Disease
3. **Frank E. Berkowitz:** Case Studies in Pediatric Infectious Diseases

4. **American Academy of Pediatrics:** Red Book

II. Journals (suggested regular reading)

1. Paediatric Infectious Diseases Journal
2. Journal of the Pediatric Infectious Diseases Society
3. Clinical Infectious Diseases
4. Lancet Infectious Diseases
5. New England Journal of Medicine
6. Lancet

References

1. The College of Paediatricians of South Africa. Regulations for admission to the examination for the post-specialisation sub-speciality certificate in infectious diseases, Cert ID(SA) Paed, November 2022 https://www.cmsa.co.za/view_exam.aspx?QualificationID=87

2. The College of Paediatricians of South Africa. Portfolio of learning for the Cert ID(SA) Paed. https://www.cmsa.co.za/view_exam.aspx?QualificationID=87