

Childhood TB

**A learning
programme for
professionals**



Developed by the
Desmond Tutu Tuberculosis Centre

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VERY IMPORTANT

We have taken every care to ensure that drug dosages and related medical advice in this book are accurate. However, drug dosages can change and are updated often, so always double-check dosages and procedures against a reliable, up-to-date formulary and the given drug's documentation before administering it.

Childhood TB

A learning programme for professionals

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Acknowledgements

The aim of this book is to promote and improve the care of all children with tuberculosis, especially in under-resourced communities in southern Africa. The learning material is presented in a way which enables groups of healthcare workers to take responsibility for their own continuing training.

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Where possible, we attempted to comply with the Guidance for the Management of Childhood Tuberculosis (World Health Organisation WH/HTM/2006.371), South African national tuberculosis programme guidelines and provincial prevention, diagnostic and management protocols.

Our sincere thanks go to the publishers for their willingness to support this project and

for their innovative vision of presenting the text in both book and web-based format. The latter will be made available at no cost together with an invitation to contribute in the form of comments which, after review, will be included in the text. The question-and-answer layout is adapted from that of the highly successful Perinatal Education Programme.

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Prof David Woods and Prof Robert Gie



Every breath counts

Introduction

THE DESMOND TUTU TUBERCULOSIS CENTRE

The Desmond Tutu Tuberculosis Centre (DTTC) is attached to the Faculty of Health Sciences, Stellenbosch University, South Africa. The main focus of the DTTC is to improve the health of vulnerable groups through influencing policy based on new knowledge created by research. The areas of research that the DTTC have actively been involved in include the epidemiology of tuberculosis (TB), childhood tuberculosis, multi-drug-resistant tuberculosis, HIV/TB interaction and operational research to prevent the spread of TB and HIV in southern African communities. In addition, the DTTC is actively involved in the education of healthcare workers and community members to improve the awareness and early diagnosis of TB and HIV.

AIM OF THIS CHILDHOOD TB COURSE

The aim of this Childhood TB course is to improve the care of children with TB in all communities, especially in poor peri-urban and rural districts of southern Africa.

Although the material was written to be used as a distance-learning course for healthcare professionals in district and regional healthcare facilities, it is also used in the training of medical and nursing students.

Childhood TB was written by South African paediatricians with the contribution of colleagues in universities and health services. This ensures a balanced, practical and up-to-date approach to common and important clinical problems.

SELF-HELP EDUCATION

If high-quality care is to be provided to all children with tuberculosis, training at all levels of healthcare workers is essential. Unfortunately this is often only achieved in the large centralised tertiary-care hospitals and not in the rural secondary- or primary-care centres. The providers of primary care in rural areas usually have the least continuing education as they are furthest away from the training hospitals in urban centres. It is not possible to send teachers to all these rural areas for long periods of time while staff shortages and domestic reasons make it impractical to transfer large numbers of doctors and nurses

from primary- and secondary-care centres to centralised tertiary hospitals for training.

Ideally all medical and nursing staff should have regular training to improve and update their theoretical knowledge and practical skills. One way of meeting these needs in continuing education is with a self-help outreach educational programme. This decentralised method allows healthcare workers to take responsibility for their own learning and professional growth. They can study at a time and place that suits them. Participants in the programme can also study at their own pace. The education programme should be cheap and, if possible, not require a tutor.

FORMAT OF THE CHILDHOOD TB EDUCATION PROGRAMME

Throughout this programme the participant takes full responsibility for his or her own progress. This method teaches participants to become self-reliant and confident.

1. The objectives

At the start of each chapter the learning objectives are clearly stated. They help the participant to identify and understand the important lessons to be learned.

2. Questions and answers

Theoretical knowledge is taught by a problem-solving method which encourages the participant to actively participate in the learning process. An important question is asked, or problem posed, followed by the correct answer or explanation. In this way, the participant is led step by step through the definitions, causes, diagnosis, prevention, dangers and management of a particular problem.

It is suggested that the participant cover the answer for a few minutes with a piece of paper or card while thinking about the correct reply

to the question. This method helps learning. Simplified flow diagrams are also used, where necessary, to indicate the correct approach to diagnosing or managing a particular problem. Copies of these flow diagrams may be of value in the labour ward or nursery.

Different forms of text are used to identify particular sections of the Programme.

Each question is written in bold, like this, and is identified with the number of the chapter, followed by the number of the question, e.g. 5-23.

Important practical lessons are emphasised by placing them in a box like this.

NOTE Additional, non-essential information is provided for interest and given in notes like this. These facts are not used in the case studies or included in the multiple-choice questions.

3. Case problems

A number of clinical presentations in story form are given at the end of each chapter so that the participant can apply his or her newly learned knowledge to solve some common clinical problems. This exercise also gives the participant an opportunity to see the problem as it usually presents itself in the clinic or hospital. A brief history and/or summary of the clinical examination is given, followed by a series of questions. The participant should attempt to answer each question before reading the correct answer. The knowledge presented in the cases is the same as that covered earlier in the chapter. The cases, therefore, serve to consolidate the participant's knowledge.

4. Multiple-choice questions

An in-course assessment is made at the beginning and end of each chapter in the form of a test consisting of 20 multiple-choice questions. This helps participants manage their own course and monitor their own progress by determining how much they know before starting a chapter, and how much they have

learned by the end of the chapter. The correct answer to each question is provided at the end of the book. This exercise will help participants decide whether they have successfully learned the important facts in that chapter and will also draw participants' attention to the areas where their knowledge is inadequate.

In the multiple-choice tests the participant is asked to choose the single, most correct answer to each question or statement from four possible answers. A separate loose sheet should be used to record the test answers before (pre-test) and after (post-test) the chapter is studied. The list of correct answers also indicates which section should be restudied for each incorrect post-test answer.

5. Skills workshops

Some courses include skills workshops which enable the participants to learn the clinical skills needed. The skills workshops, which are often illustrated with line drawings, list essential equipment and present step-by-step instructions on how to perform each task. Participants should find a colleague with the necessary experience to assist them with a hands-on demonstration of the particular skill. This enables participants to use local expertise rather than be dependent on outside tuition.

STUDY GROUPS

It is strongly advised that the courses are studied by a group of participants and not by individuals alone. Each group of five to ten participants should be managed by a local co-ordinator who is usually a member of the group, if a formal trainer is not available. The local co-ordinator orders the books and then arranges the time and venue of the group meetings (usually once every three weeks). At the meeting the chapter just studied is discussed and the post-tests, and pre-tests for the next chapter, are done. The skills workshops should also be demonstrated and practised at the meetings. In this way the group manages all aspects of their course. The

principles of peer tuition and co-operative learning play a large part in the success of PEP.

THE IMPORTANCE OF A CARING AND QUESTIONING ATTITUDE

A caring and questioning attitude is encouraged. The welfare of the patient is of the greatest importance, while an enquiring mind is essential if participants are to continue improving their knowledge and skills. The participant is also taught to solve practical problems and to form a simple, logical approach to common perinatal problems.

COPYRIGHT

To be most effective, the Perinatal Educational Programme course should be used under the supervision of a co-ordinator. Using part of the programme out of context will be of limited value only, while changing part of the programme may even be detrimental to the participant's perinatal knowledge. Therefore, copyright on all PEP materials means that no portion of the programme can be altered. However, for teaching and management purposes only, parts or all of the programme may be photocopied provided that recognition to the programme is acknowledged. If the routine care in your clinic or hospital differs from that given in the programme, you should discuss it with your staff.

FINAL ASSESSMENT

On completion of each book, participants can write a formal multiple-choice examination to assess the amount of knowledge that they have acquired. All the exam questions will be taken from the tests at the end of each chapter. The content of the skills workshops will not be included in the examination. Credit for

completing the course will only be given if the final examination is successfully passed. A separate examination is available for each book and successful examination candidates will be able to print their own certificate which states that they have successfully completed that course. A mark of 80% is needed to pass the final examinations. Any official recognition for completing a PEP course will have to be negotiated with your local healthcare authority. South African doctors can earn CPD points on the successful completion of an examination.

OBTAINING AN EXAM CODE

To write the examination, a participant first has to purchase an exam code. To purchase an exam code, visit:

www.ebwhealthcare.com

An exam code is a unique number for one participant and one course. An exam code enables participants to test their knowledge and write the final examination online. The fee and how to pay for exam codes are explained on the website.

BOOKS IN THE EBW HEALTHCARE SERIES

Maternal Care

This book addresses all the common and important problems that occur during pregnancy, labour and delivery, and the puerperium. It includes booking for antenatal care, problems during the antenatal period, monitoring and managing the mother, fetus and progress during labour, medical problems during pregnancy, problems during the three stages of labour and the puerperium, family planning after pregnancy, and regionalised perinatal care. Skills workshops teach the general examination, abdominal and vaginal examination in pregnancy and labour, screening for syphilis and HIV, use of an

antenatal card and partogram, measuring blood pressure and proteinuria, and performing and repairing an episiotomy. *Maternal Care* is aimed at professional healthcare workers in level 1 hospitals or clinics.

Primary Maternal Care

This book addresses the needs of healthcare workers who provide both antenatal and postnatal care but do not conduct deliveries. The content of these chapters is largely taken from the relevant chapters in *Maternal Care*. It contains theory chapters and skills workshops. This book is ideal for staff providing primary maternal care in level 1 district hospitals and clinics.

Intrapartum Care

This book was developed for doctors and advanced midwives who care for women who deliver in district hospitals. The chapters were developed from selected units in the *Maternal Care* manual. Particular attention is given to the care of the mother, the management of labour, and monitoring the wellbeing of the fetus. Improved care during labour, delivery, and the puerperium promises to reduce both the maternal and perinatal mortality rates, especially in rural areas. *Intrapartum Care* was written to support and complement the national protocol of intrapartum care in South Africa.

Newborn Care

Newborn Care was written for health professionals providing special care for infants in regional hospitals. It covers resuscitation at birth, assessing infant size and gestational age, routine care and feeding of both normal and high-risk infants, the prevention, diagnosis and management of hypothermia, hypoglycaemia, jaundice, respiratory distress, infection, trauma, bleeding, and congenital abnormalities, as well as communication with parents. Skills workshops address resuscitation, size and gestational age measurement, history, examination and clinical notes, nasogastric feeds, intravenous

infusions, use of incubators, measuring blood glucose concentration, insertion of an umbilical catheter, phototherapy, apnoea monitors and oxygen therapy.

Primary Newborn Care

This book was written specifically for nurses and doctors who provide primary care for newborn infants in level 1 clinics and hospitals. *Primary Newborn Care* addresses the care of infants at birth, care of normal infants, care of low-birth-weight infants, neonatal emergencies, and important problems in newborn infants.

Mother and Baby Friendly Care

With the recent technological advances in modern medicine, the caring and humane aspects of looking after mothers and infants are often forgotten. This book describes better, gentler, kinder, more natural, evidence-based ways that care should be given to women during pregnancy, labour, and delivery. It looks at improved methods of providing infant care with an emphasis on kangaroo mother care and exclusive breastfeeding. A number of medical and nursing colleagues in South Africa contributed to this book.

Saving Mothers and Babies

Saving Mothers and Babies was developed in response to the high maternal and perinatal mortality rates found in most developing countries. Learning material used in the book is based on the results of the annual confidential enquiries into maternal deaths and the Saving Mothers and Saving Babies reports published in South Africa. It addresses the basic principles of mortality audit, maternal mortality, perinatal mortality, managing mortality meetings, and ways of reducing maternal and perinatal mortality rates. This book should be used together with the Perinatal Problem Identification Programme (PPIP).

Birth Defects

This book was written for healthcare workers who look after individuals with birth defects, their families, and women who are at increased risk of giving birth to an infant with a birth defect. Special attention is given to modes of inheritance, medical genetic counselling, and birth defects due to chromosomal abnormalities, single gene defects, teratogens and multifactorial inheritance. This book is being used in the Genetics Education Programme which has been developed to train healthcare workers in genetic counselling in South Africa.

Perinatal HIV

The HIV epidemic is spreading at an alarming pace through many developing countries, increasing the maternal and infant mortality rates, and adding to the financial burden of providing health services to all communities. Nowhere is the devastating effect of this infection more obvious than in the transmission of HIV from mothers to their infants. In order to decrease this risk, all healthcare workers dealing with HIV-positive mothers and infants will need to receive additional training. *Perinatal HIV* was written to address this challenge.

This book enables midwives, nurses and doctors to care for pregnant women and their infants in communities where HIV infection is present. Special emphasis has been placed on the prevention of mother-to-infant transmission of HIV.

Chapters have been written on HIV infection, antenatal, intrapartum and infant care, and counselling. Colleagues from a number of hospitals and universities in South Africa were invited to review and comment on the draft document in order to achieve a well-balanced text. It is hoped that this training opportunity will help to stem the tide of HIV infection in our children.

Childhood HIV

Childhood HIV enables nurses and doctors to care for children with HIV infection. It covers an introduction to HIV in children, the clinical and immunological diagnosis of HIV infection, management of children with and without antiretroviral treatment, antiretroviral drugs, and infections and end-of-life care.

Childhood TB

To help tackle the tuberculosis epidemic in southern Africa, *Childhood TB* was written to enable healthcare workers to learn about the primary care of children with tuberculosis. The book covers an introduction to TB infection, and the clinical presentation, diagnosis, management and prevention of tuberculosis in children. *Childhood TB* was developed by paediatricians with wide experience in the care of children with tuberculosis, through the auspices of the Desmond Tutu Tuberculosis Centre at the University of Stellenbosch.

Child Healthcare

Child Healthcare addresses all the common and important clinical problems in children, including immunisation, growth and nutrition, acute and chronic infections, parasites, and skin conditions, as well as the home and society.

Adult HIV

Adult HIV was developed by doctors and nurses with a particular interest in HIV infection. The book covers an introduction to HIV infection, management of HIV-infected adults, preparing patients for antiretroviral treatment, the drugs used in antiretroviral treatment, starting and maintaining patients on antiretroviral treatment and an approach to opportunistic infections. The aim of the book is to enable healthcare workers at primary-care clinics to manage all aspects of HIV-related patient care.

MANAGING YOUR OWN COURSE STEP BY STEP

1. Before you start each chapter, take the test for that chapter at the back of the book. Do the test by yourself even if you are studying with a group of colleagues. Choose the best answer for each multiple-choice question and note your answers on a piece of loose paper. This is called your 'pre-test' for that chapter. There is an answer sheet that you should use to mark your completed pre-test. Record your pre-test mark.
2. Now work through the chapter. Read each question and answer, and make sure you understand it. Pay particular attention to the facts in grey boxes as these are the main messages. Read the case studies to check whether you have learned and understood the important information.
3. If you are part of a study group, use this opportunity to discuss with your colleagues any difficulties you may have experienced. Talking about what you have read is a very important part of the learning process. If the book includes skills workshops, these should be conducted at the time of the group meetings. Invite an experienced colleague who can help you master the particular skill.
4. When you have learned all the knowledge in that chapter, take the same test again. This second test is called your 'post-test'. Now mark the post-test and compare your pre-test and post-test marks. Your marks should have improved considerably. In the answers section of the book, opposite each correct answer, is the number of the section where the question was taken from. Re-read and learn the sections for any post-test answers you got incorrect. Now you are ready to move on to the next chapter.
5. Repeat steps 1 to 4 for each chapter as you work your way through the book. This enables you to obtain the knowledge, monitor your progress, and measure how much you are learning. Most people will take about two to four weeks per chapter.

6. Once you are confident that you have mastered all the main lessons in the book, you can write the final examination online at www.ebwhealthcare.com. To write the final examination you will need to have an exam code. This is a unique number that entitles you to write the examination for a course. If you don't have one yet, you or your group can buy exam codes. The fee and how to pay are described on the website. This exam code will only work once for one examination.
7. You will be able to write the examination, consisting of 75 multiple-choice questions, on the website. You will only have a limited time to answer each question and you will not be able to go back and check previous questions. Set aside an hour to write the examination. When you write the examination, do not use the book to look up the correct answers. Remember, you are your own teacher, so be strict with yourself!
8. Your examination answers will automatically be marked as soon as you have completed the last question. If you get 80% or better you have passed and will be able to print your own certificate which states that you have successfully completed the course. However, if you have failed to achieve 80%, you can purchase another exam code to write the examination again.

Tips

- Work through the course with a group of friends or colleagues.
- One person in your group (your co-ordinator or 'convenor') should take responsibility for organising meetings to discuss each chapter before you write the post-test.
- Set yourself targets, such as 'two units a month'.
- Keep your book with you to read whenever you have a chance.
- Write the examination only when you feel ready.

USING THE BOOK AS A WORK MANUAL

It is hoped that as many participants as possible will use these books as work manuals after they have completed the course. The flow diagrams should be most useful in managing difficult problems and for planning management. A further benefit of the books is that they standardise the documentation and management of certain clinical problems. This is particularly useful when patients are referred within or between healthcare regions. It is further hoped that all those who use these books will enjoy learning about new and better methods of caring for mothers and newborn infants. Every opportunity to share knowledge with both patients and colleagues should be used. By doing this you will find your career more fulfilling and you will help to improve the perinatal care in your region.

UPDATING OF THE PROGRAMME

Based on the comments and suggestions made by participants and other authorities, the chapters and skills workshops of the programme will be regularly edited to make them more appropriate to the needs of perinatal care and to keep the programme up to date with new ideas and developments. Everyone studying the programme is invited to write to the editor-in-chief with suggestions as to how the books could be improved. You can also send your comments on parts of the books on the website www.ebwhealthcare.com.

FURTHER INFORMATION

For further information on the Childhood TB Education Programme please contact:

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COMMENTS AND SUGGESTIONS

The Childhood TB Education Programme has been produced by a team of TB specialists, after wide consultation with colleagues who practise in both rural and urban settings, in an attempt to reach consensus on the care of children with tuberculosis. The programme is designed so that it can be improved and altered to keep pace with current developments in health care. Participants using this programme can make an important contribution to its continual improvement by reporting factual or language errors, by identifying sections that are difficult to understand, and by suggesting improvements to the contents. Details of alternative or better forms of management would be particularly appreciated. Please send any comments or suggestions to EBW Healthcare at any of the above contact details.

1

Introduction to childhood tuberculosis

Before you begin this unit, please take the corresponding test at the end of the book to assess your knowledge of the subject matter. You should redo the test after you've worked through the unit, to evaluate what you have learned.

Objectives

When you have completed this unit you should be able to:

- Explain what tuberculosis is.
- Describe how TB bacilli are spread.
- Explain the difference between TB infection and tuberculosis.
- Explain why children are at high risk of TB infection.
- List communities in which tuberculosis is common.
- Explain the features of pulmonary tuberculosis.
- List the common forms of extrapulmonary tuberculosis.

TUBERCULOUS INFECTION

1-1 What is tuberculosis?

Tuberculosis (TB or TB disease) is a chronic infectious disease which may involve many organs of the body, but most often affects the lungs. Tuberculosis of the lung is called pulmonary tuberculosis.

Tuberculosis is a chronic infectious disease.

1-2 What causes tuberculosis?

Tuberculosis is a bacterial illness caused by *Mycobacterium tuberculosis*. These bacteria are also referred to as TB bacilli (tuberculous bacilli).

Tuberculosis is caused by TB bacilli.

NOTE *Mycobacterium tuberculosis* was first described by Robert Koch in 1882.

1-3 How are TB bacilli spread?

Tuberculosis is an infectious disease which results from the spread of TB bacilli from one person to another. TB bacilli are usually spread

when a person with pulmonary tuberculosis talks, coughs, spits, laughs, shouts, sings or sneezes. This sends a spray of very small droplets from the person's infected lungs into the air (i.e. airborne droplet spread). Live TB bacilli in these droplets then float in the air and may be breathed in by other people. If the inhaled TB bacilli reach the alveoli they cause a tuberculous infection of the lung.

1-4 Who usually spreads TB bacilli?

TB bacilli are usually spread from adults with untreated pulmonary tuberculosis. Therefore, a child with tuberculosis almost always has been in close contact with an adult with pulmonary tuberculosis (the source of the TB bacilli). It is less common for a child to catch tuberculosis from another child as children usually do not cough up TB bacilli in large numbers. Therefore, adults with untreated tuberculosis are a danger to children in the family or household.

TB bacilli that infect children are usually spread from an adult with untreated pulmonary tuberculosis.

NOTE TB bacilli in unpasteurised or unboiled cows' milk (*Mycobacterium bovis*) can be drunk and cause infection of the tonsil or gut, but this is very uncommon in South Africa.

1-5 Which children are at greatest risk of infection with TB bacilli?

Children, especially those under five years of age, who are exposed to large numbers of TB bacilli.

1-6 Which children are exposed to large numbers of TB bacilli?

Children who live in overcrowded, poorly ventilated homes or are exposed to crowded buses, taxis, schools, crèches and spaces where there are adults with untreated pulmonary tuberculosis. A child with tuberculosis often has an adult with untreated tuberculosis living in the same

home. A mother with untreated pulmonary tuberculosis who is in close contact with her children is a great danger to her children.

Children in close, prolonged contact with adults who have untreated pulmonary tuberculosis are at greatest risk. Younger children are more likely to spend most of the day and night with an adult.

Children in poorly ventilated, overcrowded homes are at greatest risk of infection with TB bacilli.

1-7 Do all children infected with TB bacilli develop tuberculosis?

No. Most children infected with TB bacilli do not develop tuberculosis (TB disease) because their immune system is able to control the infection and kill most of the TB bacilli. As a result, the natural immune response protects most children with TB infection from progressing to tuberculosis.

It is very important to understand that a child can only develop tuberculosis if the child is first infected with TB bacilli. Furthermore, TB infection does not always progress to tuberculosis (TB disease). Therefore TB infection without further progression is not the same as tuberculosis.

Fortunately most children infected with TB bacilli do not develop tuberculosis.

The progression of TB infection to tuberculosis is more common in children than in adults.

1-8 Which children with TB infection are at the greatest risk of developing tuberculosis?

Children with a weak immune system are at the greatest risk. In these children, infection with TB bacilli may progress to tuberculosis because they have an inadequate immune system which is unable to control the infection. TB infection caused by large numbers of TB bacilli is also more likely to progress to tuberculosis.

Therefore, both TB infection and progress to tuberculosis are most common when a child with a weak immune system is exposed to large numbers of TB bacilli.

Children with weak immune systems are at greatest risk of tuberculosis.

1-9 Which children have weak immune systems?

Young children under five years, and especially if under two years, of age have immature (weak) immune systems which are unable to control severe infections. The immune system can further be weakened in:

- Children with HIV infection
- Children recovering from measles or whooping cough
- Children with severe malnutrition
- Children on large doses of oral steroids

HIV infection is the most important cause of a weakened immune system.

Children with HIV infection have the highest risk of developing tuberculosis.

1-10 Is TB infection common?

Yes, infection with TB bacilli (*Mycobacterium tuberculosis*) is very common, and it is estimated that almost 50% of adult South Africans have been infected. Most infections take place during childhood.

TB infection is common and usually occurs during childhood.

1-11 How many children with TB infection develop tuberculosis?

Only about 10% of all people with TB infection progress to tuberculosis (TB disease) during their lifetime. Therefore, TB infection is far more common than tuberculosis.

The risk of TB infection progressing to tuberculosis is greater in young children than in older children or adults. In children infected under two years of age, the risk is as high as 50%.

About 10% of people with TB infection will develop tuberculosis.

1-12 What do you understand by the incidence of tuberculosis?

The incidence is the number of people with tuberculosis per 100 000 of the population per year. This is a very useful measure as it allows the frequency of tuberculosis in different communities or countries to be compared. The incidence of a single community can also be compared from one year to the next.

1-13 What is the incidence of tuberculosis in South Africa?

While tuberculosis is uncommon in most developed countries, it is common in developing countries such as South Africa where the number of people with tuberculosis has increased rapidly in the last few years. The incidence of tuberculosis in South Africa was 948/100 000 in 2007. This is high when compared to developed countries like the United Kingdom where the incidence of tuberculosis in 2007 was 13/100 000.

In South Africa tuberculosis is particularly common in the Western Cape and KwaZulu-Natal. It is estimated that there are 400 new cases of tuberculosis per 100 000 children each year in the Western Cape. In any clinic children will make up approximately 15% of all the cases of tuberculosis.

NOTE About ten million new cases of TB occur worldwide each year with two million deaths due to TB. About 300 South Africans die of TB each day. With the AIDS epidemic this figure is rising rapidly.

1-14 In which communities is tuberculosis common?

TB is common in poor, disadvantaged communities where overcrowding, undernutrition and HIV infection are common. Tuberculosis is a disease of poverty. Tuberculosis spreads in any overcrowded living spaces, both at home and in the community. TB is often transmitted by a child's family member, friend or close neighbour. However it may also be caught in a public space if there are many untreated patients in the community.

Tuberculosis is usually seen in poor communities.

NOTE About 95% of new TB cases and 99% of TB deaths worldwide are in developing countries. In developed countries TB is virtually confined to poor, overcrowded environments and ethnic minorities.

1-15 Why is tuberculosis an important disease?

Tuberculosis is a major cause of illness and death in many poor countries. These are preventable deaths, and the large number of patients with tuberculosis is a huge drain on healthcare resources.

Tuberculosis is an important cause of illness and death.

PULMONARY TUBERCULOSIS

1-16 What is primary TB infection of the lung?

Tuberculous infection usually starts when TB bacilli are inhaled deep into the distant parts of the lungs, called alveoli. During the first six weeks of infection the immune system is unable to control the TB bacilli, which multiply rapidly in the alveoli where they cause a small, local

area of inflammation. This is called primary tuberculosis. From the primary infection TB bacilli spread along the lymphatics to the local lymph nodes at the place where the main bronchi divide into branches (hilar nodes). The primary infection in the lung, together with the infected hilar lymph nodes, is called the primary complex. Parahilar and other mediastinal nodes may also be affected.

After six weeks the immune system usually becomes active and kills most of the TB bacilli in the lung and lymph nodes. As a result, the primary infection is asymptomatic in most children and does not cause clinical illness.

Therefore, the primary TB infection usually heals and does not spread any further, as the TB bacilli have been contained by the body's natural immunity.

NOTE The primary TB infection in the lung used to be called the Ghon focus.

Inhaling TB bacilli into the lung may result in primary infection.

1-17 Can the primary TB infection cause illness due to spread of the infection within the lung?

Sometimes the primary TB infection is not controlled by the immune system and the child now becomes ill with the signs and symptoms of pulmonary tuberculosis. This is a common form of tuberculosis in children.

With progression of the primary infection to pulmonary tuberculosis, the TB bacilli continue to multiply and an area of inflammation develops in the lung and lymph nodes in an attempt to prevent the TB bacilli from spreading any further. Often the centre of the inflamed area becomes soft as the tissues die. These dead cells (caseous material) can drain into the surrounding tissues.

There are a number of different ways that the primary TB infection can spread (progress) and lead to complications.

The primary TB infection may spread to cause pulmonary tuberculosis.

NOTE The immune response to TB bacilli is dependent on T lymphocytes.

1-18 What are the pulmonary complications of the primary TB infection in the lung?

- In some children with a weak immune system, the body is unable to control the primary infection in the lung. The TB bacilli continue to multiply and spread into neighbouring parts of the lung to cause tuberculous pneumonia. Progression from the primary infection to pulmonary tuberculosis usually takes place rapidly within weeks or months and the child becomes ill. This pattern of tuberculosis, together with enlarged hilar nodes, is the commonest form of tuberculosis in young and undernourished children.
- Cavitory tuberculosis ('open tuberculosis') is usually seen in older children and adolescents. The area of tuberculous pneumonia progresses and breaks down to form a hole. This occurs most commonly in the upper parts of the lung and results in an air-filled cavity containing dead (caseous) tissue which contains huge numbers of TB bacilli. This form of pulmonary tuberculosis is very infectious as TB bacilli grow fast and many TB bacilli enter the airways. From here they are coughed into the air where they may be breathed in and infect the lungs of other people. Children and adolescents with cavitory tuberculosis are very infectious and can infect other children and adults.
- Damage to the large airways by tuberculosis can result in bronchiectasis.
- In older children and adults the TB bacilli often remain dormant (inactive or 'sleeping') in the lung for many months or even years after the primary infection. The body has been able to control but not kill all the TB bacilli. If the immune system later becomes weakened by malnutrition or another infection, such as HIV or

measles, the TB bacilli may start to multiply once more (reactivation) and a local area of tuberculous pneumonia will develop. Therefore, pulmonary tuberculosis due to reactivation of dormant TB bacilli may only present years after the primary infection.

Pulmonary tuberculosis with enlarged hilar lymph nodes is the commonest form of tuberculosis in children.

1-19 What are the pulmonary complications of TB infection in the hilar lymph nodes?

- TB bacilli may multiply rapidly in the hilar lymph nodes, causing the nodes to enlarge and compress the bronchus or trachea (airway). Clinically this may present as wheezing or stridor with either collapse or hyperinflation of a lobe or the whole lung.
- The enlarged lymph node may rupture into a bronchus spreading large numbers of TB bacilli into other areas of the lung. This results in widespread tuberculous bronchopneumonia.

Enlarged hilar lymph nodes may compress the airways causing wheezing.

1-20 Why are the lungs the commonest site of tuberculosis?

The lungs are the commonest site of tuberculosis as TB infection is usually caused by inhaling TB bacilli.

1-21 What is the difference between pulmonary tuberculosis in children and adults?

While children usually have lymph node enlargement with few TB bacilli in the sputum, adolescents and adults usually have cavitory tuberculosis with destruction of lung tissue and large numbers of TB bacilli in their sputum.

NOTE Cavities are formed in adult-type tuberculosis, usually in the upper lobes or apices of the lower lobes of the lungs. This can result in permanent lung damage and scarring (fibrosis).

EXTRAPULMONARY TUBERCULOSIS

1-22 Can tuberculous infection spread from the lung to other parts of the body?

Yes. This spread beyond the lungs is called extrapulmonary tuberculosis:

- Tuberculosis may spread from the lung to the pleura causing a pleural effusion.
- Infection with TB bacilli can spread from the lung, and especially the hilar lymph nodes, via the bloodstream (TB bacteraemia) to most organs of the body. In children the TB bacilli usually spread at the time of the primary lung infection. As a result, tuberculosis of other organs usually presents soon after the primary lung infection. However, the TB bacilli may remain dormant in these organs for many months or years before they start to multiply and cause local tuberculosis. This reactivation of TB bacilli is usually due to weakening of the immune system.
- TB bacilli can also spread to other lymph nodes via the lymphatics (e.g. from the hilar lymph nodes up to the cervical lymph nodes or down to the abdominal lymph nodes). Lymph nodes in the axilla or groin may also be involved. However, lymphatic spread is usually to the cervical nodes. TB infection of lymph nodes is called tuberculous lymphadenitis.

Tuberculous bacilli may spread from the lungs to other organs via the bloodstream or the lymphatics.

1-23 Which other organs can be involved in tuberculosis?

Although the lung is the commonest organ infected by TB bacilli, tuberculosis can involve any other organ of the body. Sometimes more than one organ is infected. The organs which are most commonly infected via the bloodstream in children are:

- The meninges (tuberculous meningitis)
- Bones, especially the spine (tuberculous osteitis)
- Joints, especially the hip joint (tuberculous arthritis)
- Intra-abdominal organs such as liver and spleen and peritoneum (abdominal tuberculosis)

NOTE The skin, tonsils, pericardium, bone marrow, middle ear and genitalia are less common sites of tuberculosis in children. Tuberculosis of the kidney usually follows five or more years after the primary infection and therefore is uncommon in childhood.

1-24 What is disseminated tuberculosis?

Tuberculosis involving multiple organs is referred to as disseminated tuberculosis. This follows spread of TB bacilli through the bloodstream to many organs. If disseminated tuberculosis includes widespread infection of both lungs, it is called miliary tuberculosis. This is a very serious illness with a high mortality rate unless diagnosed and treated early. It usually occurs in young children.

Disseminated tuberculosis is a serious illness with a high mortality rate.

1-25 Is extrapulmonary tuberculosis infectious?

Unlike pulmonary tuberculosis, tuberculosis of other organs is rarely infectious to other people.

1-26 Is extrapulmonary tuberculosis common in children?

Yes, extrapulmonary tuberculosis is far more common in children than in adults. Cervical lymph node enlargement is the commonest form of extrapulmonary tuberculosis in children.

Cervical lymph node enlargement is the commonest form of extrapulmonary tuberculosis in children.

1-27 Can one have a tuberculous infection more than once?

Yes. Previous TB infection does not give complete immunity to further TB infections. A child with a healed primary infection can, months or years later, have another new primary infection when they are exposed to an infectious case of tuberculosis, especially if their immune system is weakened by severe malnutrition or HIV.

Therefore, pulmonary tuberculosis may be due to immediate spread from the original primary infection, reactivation (relapse) of an old primary infection which had not healed fully (latent tuberculous infection), or spread from a new primary infection (reinfection). In children, spread from the primary TB infection to cause tuberculosis is most common and usually occurs within two years of being infected (90% within one year of being infected).

1-28 Can a mother with tuberculosis infect her infant either before or after birth?

Yes. During pregnancy TB bacilli in the mother can be spread via the bloodstream to the placenta. From here the TB bacilli may reach the fetus via the umbilical vessels or may infect the amniotic fluid and then be swallowed by the fetus. Infection during delivery is rare.

However, the spread of TB bacilli from a mother to her infant usually happens after delivery. The greatest risk is for an infectious

mother to cough over her newborn infant. TB bacilli do not appear in the breast milk. Therefore breastfeeding is safe as long as the mother is on treatment and the infant receives prophylaxis.

CASE STUDY 1

A child of six years develops primary TB infection in her one lung. She remains clinically well however. When she is weighed by the school nurse, the mother is reassured that the child is healthy and thriving.

1. What is the cause of TB infection?

TB bacilli (*Mycobacterium tuberculosis*).

2. Why is this child clinically well if she has a primary TB infection?

Because most children with a primary TB infection have no signs or symptoms of illness. Her immune system has controlled the TB infection.

3. Will this child develop tuberculosis?

Probably not, as most children are able to prevent the spread of TB bacilli from the primary infection.

4. Which children are at greatest risk of the primary infection progressing to tuberculosis?

Children with weak immune systems. These include young children, malnourished children and children with HIV infection.

5. How common is TB infection?

Very common. Almost 50% of adult South Africans have had a primary TB infection at some time in their lives, most during childhood.

6. How many children with TB infection develop tuberculosis?

The risk of progression from TB infection to tuberculosis during a lifetime is about 10%. However the risk is higher in children and is as high as 50% in children under two years of age. Therefore TB infection is particularly dangerous in young children.

CASE STUDY 2

An 18-month-old child lives in an overcrowded home. During the day he is looked after by his grandfather who is unwell and has had a chronic cough for the past few months. The clinic nurse is worried as the child is malnourished and recently had measles.

1. Why is this child at high risk of TB infection?

Because the grandfather probably has undiagnosed pulmonary tuberculosis. The house is overcrowded and the child has prolonged contact with the grandfather. These factors all suggest that the child is being exposed to large numbers of TB bacilli.

2. Why will the TB infection probably progress to tuberculosis?

Because the child has a weak immune system due to his young age, malnutrition and recent measles infection.

The child's age and exposure to large numbers of TB bacilli will, therefore, increase his risk of both TB infection and progress to tuberculosis.

3. What other infection may weaken the immune system?

HIV.

4. Is childhood tuberculosis common in South Africa?

Yes, especially in poor, disadvantaged communities. Childhood tuberculosis makes up approximately 15% of all the cases at a TB clinic.

5. What are the pulmonary complications of primary TB infection in the lung?

The primary infection in the lung may progress to tuberculous pneumonia. In older children and adults this may form a cavity. The grandfather probably has cavitory tuberculosis.

6. Are the hilar lymph nodes often involved in primary TB infection?

Yes. The primary TB infection in the lung is usually associated with enlarged hilar lymph nodes. Together they are called the primary complex. The enlarged hilar nodes can compress a large airway causing wheeze or stridor. Further enlargement of the lymph nodes may result in collapse or overinflation of a lobe.

CASE STUDY 3

The parents are very worried as their daughter has a lump in her neck which has been diagnosed as tuberculosis. Friends tell them that the diagnosis must be wrong as tuberculosis only affects the lungs.

1. Does tuberculosis only affect the lungs?

No. Tuberculosis may affect most organs of the body. Tuberculosis outside the lungs is called extrapulmonary tuberculosis.

2. What is the likely cause of the lump in her neck?

Tuberculosis of a lymph node (tuberculous lymphadenitis).

3. What other organs are most commonly infected with TB?

The meninges (TB meningitis), bones (TB osteitis), joints (TB arthritis) and abdominal organs (abdominal TB).

4. What is disseminated tuberculosis?

The spread of TB infection to many organs. This is a serious illness with a high mortality rate.

5. Is extrapulmonary tuberculosis infectious to others?

Usually not. However, extrapulmonary and pulmonary TB may occur in the same patient. Pulmonary tuberculosis is the most infectious form of the disease.

6. Can a newborn infant be infected with tuberculosis from the mother?

Tuberculosis can spread from mother to infant during pregnancy but this is uncommon. The greatest risk is when a mother with tuberculosis coughs onto her newborn infant.

THE FIVE MOST IMPORTANT 'TAKE-HOME' MESSAGES

1. Children are infected with TB bacilli after exposure to someone with infectious pulmonary tuberculosis.
2. Most TB infection in children does not progress to disease (tuberculosis).
3. The children at greatest risk of progression to disease are children infected when less than two years of age, HIV infected children, and children with malnutrition.
4. Pulmonary tuberculosis with enlarged hilar lymph nodes is the commonest form of tuberculosis in children.
5. Cervical lymph node enlargement is the commonest form of extrapulmonary tuberculosis in children.

2

Clinical presentation of childhood tuberculosis

Before you begin this unit, please take the corresponding test at the end of the book to assess your knowledge of the subject matter. You should redo the test after you've worked through the unit, to evaluate what you have learned.

Objectives

When you have completed this unit you should be able to:

- Recognise the general symptoms and signs of tuberculosis.
- List the symptoms and signs of pulmonary tuberculosis.
- Describe the appearance of tuberculous lymph node enlargement.
- Clinically diagnose tuberculous meningitis.
- Clinically diagnose abdominal tuberculosis.
- Clinically diagnose spinal tuberculosis.
- Clinically diagnose disseminated tuberculosis.

EARLY PRESENTATION OF TUBERCULOSIS

2-1 How is the clinical diagnosis of tuberculosis made?

The clinical diagnosis of tuberculosis depends on the following five steps:

1. Having a high index of suspicion.
2. The patient being in contact with an adult with pulmonary tuberculosis.
3. Taking a careful history.
4. Completing a full general examination.
5. Requesting special investigations.

2-2 What would make you suspect that the child may have tuberculosis?

Always suspect tuberculosis if one or more of the following are present:

- A history of close contact with someone suffering from tuberculosis in the family or household, especially if recently diagnosed.
- Poor, overcrowded living conditions.
- The child has HIV infection.
- The child is losing weight or is severely malnourished.
- The child has a chronic, persistent cough.

- The child has pneumonia which does not respond to antibiotics.
- The child has fever for more than 14 days and is not responding to antibiotics.
- The child is unwell with vomiting and a decreased level of consciousness, with or without convulsions.

Having a high index of suspicion that the child has been in close contact with someone with tuberculosis in a community, especially if they live in the same household, is often the most important step in making the diagnosis. A high index of suspicion is very important in the early diagnosis of tuberculosis, as tuberculosis may present in many different ways and may be confused with a wide range of other diseases.

Suspecting tuberculosis is important in making the diagnosis.

2-3 What are the symptoms and clinical signs of tuberculosis?

- The early symptoms and signs of tuberculosis are often vague and non-specific, making the diagnosis difficult. These general symptoms and signs are caused by tuberculosis at any site in the body. Children are usually asymptomatic in the early stages of tuberculosis.
- The later signs of tuberculosis usually depend on which organ or organs are infected. The organ most commonly affected is the lung (pulmonary tuberculosis).

Symptoms are what the child or parent complains of, while signs are what you observe.

2-4 What are the early general symptoms and signs of tuberculosis?

- Failure to thrive with poor weight gain or weight loss. Children with tuberculosis are often thin and undernourished. This may first be noticed when the child's weight is plotted on the Road-to-Health card.
- Feeling generally unwell with loss of appetite, apathy and fatigue, are common

symptoms. In young children the parents complain that the child is not as playful as usual. Older children may complain of feeling weak and tired.

- A fever for more than two weeks when no other cause of fever can be found and there is no response to antibiotics. Fever due to viral infections usually lasts less than seven days.
- Night sweats, especially if the child is so wet that their clothes need to be changed. However severe night sweats are not common in young children with tuberculosis.
- Children with tuberculosis have usually been unwell for a few weeks when they first present. Unlike the sudden onset in acute bacterial or viral infections, the symptoms and signs of tuberculosis usually develop over a number of days or weeks.
- There are often no clinical signs on examination in the early stages of tuberculosis.

A detailed history is very important when considering a diagnosis of tuberculosis as the history is often the most important clue to the correct diagnosis. Therefore always consider tuberculosis in a child with a chronic cough, weight loss, failure to thrive or unexplained fever for more than two weeks, especially if there is an adult with a chronic cough or known pulmonary tuberculosis in the family.

A careful history is very important in the diagnosis of tuberculosis.

PULMONARY TUBERCULOSIS

2-5 What are the symptoms of pulmonary tuberculosis?

These symptoms and signs are important as pulmonary tuberculosis is the commonest form of tuberculosis in children and adults.

- In addition to the early general symptoms and signs, the most important sign of pulmonary tuberculosis is a persistent cough lasting more than two weeks. The cough may be dry or productive and shows no signs of improving.
- The enlarged hilar nodes may press on a bronchus (airway) causing wheezing, cough or stridor. The wheeze does not respond to inhaled bronchodilators.
- Shortness of breath and fast breathing are not common in children with tuberculosis. Chest pain and blood-stained sputum (haemoptysis) may be present in adolescents, but are rare in children.

A persistent cough lasting longer than two weeks is an important symptom of pulmonary tuberculosis.

2-6 What are the clinical signs of pulmonary tuberculosis?

- Usually there are no abnormal clinical signs on examination of the chest. Therefore, a lack of signs does not exclude the diagnosis of tuberculosis.
- There may be signs of pneumonia (fast breathing, crackles and decreased air entry).
- There may be wheezing due to airway compression by enlarged hilar lymph nodes. The wheeze does not respond to bronchodilators.
- There may be signs of a pleural effusion (dullness over one side of the chest with poor air entry and possibly shortness of breath), especially in older children and adolescents.
- Often children with extensive tuberculosis are not acutely ill, do not require supplementary oxygen and have very few clinical signs on chest examination but have extensive changes on chest X-ray.

Commonly there are no clinical signs on chest examination in children with pulmonary tuberculosis.

Children with tuberculosis may also have symptoms and signs of HIV infection.

EXTRAPULMONARY TUBERCULOSIS

2-7 What is the clinical presentation of extrapulmonary tuberculosis?

This depends on whether TB bacilli spread to only one organ (e.g. the meninges), or to two or more organs at the same time.

ENLARGED TUBERCULOUS LYMPH NODES

2-8 What is the common site of enlarged tuberculous lymph nodes?

Enlarged lymph nodes (lymphadenopathy) due to tuberculosis occur most commonly in the neck (cervical nodes).

Enlarged cervical lymph nodes may be due to tuberculosis.

2-9 What are important signs of enlarged cervical lymph nodes?

Often the mother first notices that the child has lumps in the neck. At first the nodes are typically firm and non-tender on examination. Later they may feel matted (stuck together). Enlarged tuberculous lymph nodes may lead to complications.

2-10 What are the complications of enlarged cervical lymph nodes?

The lymph nodes may become tender and soft due to inflammation and the breakdown of tissue in the node (lymphadenitis) to form a lymph node abscess. Later lymph nodes may become attached to the skin and discharge the soft (caseous) material onto the skin. This results in a fistula. With healing, tuberculous fistulas leave scars.

2-11 What is a common cause of enlarged lymph nodes in the axilla?

Enlarged lymph nodes in the axilla (arm pit) are common a few weeks or months after a BCG immunisation on the upper arm on the right side. This is not caused by tuberculosis but results from the BCG immunisation in young children. Complications of enlarged axillary lymph nodes due to BCG are common in children with HIV infection.

TUBERCULOUS MENINGITIS

2-12 What is tuberculous meningitis?

Infection of the membranes which cover the brain (the meninges) by TB bacilli.

2-13 What is the clinical presentation of tuberculous meningitis?

The symptoms and signs of tuberculous meningitis are:

- Drowsiness, irritability and vomiting in a child who has been unwell for a few days.
- Depressed level of consciousness.
- Older children may complain of headaches.
- Convulsions.
- The fontanelle may be full with a rapidly increasing head circumference.
- Muscle weakness progressing to one-sided paralysis (hemiplegia) due to a stroke.

On examination there may be neck stiffness.

Depressed level of consciousness is an important sign of tuberculous meningitis.

It is important to suspect tuberculous meningitis in any child with drowsiness, headache and vomiting. The onset of symptoms and signs are often slow over a number of days. A depressed level of consciousness, convulsions and paralysis are late and dangerous signs.

2-14 Do children with tuberculous meningitis always die?

It depends on whether the diagnosis is made early or late. Full recovery is possible after an early diagnosis. However children who present late with depressed level of consciousness and signs of a stroke often die despite treatment. Children who survive after the development of late signs may survive with permanent disability (blindness, deafness, cerebral palsy, mental retardation and hydrocephalus).

It is very important to suspect TB meningitis in any child with unexplained drowsiness, headache or vomiting so that an early diagnosis can be made and immediate treatment started.

ABDOMINAL TUBERCULOSIS

2-15 What is abdominal tuberculosis?

Tuberculosis of one or more organs in the abdomen. It is usually due to the spread of TB bacilli from the lungs. Newborn infants may have abdominal tuberculosis as a result of TB bacilli spreading from the infected placenta.

2-16 What are the clinical signs of abdominal tuberculosis?

The most common presentation of abdominal tuberculosis is:

- Abdominal distension (swelling). This may be due to fluid (ascites) or enlarged lymph

nodes. The liver and spleen may also be enlarged.

- Abdominal pain may be present.
- Weight loss.
- Fever with no obvious cause.

TUBERCULOUS BONE AND JOINT DISEASE

2-17 What bones and joints may be infected with TB bacilli?

The most common sites are the spine (spinal tuberculosis) and large joints such as the hip, knee or ankle. However, any bone or joint can be infected.

2-18 When do children develop bone tuberculosis?

Bone tuberculosis (tuberculous osteitis) usually develops months to years after the primary TB infection. It is due to reactivation of TB bacilli that have been dormant in the bone ever since they were first carried there by blood spread from the lungs. Therefore it is uncommon in young children and usually seen in older children and adolescents.

2-19 What is the presentation of spinal tuberculosis?

Tuberculous osteitis of the spine usually occurs in the lower thoracic or upper lumbar vertebrae with:

- Local pain and tenderness
- Local deformity (gibbus)
- Spinal cord compression (difficulty walking and passing urine)

Any child with local pain and tenderness over the spine must be suspected of having spinal tuberculosis. A rapid onset of a gibbus ('hump back') is almost always due to tuberculosis.

Spinal tuberculosis presents with local pain and tenderness.

DISSEMINATED TUBERCULOSIS

2-20 What is disseminated tuberculosis?

Disseminated tuberculosis occurs when TB bacilli spread throughout the body via the bloodstream as the immune system cannot contain them in the lung. This leads to tuberculosis in a number of organs other than the lungs, such as the meninges, abdominal lymph nodes, liver, spleen, bones and joints.

2-21 Which children are at high risk of disseminated tuberculosis?

- Children under the age of one year
- Children who have not had BCG immunisation
- Children with severe malnutrition
- Children with HIV infection

Disseminated tuberculosis is most often seen in infants.

2-22 What is the clinical presentation of disseminated tuberculosis?

- At first the child becomes generally unwell with loss of appetite, failure to thrive and fever.
- There may be a history of cough.
- The liver and spleen may be enlarged.
- There may be features of tuberculous meningitis.

2-23 Why is it important to diagnose disseminated tuberculosis as soon as possible?

Because these children become extremely ill and may die if not diagnosed and treated rapidly and correctly.

2-24 What is miliary tuberculosis?

Miliary tuberculosis is the spread of TB bacilli throughout both lungs. It is seen in some

cases of disseminated tuberculosis and can be diagnosed on chest X-ray.

NOTE The word 'miliary' comes from the Latin for millet seed as the X-ray in a child with miliary tuberculosis shows small spots throughout both lungs.

SCORING SYSTEMS TO IDENTIFY TUBERCULOSIS

2-25 Can a scoring system be used to help make a clinical diagnosis of tuberculosis?

Scoring methods are available, but they are not very accurate in children, especially if HIV infection is also present. However, they are useful in identifying children who are at high risk of having tuberculosis and need to be referred for further evaluation and special tests.

CASE STUDY 1

A grandmother presents at a primary-care clinic with her three-year-old granddaughter. She gives a history that the child has a poor appetite, weight loss and fever for the past three weeks. The local general practitioner prescribed amoxicillin for a respiratory tract infection but this has not helped. The mother died of HIV infection a few months ago.

1. Why should you suspect tuberculosis?

Because the child has a number of the general symptoms which suggest tuberculosis (poor appetite with weight loss and prolonged fever). Failure to respond to the antibiotic treatment given for a bacterial respiratory tract infection also suggests tuberculosis.

2. What social history would be important?

It would be important to know if anyone in the home has tuberculosis or a chronic cough which may be due to undiagnosed

tuberculosis. You should also ask about overcrowding and poverty.

3. Why is the history of the mother's death important?

She might have died of tuberculosis complicating HIV infection. If the child is HIV positive this would greatly increase the risk of tuberculosis.

4. What clinical signs would you expect to find?

Often there are very few clinical signs early in tuberculosis. It would be important to weigh the child and plot the weight on the Road-to-Health chart to assess weight loss. Signs of malnutrition and HIV infection should also be looked for.

5. Do children with tuberculosis often have night sweats?

No.

6. Would a scoring system be useful in diagnosing tuberculosis?

It would be more accurate to identify children who are at high risk of tuberculosis and need further investigation.

CASE STUDY 2

A four-year-old child presents with a chronic cough for the past month, together with feeling weak and tired. As the examination of the chest is normal, the medical officer assures the parents that the child does not have pulmonary tuberculosis.

1. Could this child have pulmonary tuberculosis?

Yes. A chronic cough, especially if not improving, should always suggest tuberculosis. There is not enough information to exclude tuberculosis.

2. Would a normal chest examination exclude pulmonary tuberculosis?

No, as children with pulmonary tuberculosis often do not have abnormal chest signs on examination.

3. What would be the likely cause if a wheeze was present?

If the child had no previous history of wheezing, it would be important to think of an enlarged hilar lymph node pressing on a large airway. If this were correct, the wheeze would not respond to an inhaled bronchodilator.

4. What would the likely diagnosis be if there was poor air entry and dullness to percussion on one side of the chest?

A pleural effusion. This might also cause shortness of breath.

5. How should this child be managed?

Further investigations are indicated to confirm or exclude a clinical diagnosis of tuberculosis.

CASE STUDY 3

A ten-year-old girl is seen in the outpatient department of a district hospital with a swelling in her neck. Examination suggests enlarged cervical lymph nodes. There is no history of tuberculosis in the home.

1. How common are enlarged cervical lymph nodes in tuberculosis?

Cervical lymph node enlargement is common in children with tuberculosis.

2. What are the typical clinical findings?

Usually the lymph nodes are firm and painless, but may feel matted (stuck together).

3. What complication can occur in tuberculous lymph node enlargement?

The nodes may become painful and soft (lymphadenitis) and form an abscess or fistula which drains onto the skin.

4. What may cause enlarged axillary (arm pit) lymph nodes?

BCG immunisation on that side.

5. How do TB bacilli reach the cervical nodes?

By lymphatic spread from lymph nodes in the chest.

CASE STUDY 4

An ill six-month-old child presents with a two-week history of fever, poor feeding, drowsiness and irritability. A few hours back the child had a convulsion. The father started on TB treatment a month before.

1. What is the likely clinical diagnosis?

Tuberculous meningitis. The father is almost certainly the source of the infection.

2. How do TB bacilli reach the meninges?

They get there via the bloodstream. Tuberculous meningitis is usually seen in infants and young children, and occurs soon after the primary infection.

3. Is it important that this child has had a fit?

Yes, as this is a late and serious sign of tuberculous meningitis and increases the risk of death or permanent disability. Therefore it is important to make the diagnosis as soon as possible.

4. What is miliary tuberculosis?

Disseminated tuberculosis with widespread involvement of both lungs. These children are seriously ill.

5. What are important local signs of abdominal tuberculosis?

Abdominal pain and distension. Sometimes an enlarged liver and spleen may be palpated.

THE FIVE MOST IMPORTANT 'TAKE-HOME' MESSAGES

1. Close contact with a person with untreated tuberculosis in the household is the most important clue to suspecting tuberculosis in a child.
2. Children who are unwell with a chronic cough or weight loss should be investigated for tuberculosis
3. A normal clinical examination does not exclude tuberculosis in a child.
4. Tuberculous meningitis is a very serious form of tuberculosis and should be suspected in any child with lethargy, headache and vomiting.
5. Disseminated tuberculosis is most commonly seen in young infants and children with HIV infection or malnutrition.

3

Diagnosis of childhood tuberculosis

Before you begin this unit, please take the corresponding test at the end of the book to assess your knowledge of the subject matter. You should redo the test after you've worked through the unit, to evaluate what you have learned.

Objectives

When you have completed this unit you should be able to:

- Explain the importance of special investigations in the diagnosis of tuberculosis.
- Perform and interpret a Mantoux skin test.
- Correctly collect a sputum sample.
- Interpret the results of a sputum smear examination.
- Recognise tuberculosis on a chest X-ray.
- Give the indications for a fine needle aspiration of a lymph node, lumbar puncture and HIV screening in children with suspected tuberculosis.

CONFIRMING THE CLINICAL DIAGNOSIS OF TUBERCULOSIS

3-1 How is the clinical diagnosis of tuberculosis confirmed?

A history of chronic cough and contact with an adult with tuberculosis must always suggest tuberculosis. However the suspected clinical diagnosis of tuberculosis is often difficult to prove, especially in children. Therefore special investigations are important to help confirm or reject the clinical diagnosis.

Special investigations are important to confirm the clinical diagnosis of tuberculosis.

3-2 Which special investigations are important in diagnosing tuberculosis?

A number of special investigations are useful in confirming a clinically suspected diagnosis of tuberculosis.

- Tuberculin skin test
- Sputum smear examination
- Sputum culture
- Chest X-ray

- Fine needle aspiration of a lymph node
- Lumbar puncture

These special investigations must always be used together with a careful history and full physical examination. The tuberculin skin test and chest X-ray are particularly important.

The diagnosis of tuberculosis in children usually depends on a careful history, clinical examination, tuberculin skin test and chest X-ray.

TUBERCULIN SKIN TESTS

3-3 What is a tuberculin skin test?

This is a skin test done with tuberculin which contains protein from dead TB bacilli. Usually PPD (i.e. Purified Protein Derivative) in the form of tuberculin is used. It is safe as it does not contain live TB bacilli. The most accurate method of tuberculin skin testing is the Mantoux test, where a small amount of standardised PPD is injected into the skin (intradermally).

A tuberculin skin test determines whether the person has become infected with TB bacilli. Tuberculin skin tests usually become positive four to eight weeks after infection with TB bacilli.

NOTE Another less accurate method of skin testing is the the Tine test.

The Mantoux skin test is the preferred method of tuberculin skin testing.

3-4 How is the Mantoux skin test done?

A 1 ml syringe and size 26 needle are used to inject 0.1 ml of tuberculin (standardised PPD) into the skin over the inner side of the left forearm. It is very important that the tuberculin is injected *into* the skin and not under the skin (subcutaneously). If the tuberculin is correctly injected into the skin, a raised, pale wheal of 5 mm is formed. This is slightly painful. If no

wheal is raised, the tuberculin has been injected too deep in error. Incorrect injection under the skin may make the result difficult to interpret.

3-5 How should you read a Mantoux skin test?

The Mantoux skin test must be read by examining the site of the test two to three days (48 to 72 hours) after it is done. The widest transverse diameter (across the arm) of induration (raised, swollen, thickened area of skin) is measured. It is important that the induration and not the area of redness is measured. The diameter of the induration is best measured with a ruler. Never guess the size of a Mantoux skin test. The result should be reported in millimeters and not simply as positive or negative.

NOTE PPD stimulates a delayed reaction with sensitised lymphocytes being attracted to the site where they release inflammatory mediators which result in oedema and erythema.

3-6 How is the result of a Mantoux skin test interpreted?

There are three possibilities when interpreting a Mantoux skin test:

1. If the diameter of induration is 0 to 4 mm the test is negative.
2. A diameter of induration of 5 to 9 mm is intermediate.
3. A diameter of induration of 10 mm or more is positive.

Therefore the greater the diameter the more significant is the result.

A Mantoux skin test of 10 mm or more is positive.

3-7 What is the meaning of a negative skin test?

A negative skin test strongly suggests that the child has not been infected with TB bacilli. However the test may still be negative after a recent TB infection as it takes four to eight weeks to become positive.

3-8 What is the meaning of an intermediate skin test?

An intermediate result may be due to either BCG immunisation in the past two years or TB infection. In a healthy HIV-negative child this usually indicates that BCG has been given. The response to BCG becomes less with time. Unlike BCG, the skin test with tuberculosis does not fade as children get older.

NOTE BCG could give a reactive Mantoux test within four to eight weeks of the immunisation. An area of induration of 5 to 9 mm may also indicate infection with a non-tuberculous *Mycobacterium*.

3-9 What is a significant Mantoux skin test in a child with HIV infection?

In HIV-infected or severely undernourished children, an intermediate Mantoux skin test (5–9 mm) indicates TB infection. Both malnutrition and HIV infection reduce the response to PPD.

3-10 What is the meaning of a positive skin test?

A positive skin test indicates that the child has been infected with TB bacilli. However it does not necessarily imply that the child has tuberculosis. Therefore a positive test cannot differentiate between TB infection and active tuberculosis. A positive skin test does not indicate that the child is immune to tuberculosis (i.e. does not mean that the child is protected against tuberculosis).

A positive Mantoux skin test indicates tuberculous infection but not necessarily tuberculosis.

3-11 Does a negative Mantoux test exclude infection with tuberculous bacilli?

A negative skin test in a well-nourished child who is HIV negative usually means that the child has not been infected with TB bacilli and does not have tuberculosis. However the test may be negative in spite of active infection with TB bacilli if the child's immune

system cannot react to the tuberculin in the following situations:

- In early tuberculous infection (the Mantoux skin test usually becomes positive only four to eight weeks after the TB infection)
- Young infants
- Children with severe malnutrition
- HIV infection, especially if the CD4 count is low
- After measles infection (for about six weeks)
- Children with severe tuberculous disease
- If the PPD is old or inactive due to incorrect storage
- If poor technique was used in doing the Mantoux skin test

Therefore the Mantoux skin test may be negative even though the child has TB infection or tuberculosis (a false negative test).

The Mantoux test may be negative in children with severe malnutrition, HIV infection, severe tuberculosis or soon after measles.

3-12 How should tuberculin be stored?

To obtain an accurate Mantoux test the PPD must be correctly stored and the intradermal injection must be given correctly. Failure of either may result in a negative test in a child with tuberculosis. The PPD must be stored away from light and heat as these will damage it. Freezing also damages PPD.

Therefore, PPD should be stored in a refrigerator between 2 and 8 °C (not in the freezer compartment) and kept in a cool bag while being transported. Once the vial has been opened, it should be kept cool and used within six hours as it is a live vaccine.

3-13 Are there other tests to identify sensitivity to TB bacilli?

There are a range of new blood tests which can accurately identify infection with TB bacilli. One day they may replace the tuberculin skin test. However, like the present skin tests, they indicate whether the child has TB infection only

and not active tuberculosis. At present these tests are not yet recommended as standard care as they are expensive and their value in children living in countries with a high prevalence of tuberculosis and HIV is yet to be determined.

NOTE These tests detect gamma interferon which is released by lymphocytes sensitised to *Mycobacterium tuberculosis*. They can accurately distinguish between *Mycobacterium tuberculosis* and BCG.

IDENTIFYING TB BACILLI IN SPUTUM

3-14 How useful are sputum tests in diagnosing tuberculosis?

Sputum tests are very important as they are a way of identifying TB bacilli. If TB bacilli are identified in the sputum the child has pulmonary tuberculosis.

Identifying TB bacilli in sputum is a more accurate method than demonstrating sensitisation to TB bacilli (Mantoux skin test) when diagnosing tuberculosis.

Finding TB bacilli in the sputum is a very important way of diagnosing tuberculosis.

3-15 Which are the commonly used sputum tests?

- Sputum smear examination
- Sputum culture of TB bacilli

TB bacilli in the sputum are usually identified by seeing the TB bacilli under a microscope or by growing (culturing) TB bacilli.

In addition, newer tests can identify TB bacilli by finding their DNA in the sputum.

TB bacilli can be identified in sputum by smear examination or culture.

3-16 How is a specimen of sputum obtained for examination?

This is easy in an adult or older child who is asked to cough up a sample of sputum into a clean plastic container. It is essential that a sample of sputum and not saliva is obtained. Usually two samples of coughed up sputum on consecutive days are collected, at least one being collected early in the morning before brushing teeth or eating or drinking anything. The method is very successful if careful instruction is given on how to produce a sputum specimen. However, it is far more difficult in young children. Therefore other methods have to be used in younger children, especially children below six years of age who usually swallow their sputum:

- Gastric aspirate
- Saline-induced sputum

3-17 How is a sample of gastric aspirate obtained?

If a sputum sample cannot be coughed up by a child it is advised to collect a sample of gastric fluid which contains swallowed sputum. The gastric aspirate is best collected early in the morning before the first feed, the child having been nil per mouth for at least six hours. A nasogastric tube is passed through the infant's nose and pushed down into the stomach. Once a sample of gastric aspirate is obtained, the tube is removed. This is an uncomfortable procedure for the child.

As gastric fluid is highly acid, 4% sodium bicarbonate in an equal volume to the gastric aspirate should be added to the specimen to neutralise the stomach acid. Otherwise the TB bacilli will be killed before they can be cultured. A sample of gastric aspirate should be collected on two consecutive mornings.

NOTE Sodium hydroxide (preferably with N-acetyl-L-cysteine) can also be added to the sample of sputum to liquefy it and kill any contaminants. A mucolytic makes it easier to centrifuge the specimen, which concentrates any TB bacilli.

3-18 How can saline be used to improve the chance of collecting sputum?

The saline-induced method of obtaining sputum in young children is very useful when they are not able to cough up a sample themselves. This technique requires extra equipment and staff with special training. At present it is mostly used in tertiary-care hospitals but may in the future be used more widely.

It is important that a good sample of sputum is obtained to increase the chance that any TB bacilli will be detected.

NOTE In a child who has had nothing to eat or drink for three hours, nebulised hypertonic saline is breathed in in order to mobilise sputum. The saline is an irritant that is used to induce a cough.

3-19 How rapidly should the sputum sample be sent to a laboratory for examination?

The sputum sample should be sent as quickly as possible to the nearest TB laboratory. It is best if the sputum smear is made within a few hours. The sooner the smear is made, the better the chance of seeing TB bacilli. The sputum container must be clearly marked and properly closed with the patient's name and kept out of direct sunlight.

3-20 Do sputum samples always contain TB bacilli in children with pulmonary tuberculosis?

Young children usually cough up fewer TB bacilli than older children, adolescents and adults do. This is because they do not have 'adult-type' tuberculosis. Adults with tuberculosis usually have cavities in their lungs and cough up very large numbers of TB bacilli. Therefore they are very infectious and are said to have 'open TB'. Sputum microscopy can identify the most infectious patients.

NOTE Children with only a few TB bacilli in their sputum are said to have 'paucibacillary TB'.

3-21 Is there a danger to the staff if they collect sputum samples?

Yes. It is therefore important that the staff are protected against inhaling TB bacilli when coughed-up sputum samples are collected. The room should be well ventilated and the staff should wear N95 respirators. Children can also wear masks to prevent the spread of small droplets which may contain TB bacilli. This is particularly important if the tuberculosis is resistant to first-line antibiotics. Although children spread fewer TB bacilli, they can still infect staff collecting sputum. Staff should wash their hands after collecting a sputum sample.

SPUTUM SMEAR EXAMINATION

3-22 How useful is a sputum smear examination in diagnosing tuberculosis?

Examining a sputum smear under a microscope (sputum smear microscopy) is the easiest way of identifying TB bacilli and the oldest test used in identifying patients with tuberculosis.

Smear sputum examination is an important method of proving tuberculosis.

3-23 How is a sputum smear examined for TB bacilli?

In order to see TB bacilli, a smear of the sputum is made on a glass slide. The smear is stained and then examined under a microscope. Two methods are used to stain and examine a sputum smear.

1. The traditional method is to stain the smear with Ziehl-Neelsen stain and then look for TB bacilli under a light microscope. With this method the TB bacilli are first stained and then washed with acid. Unlike other types of bacteria, TB bacilli do not lose the stain when the slide is washed with acid. As a result the TB

bacilli are called 'acid-fast bacilli' or 'AFBs'. A result can be obtained in 20 minutes.

2. A new method uses auramine-O stain before the smear is examined with a microscope using a blue light. The blue light makes the TB bacilli easy to see (they glow or fluoresce). This is a quicker and more accurate method. A result can be obtained in ten minutes.

Patients with a positive smear (TB bacilli are seen) are called 'smear-positive' patients. They are far more infectious than patients with tuberculosis who are 'smear negative'. The more TB bacilli that are seen, the more infectious the patient is to others.

Patients are called 'smear positive' if TB bacilli can be seen in their stained sputum.

NOTE With the auramine-O method a blue light-emitting diode (LED) can be used instead of an expensive mercury vapour lamp. The accuracy of microscopy depends on the number of TB bacilli, the expertise of the examiner and the time spent looking for TB bacilli.

3-24 How reliable is a sputum smear examination in diagnosing tuberculosis?

Unfortunately it is not very reliable in children as many children with pulmonary tuberculosis have few TB bacilli in their sputum. It is a far more reliable test in adults. If the sputum smear examination is positive the child has pulmonary tuberculosis. However a negative smear does not rule out tuberculosis.

Most children with pulmonary tuberculosis will have a negative sputum smear because they have very few bacilli in their sputum.

CULTURE FOR TB BACILLI

3-25 Can TB bacilli be cultured from children with tuberculosis?

Yes, TB bacilli can be cultured (grown), especially from children with pulmonary tuberculosis. However it is not possible to culture TB bacilli from all children with tuberculosis.

3-26 How is sputum collected for sputum culture?

The same sputum collection methods that are used for sputum smear examination are also used for sputum culture. It is important to keep the sputum specimen cool at 4–10 °C and get it to the TB laboratory as soon as possible.

3-27 How is sputum cultured?

Either a solid or liquid culture medium is used. It may take four to eight weeks to get a positive culture on solid medium although the growth of TB bacilli is faster at two to three weeks with a liquid (broth) medium. This long wait is the main problem with TB culture. However, an advantage is that drug sensitivity or resistance testing can be done if a positive culture is obtained.

Like sputum smear staining, sputum culture in children is not as sensitive as in adults, as there are usually far fewer TB bacilli in the sputum.

3-28 Is sputum culture more sensitive than sputum smear examination?

Yes. Culture is far more accurate than sputum smear examination as it can detect far fewer TB bacilli. The culture may be positive when the smear is negative in a child or adult with tuberculosis. Therefore TB culture is important, especially if the smear is negative in a child with a history, clinical examination, Mantoux skin test and chest X-ray suggesting tuberculosis.

Sputum culture is particularly useful in children with a negative smear.

3-29 Do all children with pulmonary tuberculosis have a positive sputum culture for TB bacilli?

Unfortunately, no. Due to the small number of TB bacilli in their sputum, many children with tuberculosis will have both a negative sputum smear and culture. Therefore the diagnosis of tuberculosis in children may have to be made on the history, clinical examination, chest X-ray and Mantoux test alone.

NOTE In as many as 40% of children with tuberculosis, the diagnosis cannot be confirmed by sputum culture.

3-30 What new tests can be used to identify TB bacilli in sputum?

New rapid tests which identify TB bacilli in sputum samples or TB cultures are very exciting as they are sensitive and give quick and accurate results within 48 hours. At present they are expensive and require a specialised TB laboratory.

NOTE New PCR-DNA rapid tests are very specific and can identify different species of Mycobacteria and detect drug resistance.

3-31 May TB bacilli be seen and cultured from other sites?

Yes. TB bacilli can be identified in CSF (cerebrospinal fluid), pleural effusions or ascites fluid. They may also be identified in fine needle aspirates of lymph nodes and in tissue biopsies. TB bacilli may also be seen in pus from an abscess or discharging ear.

CHEST X-RAY

3-32 How useful is a chest X-ray in diagnosing tuberculosis?

A chest X-ray is one of the most important special investigations in diagnosing tuberculosis, especially in children with a negative sputum test. In these children it may be the only way of confirming a diagnosis of pulmonary tuberculosis.

Chest X-ray is very important in diagnosing tuberculosis.

3-33 What chest X-ray views are needed?

It is important to get good quality frontal X-rays. A lateral view is useful but not essential.

3-34 What is the typical chest X-ray appearance in primary tuberculosis?

In pulmonary tuberculosis in children the most common finding on chest X-ray is hilar lymph node enlargement only.

3-35 What complications of primary tuberculosis can be seen on a chest X-ray?

- Tuberculous pneumonia with areas of consolidation (opacification). This may be local or widespread.
- TB with cavities (areas of breakdown)
- Areas of lung collapse due to compression of large airways by the hilar lymph nodes
- Pleural effusion
- Miliary tuberculosis with tiny spots throughout both lungs

3-36 Are the chest X-ray findings easy to interpret in children with tuberculosis?

While the X-ray findings may be typical of tuberculosis, the diagnosis may be difficult. Tuberculosis may present with a wide range of appearances while other chest conditions may look like tuberculosis. The chest X-ray is often particularly difficult to interpret in children

with HIV infection. Unlike acute bacterial or viral pneumonia, the chest X-ray findings do not rapidly disappear when treatment is started. Diagnosis should not be made on chest X-ray alone.

Sometimes a short trial of treatment for acute pneumonia with a drug such as amoxicillin, which is not effective for tuberculosis, may be used if the clinical diagnosis is uncertain. A failure to improve both clinically and on chest X-ray would support a diagnosis of tuberculosis.

FINE NEEDLE ASPIRATION OF A LYMPH NODE

3-37 When is a fine needle aspiration indicated?

Enlarged lymph nodes (lymphadenopathy) or inflamed or fluctuant lymph nodes in the neck are common in childhood tuberculosis. Aspiration with a thin needle is a very useful way of detecting TB bacilli. The TB bacilli can be identified on a smear examination or culture using the same methods as for sputum. The same tests can be done on pus from a discharging sinus.

3-38 How is a needle aspiration performed?

Aspiration is done with a 22 or 23 gauge needle. Instead of an aspiration, sometimes the whole node may be excised and examined for TB bacilli. It is important not to incise (cut into) the node as this may lead to sinus formation.

LUMBAR PUNCTURE

3-39 How is the clinical diagnosis of tuberculous meningitis confirmed?

If the symptoms and clinical signs suggest tuberculous meningitis, a lumbar puncture must be done to obtain a sample of

cerebrospinal fluid (CSF) for examination. Patients with tuberculous meningitis have a raised CSF protein and low glucose concentration with many white cells, especially lymphocytes. TB bacilli are seldom seen on a stained smear of CSF but may be cultured.

NOTE Sometimes a lumbar puncture is contraindicated until after a computed tomography (CT) scan is done.

SCREENING FOR HIV

3-40 Should all patients with suspected tuberculosis be screened for HIV?

Yes. This is important as many children with tuberculosis will also have HIV infection. Usually the HIV Rapid test can be used to screen children. However children under 18 months with a positive HIV Rapid test must also have a PCR test to confirm whether they are HIV infected (PCR positive) or only exposed to HIV with maternal antibodies (PCR negative).

Tuberculosis usually spreads more rapidly if the child is also HIV infected. Therefore it is important that all children with tuberculosis be screened for HIV infection. There are three important reasons to screen for HIV.

1. The diagnosis of tuberculosis is more difficult in children with HIV infection. The Mantoux test may be negative while the clinical signs and chest X-ray appearance may be similar in tuberculosis and other HIV-related lung disease.
2. All HIV-infected children treated for tuberculosis need to be referred for antiretroviral treatment.
3. There are many drug interactions when children are treated for both tuberculosis and HIV. Therefore the medication, especially antiretroviral treatment, may require adjustment.

All patients with suspected tuberculosis must be screened for HIV infection.

CASE STUDY 1

A young child, whose mother has pulmonary tuberculosis, is brought to a clinic where the nurse performs a Mantoux skin test. BCG immunisation is recorded on the child's Road-to-Health card. The mother is asked to bring the child back the following day so that the skin test can be read.

1. What is a Mantoux skin test?

Tuberculin (protein from dead TB bacilli) is injected into the skin. Later the site is examined for a reaction (an area of swelling).

2. When should the test be read?

48 to 72 hours (two to three days) after the test is done. It is too soon to read the test the following day as the skin reaction may not be fully developed yet.

3. How is the test read?

Using a ruler, the largest transverse (across the arm) diameter of the induration is read in millimetres.

4. What is a positive test?

An area of induration 10 mm or more. The area of redness is not important.

5. What does this result mean?

The child has TB infection. However a positive test cannot indicate whether the child also has tuberculosis.

6. Could the result be due to BCG immunisation?

No, as BCG usually gives an intermediate test result (i.e. 5 to 9 mm induration). A

Mantoux skin test done a few years after BCG immunisation may be negative.

CASE STUDY 2

A four-year-old child with suspected tuberculosis is referred to a TB clinic for sputum examination. It is also suggested that the child has a chest X-ray.

1. How should a sputum sample be obtained?

Unlike adults and older children, young children usually cannot cough up a sample of sputum. Therefore it has to be obtained by gastric aspirate or saline-induced collection.

2. What tests will be done on the sputum?

A smear examination and culture.

3. Does a negative smear exclude pulmonary tuberculosis?

No, as a negative smear is common in children with tuberculosis. However a positive smear will confirm a clinical diagnosis of tuberculosis.

4. Is it worth asking for a culture if the smear is negative?

Yes, as the culture is more sensitive. Commonly in children the culture will be positive when the smear is negative. This is because there often are only a few TB bacilli in the sputum of children.

5. How long does it take to get a culture result?

Up to four weeks with liquid culture medium. New rapid tests will give a result in 48 hours, but only if the sputum smear is positive.

6. Is a chest X-ray also necessary?

Not if the sputum smear test is positive in older children. If the smear test is negative a chest X-ray is useful to confirm the diagnosis. The chest X-ray can be difficult to interpret in

children with tuberculosis, especially if they are also infected with HIV.

CASE STUDY 3

A young child with enlarged cervical nodes presents at a district hospital. The medical officer phones the referral hospital for advice on what investigations to do. There is a strong family history of tuberculosis.

1. What samples are required?

Obtain a sputum sample and a fine needle aspirate from an enlarged lymph node. The sputum sample will probably be collected by gastric aspirate.

2. What investigations are needed?

Smear examination and culture on both samples.

3. How should the gastric aspirate be prepared?

An equal volume of 4% sodium bicarbonate should be added to the gastric aspirate to neutralise the stomach acid. This will increase the chance of a positive culture. The sample should be kept cool and sent to the laboratory as soon as possible.

4. Is it not easier to simply take a chest X-ray?

In children it is difficult to diagnose tuberculosis on a chest X-ray alone. It is better to identify TB bacilli on sputum or some other sample such as a lymph node aspirate, pleural

aspirate or cerebrospinal fluid. Many children with peripheral (cervical) lymphadenopathy have a normal chest X-ray.

5. What stains are used on a sputum smear?

Either a Ziehl-Neelsen or auramine-O stain.

6. Is it dangerous for health workers to collect a sputum sample?

It is possible to become infected with TB bacilli while collecting a coughed-up sputum sample. Therefore the health worker should wear a mask, choose a well-ventilated space and wash his or her hands well afterwards. This is particularly important in communities where drug-resistant tuberculosis is common.

THE FIVE MOST IMPORTANT 'TAKE-HOME' MESSAGES

1. A positive Mantoux skin test indicates TB infection and not necessarily disease.
2. A diagnosis of tuberculosis in a child depends on a history of exposure to tuberculosis, chronic symptoms of cough, a positive Mantoux skin test and typical chest X-ray findings. Not all have to be present to diagnose tuberculosis.
3. Tuberculosis is confirmed by identifying or culturing TB bacilli in the sputum, gastric aspirate or other sample.
4. A chest X-ray is important for diagnosing tuberculosis but not monitoring the response to treatment.
5. HIV screening is essential in all children suspected of having tuberculosis.

4

Management of childhood tuberculosis

Before you begin this unit, please take the corresponding test at the end of the book to assess your knowledge of the subject matter. You should redo the test after you've worked through the unit, to evaluate what you have learned.

Objectives

When you have completed this unit you should be able to:

- Give the principles of managing a child with tuberculosis.
- Identify which children can be managed at home.
- Describe first-line treatment.
- Explain the importance of good adherence.
- Monitor a child on treatment.
- Clinically recognise drug resistance.
- Understand the role of improved nutrition.
- List the problems of treating tuberculosis and HIV co-infection.

PLANNING THE MANAGEMENT OF A CHILD WITH TUBERCULOSIS

4-1 What are the principles of managing children with tuberculosis?

- Correct treatment
- Good adherence
- Careful follow up
- Improved nutrition
- Screening for HIV

4-2 Should all children with tuberculosis be treated in hospital?

Most children with uncomplicated pulmonary tuberculosis or tuberculous lymphadenopathy do not need admission to hospital. They can be treated at home and managed from a local clinic. Usually bed rest is not required.

Children with complicated tuberculosis (severe pulmonary or miliary tuberculosis or tuberculous meningitis) should be admitted to hospital.

TREATING TUBERCULOSIS

4-3 Can tuberculosis in children be cured?

Most cases of uncomplicated tuberculosis (more than 90%) can be cured with multiple drug treatment.

Most patients with tuberculosis can be cured.

4-4 What are the aims of treating tuberculosis?

- To cure the tuberculosis
- To make the patient not infectious to others
- To prevent relapse of tuberculosis
- To prevent the development of drug resistance

4-5 How many drugs are used in the treatment of tuberculosis?

Two or more drugs are always used. Tuberculosis is never treated with one drug alone. Usually three or four drugs are used together. One drug (usually INH) may be used in prophylaxis.

4-6 Why is more than one drug needed?

Multiple drugs (two or more) are used as they are more effective than one drug only. This makes sure that tuberculosis is cured.

There is also less chance of drug resistance developing if multiple drugs are used. TB bacilli rapidly become resistant if only a single drug is used.

NOTE Some drugs kill rapidly growing bacilli (bacteriocidal drugs) while others kill slow growing bacteria (sterilising drugs).

4-7 What is first-line treatment?

These are the drugs usually used to treat children who present with tuberculosis. They are the first choice as they are cheap, effective and have few side effects (adverse events). All

adverse events from drugs should be reported to the local authority.

4-8 What drugs are used for first-line treatment?

The three commonly used first-line anti-tuberculous drugs in uncomplicated childhood tuberculosis are:

- Isoniazid (INH)
- Rifampicin
- Pyrazinamide (PZA)

Other first-line drugs (ethambutol and streptomycin) have also been used. However they are less effective and have more serious adverse events. Streptomycin is no longer used in children.

Commonly used first-line drugs to treat tuberculosis are isoniazid, rifampicin and pyrazinamide.

NOTE Streptomycin was used in 1946 as the first anti-tuberculous drug.

4-9 How long is a course of first-line treatment?

For uncomplicated tuberculosis, the course of treatment usually lasts six months. This is divided into two phases.

1. The intensive phase of two months
2. The continuation phase of four months

All three drugs (isoniazid, rifampicin and pyrazinamide) are used for the intensive phase while only two drugs (isoniazid and rifampicin) are used during the continuation phase.

Drug treatment for many months is needed to cure tuberculosis.

4-10 What is the aim of the intensive phase of treatment?

To rapidly kill as many TB bacilli as possible. To achieve this intensive treatment is needed with a number of drugs that have a high ability to

kill TB bacilli. Rapidly reducing the number of TB bacilli stops the progression of the disease, makes patients less infectious and helps to prevent the development of drug resistance.

4-11 What is the aim of the continuation phase of treatment?

This longer phase of treatment is necessary to make sure that the remaining TB bacilli do not start to multiply once again. Fewer drugs are needed to achieve this.

4-12 What is short-course treatment?

This is the modern way of treating tuberculosis where a six-month course of drug treatment is used. Before rifampicin was developed, courses of 12 to 18 months were used. However compliance was often poor with these longer courses as many patients did not take their medication regularly or stopped treatment too soon. The cure rate of tuberculosis has improved with shorter, well-monitored courses of anti-tuberculous drugs. Short-course treatment is more cost effective but must be well managed.

4-13 How are drug doses calculated in children?

Usually body weight is used to calculate drug doses in children (i.e. mg/kg). When children respond to treatment and gain weight, the dose may need to be increased even though the dose per kg body weight remains the same.

4-14 How is isoniazid given?

Isoniazid (INH) is an excellent drug which is taken by mouth. It is cheap, has few side effects in children, and is particularly good at killing TB bacilli during the intensive phase. INH is given throughout the six-month course of treatment.

The dose of INH is 10 mg/kg/day. It is important not to use a smaller dose.

NOTE Range is 10 to 15 mg/kg/day.

4-15 How is rifampicin given?

Rifampicin is also very good at killing TB bacilli and is used throughout the six-month course. It is given by mouth and has adverse events in children. Rifampicin colours the urine orange but this is harmless.

The dose of rifampicin is 15 mg/kg/day.

NOTE Range in 10 to 20 mg/kg/day.

4-16 How is pyrazinamide given?

Pyrazinamide is used during the intensive phase to help kill dormant TB bacilli which are not multiplying. It is also taken by mouth.

The dose of pyrazinamide is 35 mg/kg/day.

NOTE Ethambutol (20 mg/kg/day) is sometimes added to first-line treatment to help prevent the development of resistance to the other anti-tuberculous drugs in more extensive disease in children. The dosing range of ethambutol is 15 to 25 mg/kg/day.

4-17 How often are first-line drugs taken?

In South Africa INH, rifampicin and pyrazinamide are taken by mouth at the same time once a day, usually in the morning before breakfast.

NOTE In some countries treatment is given in larger doses two or three times a week. Treatment twice a week is not recommended by WHO as one missed dose is a large part of the weekly treatment.

4-18 What are the adverse effects of first line drugs?

Usually there are few serious adverse effects (side effects) with children. Adverse effects are more common in adults. The organ most commonly affected by first-line anti-TB drugs is the liver. All commonly used first-line drugs can cause hepatitis. There is no need to routinely measure liver enzymes. However liver enzymes must be measured in patients who are jaundiced and all anti-TB drugs should be stopped and patients referred for investigation and change of anti-TB treatment.

If a child develops hepatitis on TB treatment other common causes of hepatitis must be looked for e.g. viral hepatitis A. Nausea and skin rashes may occur.

NOTE INH may cause peripheral neuropathy, but this is very uncommon in children and routine pyridoxine supplementation is not needed. Hepatitis recovers once the drug causing the problem is stopped.

Drugs used to treat tuberculosis can cause hepatitis.

4-19 What are the advantages of fixed-dose combination drugs?

First-line drugs are often given as fixed-dose combination drugs especially in older children. All three drugs are given as a single tablet (fixed-dose combination). This reduces the number of tablets that have to be taken and prevents children leaving out the drugs they do not like. As a result adherence is improved and the development of drug resistance reduced.

4-20 What is the management of complicated tuberculosis?

Children with severe pulmonary or miliary tuberculosis must be treated in hospital. Usually treatment is given for six to nine months and ethambutol is added as an extra drug to prevent the development of drug resistance.

In South Africa the treatment of tuberculous meningitis is for six months and ethionamide is used instead of ethambutol as it crosses well into the CSF (cerebrospinal fluid).

Children with complicated tuberculosis must be managed in hospital by doctors who have the required training and experience.

4-21 Why is streptomycin no longer used in children?

Streptomycin is not used in treating tuberculosis in children because:

- It has to be given by injection which is painful.

- Syringes and needles are expensive.
- It can cause permanent nerve damage leading to deafness and difficulty with balance.
- Dirty needles can spread HIV.

4-22 How does the treatment of children and adults differ?

Four drugs are used in adults during the initial phase of two months. Ethambutol is added to INH, rifampicin and pyrazinamide. This is because there are far more TB bacilli in tuberculosis with cavities which commonly occurs in adults. As children rarely have cavities, only three drugs are used in the initial phase. Just like in children, adults are usually treated with INH and rifampicin for the four-month continuation phase.

4-23 When should treatment be started?

When the diagnosis of tuberculosis is confirmed by identifying TB bacilli, usually in the sputum.

When the history, examination, skin test and chest X-ray strongly suggests tuberculosis even if the diagnosis cannot be confirmed by identifying TB bacilli. Some of these children are diagnosed after failing to respond to treatment for acute pneumonia. Therefore, some children are treated for tuberculosis without confirming the diagnosis on sputum examination.

Drug treatment should be started if tuberculosis is proven or if there is a high clinical suspicion of disease.

GOOD ADHERENCE

4-24 What is good adherence?

Excellent adherence (compliance) means that every dose of medication is taken each day at the correct time. If more than 80% of the

doses are taken correctly, adherence is said to be good.

4-25 Why is good adherence important?

- It greatly increases the chance for a cure.
- It greatly reduces the risk of drug resistance developing.
- It prevents the relapse (recurrence) of tuberculosis.

The most important aspect of treating a child with tuberculosis is to ensure that the medicine is taken correctly and regularly. This is often difficult as medication has to be taken for many months.

Good adherence is essential to cure the patient and prevent drug resistance.

4-26 How can adherence be improved?

- By the healthcare worker clearly explaining what tuberculosis is, and why treatment must be given for such a long time even if the child is clinically improving
- By the healthcare worker giving clear instructions on when and how to take the medication
- By a good understanding of these instructions by the child and parents
- It is essential that the clinic staff establish a good relationship with mother and child.
- With a written treatment plan
- By supporting the family
- By good follow up to check adherence
- With a treatment diary to record medication taken
- Using a daily pill box
- Using 'DOT'

4-27 What is DOT?

'DOT' stands for Directly Observed Therapy. With DOT some responsible person in the community observes the child swallowing every dose of the anti-tuberculous drugs. In practice, this is usually done from Monday to Friday with the family making sure that the drugs are taken over weekends. The DOT worker (community

trained treatment supporter) does not have to be a health professional and is usually not a family member. However the DOT support person must be reliable and trained for the task. They should be encouraging and make sure that the correct dose of each drug is taken. Unfortunately DOT is often not correctly implemented.

With DOT a responsible person must see the child takes the tablets.

NOTE In contrast to DOT, DOTS (Directly Observed Therapy-Short course) is a strategy which has five elements: political commitment, sputum smear or culture diagnosis, regular supply of drugs, treatment supervision, and recording and reporting. DOT is only the supervision part.

4-28 What are the advantages of DOT?

DOT ensures good adherence without the child having to go to the clinic for every dose. If DOT is correctly used, the failure rate of treatment is greatly reduced and over 90% of children should be cured. The general public can play an important role in the control of TB by supporting DOT. DOT is a key factor in obtaining high cure rates and reducing the risk of drug resistance.

The success of treatment depends on good support.

NOTE The cure rate for TB without DOT in poor countries may be as low as 40%.

MONITORING TREATMENT

4-29 How is treatment monitored?

The child should be carefully followed up at the treatment clinic (ideally a clinic close to the family home). Each child must have a treatment sheet where each visit is recorded. The child's clinical condition, weight, drugs taken and any identified problems must be noted. A careful record of the date of the next

appointment must be made. If the child fails to attend on that date, the family must be contacted by phone or by a community health worker. It is important to be aware when a child misses a clinic appointment.

4-30 How is the response to treatment monitored?

Once the child has been on triple drug treatment for a few weeks the signs and symptoms should gradually improve and the child should start to feel well and gain weight. The most reliable feature of a good response to treatment is the disappearance of symptoms and weight gain.

After starting treatment the child should be seen every two weeks for the first month and then monthly for the rest of the treatment. The child should be weighed at every visit. As the child gains weight the drug dosages must be adjusted.

In older children with sputum smear-positive tuberculosis, a sputum sample for smear examination is collected at the end of the initial phase at two months. This should be negative for TB bacilli. Sputum samples are collected again after five months of treatment. If sputum smears or culture remain positive, drug susceptibility testing must be done to exclude drug resistance.

A definite improvement in the chest X-ray may be seen in early infections after a month. However, the X-ray changes may take months to improve. Therefore X-rays are not routinely used to determine if a child is responding to treatment.

4-31 What are the commonest causes of failure to cure tuberculosis?

- Failure to take the medication correctly as prescribed (non-adherence). If doses of the drugs are missed repeatedly the tuberculosis will not be cured and drug resistance may develop.
- If the treatment is stopped too soon the tuberculosis can return (relapse). In many

poor countries it is common for patients with tuberculosis not to complete their full course of treatment. Once they feel well again they stop their medication. As a result, relapse of TB occurs, drug resistance develops and many people die of TB.

- The child is HIV infected and is not receiving antiretroviral treatment. Response to anti-TB treatment is usually good in children with HIV infection.
- Tuberculosis caused by multi-drug-resistant TB.

Treatment of tuberculosis is difficult as it is lengthy and requires good adherence.

DRUG-RESISTANT TUBERCULOSIS

4-32 What is drug-resistant tuberculosis?

This is tuberculosis where the TB bacilli are resistant to one or more of the first-line drugs.

Resistance to both INH and rifampicin is called multi-drug-resistant (MDR) tuberculosis. In multi-drug resistance, the TB bacilli continue to multiply and are not killed by the usual combination of first-line drugs.

Multi-drug-resistant tuberculosis may develop because of incorrect treatment or poor adherence (acquired resistance). Multi-drug-resistant tuberculosis can then be transmitted to close contacts (primary resistance). Both forms of multi-drug resistance are becoming a major problem in South Africa. Primary drug resistance is far more common than acquired resistance in children.

With extensively drug-resistant (XDR) tuberculosis, the TB bacilli are resistant to a wide range of anti-TB drugs including INH and rifampicin. This is extremely dangerous as most of these patients die. Like multi-drug resistance, extensively drug resistance may be primary or acquired.

Patients with multi-drug-resistant or extensively drug-resistant tuberculosis must be admitted to hospital for management with other expensive anti-TB drugs which often have more side effects.

Drug resistance is becoming a major problem in South Africa.

NOTE Patients with XDR TB are resistant to rifampicin and INH plus injectable second-line drugs (kanamycin, amikacin or capreomycin) as well as the fluoroquinolones (e.g. ofloxacin or moxifloxacin).

4-33 How is drug resistance diagnosed?

These patients fail to respond clinically to correct treatment with first-line drugs. This should always suggest drug resistance especially if there has been good adherence. It is very important to recognise drug resistance as soon as possible.

In children, drug-resistant tuberculosis should be suspected if they are in contact with an adult suffering from drug-resistant pulmonary tuberculosis.

Drug resistance can be diagnosed by one of two methods.

1. In the first method TB bacilli are cultured and then tested against the anti-TB drugs (INH and rifampicin). Using this method takes weeks to months to get a result.
2. In the second method drug resistance can be proved by rapid tests which identify the abnormalities in the DNA of TB bacilli which are known to be associated with drug resistance. Resistance to INH and rifampicin are usually determined. These new rapid tests can be done on a sputum sample or culture and the results are available in a few days. This method is being introduced in South Africa.

Drug-resistant tuberculosis should be suspected when children with good adherence fail to improve clinically or have been in contact with a multi-drug-resistant patient.

4-34 What are the causes of acquired drug resistance?

These patients do not have drug resistance when antituberculous treatment is started. It develops during the course of treatment because of failure of good adherence due to:

- Inadequate patient education on the importance of good adherence
- Failure to understand the importance of completing the full course of treatment even if the patient is feeling much better
- Poor support (failed DOT)
- Inadequate supply of drugs (no drugs available at the clinic)
- Side effects leading to poor adherence or stopping one drug
- Poor follow up of patients on treatment

These factors are all related to the inadequate care of patients with tuberculosis. Therefore, poor management of tuberculosis in the community is the main cause of drug resistance.

Drug resistance is caused by poor tuberculosis management.

4-35 How are patients with drug resistance managed?

They must be managed by special TB units with doctors who are experienced in caring for these patients.

GOOD NUTRITION

4-36 Why is good nutrition important in children with tuberculosis?

- Because malnutrition and tuberculosis go 'hand in hand', most children with tuberculosis are underweight.
- Malnourished children with an inadequate diet have a weakened immune system and are at high risk of developing tuberculosis.
- Tuberculosis leads to poor appetite, failure to thrive and weight loss which results in malnutrition.
- Poverty and overcrowding are common factors in both malnutrition and tuberculosis.

It is therefore important to improve the nutrition of all children to help protect them against tuberculosis, and improve the nutrition in children with tuberculosis.

Malnutrition and tuberculosis are often found together.

4-37 How can the nutrition of children be assessed?

Weighing is the best method of screening children for malnutrition. All children with a weight below the normal range for their age are at high risk of malnutrition.

The weight of children with tuberculosis must be regularly recorded and plotted on a weight-for-age chart. The Road-to-Health card should be used in children under five years of age. Gaining weight is an important sign that the child is responding to anti-tuberculous treatment.

Plotting weight is an important way of assessing a child's response to treatment.

4-38 How can nutrition be improved?

By improving the child's diet. Sugar or vegetable oil will add energy to a meal while milk powder or beans will add protein.

All children with tuberculosis should receive 200 000 units of vitamin A once by mouth as well as a daily multivitamin supplement.

Once the appetite returns the amount of food eaten each day will need to be increased. Financial assistance (e.g. child support grants) or food parcels may be needed.

TREATING TUBERCULOSIS AND HIV CO-INFECTION

4-39 What is the relation between tuberculosis and HIV infection?

Often both TB and HIV infections occur together. The risk of getting tuberculosis is many times higher in children who are HIV infected, especially if they are not on antiretroviral treatment.

Tuberculosis is more severe in children with an immune system weakened by HIV infection. Children with HIV infection are also more likely to develop tuberculosis if they are infected with TB bacilli.

In turn, tuberculosis speeds up the progress from asymptomatic HIV infection to severe clinical disease.

Therefore, all children presenting with tuberculosis must have provider-initiated HIV screening.

4-40 How may HIV infection interfere with the drug treatment of tuberculosis?

There may be an interaction between the drugs used to treat tuberculosis and the drugs used to treat HIV infection. Adherence may also be poor as a greater number of drugs have to be taken while the risk of side effects to some of the anti-TB and antiretroviral drugs increases.

Rifampicin lowers the blood levels of some antiretroviral drugs especially nevirapine and the protease inhibitors.

When children with tuberculosis also have HIV infection, both infections must be treated. This should be managed at a clinic with the experience and expertise to treat children with TB/HIV co-infection.

4-41 What is immune reconstitution inflammatory syndrome (IRIS)?

This is the unexpected clinical deterioration in a patient who was improving on anti-TB and anti-retroviral treatment. IRIS presents a few weeks after antiretroviral treatment is started. As the immune system starts to recover the body may have an inflammatory reaction to the TB bacilli resulting in IRIS.

The two most common symptoms of IRIS are unexplained fever and enlarging lymph nodes. These children need to be referred to facilities with experience in managing TB/HIV co-infected children as the diagnosis can be difficult and other causes of deterioration such as drug resistance need to be excluded.

IRIS due to previous BCG immunisation may also occur once antiretroviral treatment is started in infants.

CASE STUDY 1

A boy of six years old is diagnosed with uncomplicated pulmonary tuberculosis and is followed up at a district hospital. His parents are told he will need to take medication every day for six months. They are worried that tuberculosis cannot be cured.

1. Can uncomplicated pulmonary tuberculosis be cured?

There is an excellent chance that he will be cured provided that adherence to treatment is good.

2. What drugs should be used to treat this boy?

He should receive first-line treatment of rifampicin, INH and pyrazinamide for two months followed by rifampicin and INH only for another four months. This is known as short-course treatment. The first two months of treatment is called the intensive phase while the last four months are called the continuation phase.

3. Why is he not treated with rifampicin alone?

Because TB bacilli become resistant to treatment if only a single drug is used. That is why either two or three drugs are always used together as multiple-drug treatment.

4. How often should the drugs be taken?

It is best if the drugs are taken once every day of the week, usually at breakfast.

5. Are side effects to the drugs common?

Children usually have no, or only mild, side effects to the first-line drugs used to treat tuberculosis.

6. How are the doses of the drugs calculated?

The child's body weight is used to calculate the daily dose. As the child improves and gains weight, the daily dose may have to be increased.

CASE STUDY 2

A seven-month-old child is admitted to hospital with tuberculous meningitis. One of the older children in the family is also found to have tuberculosis. The mother asks whether the infant can be treated at home as it is a long way to the hospital.

1. What drugs are used to treat tuberculous meningitis?

The standard first-line drugs plus ethionamide. This drug is chosen as it crosses the blood brain barrier well. Treatment is given for six to nine months.

2. What other anti-TB drug is added for severe pulmonary or miliary tuberculosis?

Ethambutol.

3. Is streptomycin also used in children with complicated tuberculosis?

No, as it is a painful injection which has to be given daily and has serious side effects. The needles and syringes are expensive and can spread HIV if they are reused.

4. Should treatment be started if a definite diagnosis of tuberculosis cannot be made?

If there is a strong clinical suspicion of tuberculosis but TB bacilli cannot be identified, for example in the sputum, treatment should be started.

5. Can this infant with tuberculous meningitis be treated at home?

While the child remains clinically ill treatment must be given in hospital. If discharged home, it is essential that treatment is strictly supervised as a break in treatment may result in death or serious neurological damage.

6. What other infection must always be screened for in children with tuberculosis?

HIV.

CASE STUDY 3

An adolescent with pulmonary tuberculosis is referred to hospital because she has not improved after six weeks of treatment. The home conditions are poor and she admits that she often does not take her medication. Her

family is always fighting and is not interested in helping her with her treatment.

1. Why is she failing to respond to treatment?

Poor adherence. Not taking medication regularly every day is a common cause of treatment failure. Lack of family support is a serious problem when treating childhood illnesses such as tuberculosis.

2. How can this problem be corrected?

By using DOT (Directly Observed Therapy). A treatment supporter must support her taking her medication each day while the importance of good adherence must be explained to her. Trained members from the community can become DOT supporters.

4. What other steps can be taken to improve adherence?

A written treatment plan, treatment diary and pill box should help to improve adherence. Support from the clinic staff is also very important.

5. What other problem may result from poor adherence?

Drug resistance to the medication used for first-line treatment.

6. What is multi-drug resistance?

Resistance to both rifampicin and INH. This is becoming a major problem in South Africa.

THE SIX MOST IMPORTANT 'TAKE-HOME' MESSAGES

1. Uncomplicated tuberculosis in children is treated with three first-line drugs.
2. Good adherence is essential to cure tuberculosis.
3. Good appetite and weight gain are early indicators of response to treatment

4. Good nutrition is an important part of managing children with tuberculosis.
5. Poor response to treatment in spite of good adherence suggests multi-drug resistance.
6. Suspect drug resistance if the child has been in contact with an adult suffering from drug-resistant pulmonary tuberculosis.

5

Preventing childhood tuberculosis

Before you begin this unit, please take the corresponding test at the end of the book to assess your knowledge of the subject matter. You should redo the test after you've worked through the unit, to evaluate what you have learned.

Objectives

When you have completed this unit you should be able to:

- List ways of preventing tuberculosis.
- Provide BCG immunisation.
- Reduce the risk of exposure to TB bacilli.
- Give TB prophylaxis when indicated.
- Report a case of tuberculosis.
- Describe the aims of the national tuberculosis programme.
- Give ways of educating the community about tuberculosis.
- Understand the importance of reducing the spread of HIV if the tuberculosis epidemic in South Africa is to be controlled.

PRINCIPLES OF PREVENTION

5-1 How can the risk of childhood tuberculosis be decreased?

- BCG immunisation
- Avoiding exposure to adults with tuberculosis
- TB prophylaxis in children
- Reporting and effectively treating cases of tuberculosis
- Educating the community about tuberculosis
- Controlling the spread of HIV

BCG IMMUNISATION

5-2 What is BCG?

BCG (Bacille Calmette Guerin) is a freeze-dried live vaccine. It is made from a weakened live (attenuated) form of *Mycobacterium bovis*, the bacilli which causes tuberculosis in cattle and sometimes in children who drink milk that was not pasteurised. BCG is included in the expanded programme on immunisation (EPI) in children.

NOTE In South Africa the Danish strain of BCG is being used. Each year over 100 million doses of BCG are given worldwide. BCG was first used in 1921.

5-3 Why should children be immunised with BCG?

BCG does not prevent infection with TB bacilli but reduces the risk of TB meningitis and disseminated TB in young children by 75%. Unfortunately it is less effective in preventing pulmonary TB, especially in malnourished children and children with HIV infection. It also gives less protection in older children, adolescents and adults which makes reimmunisation at an older age unnecessary.

BCG reduces the risk of disseminated tuberculosis and tuberculous meningitis in children.

5-4 How should BCG be stored and mixed?

BCG vaccine should be stored in a refrigerator between 2 and 8 °C and must not be frozen. Keep it and the diluent on the middle shelf. It must also be kept out of direct sunlight. To prepare the vaccine for administration the vial of diluent should be added to the vial of dried vaccine. Do not use alcohol or ether to clean the top of the vial as it may kill the BCG. After adding the diluent, the vaccine will last for six hours if kept in a refrigerator or cool box. After six hours the vaccine must be discarded as the bacilli may be dead.

5-5 When should BCG be given?

Usually BCG is given during the first few days after birth in well infants and on the day of discharge from hospital or clinic in infants who have been ill or are low birth weight. If there is any doubt about whether BCG was given after birth, it should be given at six weeks with the other routine immunisations. BCG is not usually given to children older than one year and most clinics do not stock BCG.

5-6 Should some newborn infants not be given BCG?

In South Africa BCG is currently given to all infants after birth. However, BCG can cause serious adverse effects in HIV-infected infants. Due to the fact that the prevention of mother-to-child transmission programme is reasonably efficient in South Africa, an accurate diagnosis of HIV infection can be made at six weeks after delivery by PCR, and antiretroviral treatment is started early, it is still recommended that all neonates be given BCG at birth. Infants known to be infected with HIV should not be given BCG if this has not already been given at birth.

5-7 How is BCG given?

BCG is given by intradermal injection over the right upper arm as follows:

- Add 1 ml of diluent into the vial containing BCG. Gently turn the vial upside down at least five times until fully mixed. Do not shake.
- Draw up 0.05 ml of BCG vaccine in a sterile syringe (a special syringe to accurately measure 0.05 ml).
- Clean an area of skin over the right deltoid muscle (upper arm) with soap and water, not an alcohol swab.
- Stretch the skin over the right deltoid muscle with your thumb and forefinger. Slowly insert the needle intradermally (bevel facing up). Insert the needle for less than 2 mm into the skin. The needle can be seen through the skin.
- Inject the 0.05 ml of vaccine. A wheal (raised lump) indicates that the intradermal injection has been given successfully. The most common error is to inject the BCG under the skin when no wheal will be seen. With no wheal, start again at a different site and inject into the skin.

It is important that BCG is given correctly.

5-8 What are the adverse effects of BCG immunisation?

In the majority of infants a raised nodule develops at the site of the immunisation after two to four weeks. A small crust may develop or it may ulcerate. The nodule will heal by itself and no dressing should be applied. After eight weeks the nodule starts to decrease in size and by six months a small flat scar will form. The lymph nodes in the axilla on that side may enlarge slightly, which is normal. BCG immunisation does not always leave a scar in an infant. It is not necessary to repeat the BCG immunisation if no scar is seen.

The most common adverse effects are local pain and ulceration at the site of the immunisation and enlarged lymph nodes in the axilla and sometimes the neck.

Serious adverse effects in infants who are not HIV infected are very rare. However there is a high risk of serious adverse effects in HIV-infected infants. They include:

- An abscess may form at the site of the BCG immunisation.
- Axillary and rarely cervical (neck) lymph nodes may enlarge rapidly to more than 3 cm. A lymph node abscess may form and a sinus can develop.
- Disseminated BCG which presents in a similar way to disseminated tuberculosis.
- BCG IRIS (immune reconstitution inflammatory syndrome due to BCG) can develop after beginning antiretroviral treatment. This presents with enlarged axillary (arm pit) lymph nodes two to eight weeks after starting antiretroviral treatment.

All HIV-infected infants must be identified as early as possible and referred for investigation and treatment.

NOTE An adverse effect to BCG must be reported if an abscess larger than 10 mm forms at the site of immunisation or an axillary lymph node larger than 15 mm occurs. BCG adverse events are reported to the EPI program.

AVOIDING EXPOSURE TO TB BACILLI

5-9 When are children at high risk of exposure to TB bacilli?

There is a high risk of infection when children come into contact with someone who has untreated smear-positive tuberculosis. This is usually an adult with a cavity on chest X-ray. They have a chronic cough but are not aware that they have pulmonary tuberculosis. The risk is the highest if the child lives in the same household (close contact). Children are also at risk if their caregivers or family members they regularly visit have tuberculosis.

This situation is far more common in poor families where there is overcrowding in inadequate, dark, poorly ventilated housing. Children may also be exposed to large numbers of TB bacilli in taxis, buses, clinics or other confined spaces.

NOTE The concentration of TB bacilli in the air, the closeness of contact and the time a person is exposed to the contaminated air are major factors in determining who will become infected. TB bacilli are rapidly killed by direct sunlight.

5-10 How can exposure to TB bacilli be prevented?

- It is the public health responsibility of both the healthcare services and the general public to be aware of anyone who has the symptoms of tuberculosis, especially a chronic cough (more than two weeks). They need to be investigated.
- Improved living conditions with better housing and good nutrition.
- Whenever someone is diagnosed with tuberculosis, the family and others living in the same house should be screened for tuberculosis. This is usually done by taking a good history and referring those with symptoms for sputum examination. If the sputum examination is negative and symptoms persist then a chest X-ray must be taken. If there is one person with

tuberculosis in the family, there is an increased chance that there will be others.

5-11 What is contact tracing?

This is the finding and screening of people (the 'contacts') who have been exposed to someone with tuberculosis (the 'source'). Both adult and child contacts may have undiagnosed tuberculosis and need treatment.

Some children will have TB infection only (a positive Mantoux skin test with no symptoms or signs of disease). Infected children younger than five years of age and children of any age who also have HIV infection will benefit from TB prophylaxis.

Contact tracing of infectious people is a very important part of controlling the spread of tuberculosis in a community. The most effective public health measure to control tuberculosis is the identification and cure of infectious cases.

Contact tracing is an essential part of controlling the spread of tuberculosis.

NOTE While the family are encouraged to bring exposed children and adults with symptoms to be screened at the clinic (passive contact tracing), home visits to screen the family (active contact tracing) should be done, but is not commonly practised in South Africa.

5-12 How can infected patients prevent the spread of tuberculosis?

- By starting anti-TB treatment as soon as possible and taking their medication regularly and correctly.
- By teaching the correct cough behaviour to communities (cough etiquette). This requires adults to cough into a handkerchief and not onto other people. They should cover the nose when sneezing.
- Ensuring that public spaces are well-ventilated by opening windows.
- Meet out of doors if possible.
- By practising infection control in all healthcare facilities.

- Patients with pulmonary tuberculosis are usually no longer infectious to others after taking their medication correctly for 14 or more days.

5-13 What investigations should be done on children exposed to infectious patients?

- Careful history and examination for symptoms and signs of tuberculosis
- Mantoux skin test
- Record and plot their weight on the Road-To-Health chart. Look for lack of weight gain.
- Screen for malnutrition
- HIV screening test if indicated
- If there is any suspicion that a child has tuberculosis then the child must be investigated, which would include a chest X-ray, a sputum sample in older children (above eight years) and gastric aspirate if possible in younger children, for smear and culture.

5-14 How can health workers avoid infection?

Health workers are exposed to TB bacilli, especially while examining patients with a cough or while collecting sputum samples. Masks should be worn by healthcare workers when examining patients suspected of having infectious tuberculosis and hands should be washed after the examination. Good ventilation in examination and procedure rooms is essential.

TB PROPHYLAXIS IN CHILDREN

5-15 What is TB prophylaxis in children?

Usually INH for six months is used for prophylaxis against tuberculosis in children. The treatment is given daily using the same daily dose as for short-course treatment (10 mg/kg/day).

5-16 Who should receive TB prophylaxis?

The following children should be given prophylactic treatment:

- Clinically well asymptomatic children under five years of age who have been in close contact with someone who has smear-positive pulmonary TB. These young children are at high risk of developing tuberculosis themselves as they have an immature immune system.
- Children under five years who have a positive Mantoux skin test (10 mm or more), who are clinically well with no symptoms or signs of tuberculosis and have not recently been treated for tuberculosis. They have been infected with TB bacilli and are at high risk of the infection progressing to tuberculosis. They are at particular risk of disseminated tuberculosis.
- HIV-infected children of any age who are in contact with adults with smear-positive or culture-positive tuberculosis. They are at an increased risk of tuberculosis because they have a depressed immune system.

Asymptomatic HIV-negative children of five years and older, who have been in close contact with an adult with untreated pulmonary TB, or have a positive Mantoux test, are *not* given prophylaxis, as they are at far less risk of developing tuberculosis. However, they should be followed and investigated for tuberculosis if they develop any early symptoms or signs of TB.

Prophylactic treatment is given to well children under five years of age, and HIV-infected children of any age, who have been exposed to someone with untreated tuberculosis.

NATIONAL TUBERCULOSIS PROGRAMME

5-17 What is the aim of a national tuberculosis programme?

The aim of a national tuberculosis programme is to prevent the spread of tuberculosis and to promote the accurate diagnosis and correct treatment of tuberculosis. This should reduce the mortality and morbidity due to tuberculosis and reduce the risk of drug resistance. The national tuberculosis programme in South Africa (National TB Control Programme) was started in 1996 with widespread implementation of the DOTS strategy.

5-18 Do children with tuberculosis need to be reported?

Yes. All children who are treated for tuberculosis need to be recorded and reported to the local health (EPI) authority. Children are reported in two age groups, zero to four, and five to 14 years of age.

5-19 Why is it important for children with tuberculosis to be recorded and reported?

It is important that children with tuberculosis are reported and recorded for two main reasons.

1. To know how many children require treatment for tuberculosis to ensure sufficient child-friendly treatment courses.
2. The number of children with tuberculosis, especially in the zero to four age group, gives an indication of the amount of recently transmitted infection. An evaluation of this group of children gives an indication of the quality of the National TB Programme.

5-20 Do we need to record and report on children receiving prophylaxis?

It is not required at present to register these children. However it would be an advantage

if each clinic knew which children were receiving prophylaxis, how many completed the course of prophylaxis, and what the outcome of these children was. This would help with the planning of the service.

5-21 What are the Millennium Developmental Goals?

These are eight developmental goals set by the United Nations to improve the living conditions in the world's poorest countries. Goal number six addresses important infectious diseases. In South Africa these are HIV and TB infection. The challenge is to reduce the incidence of tuberculosis by half by 2015.

Reducing the incidence of tuberculosis is included in the Millennium Developmental Goals.

NOTE The Stop TB strategy of the WHO in 2006 spells out the steps needed to reach this goal.

COMMUNITY INVOLVEMENT

5-22 What community education is needed?

It is important that the community in all areas is aware of the following:

- Know that tuberculosis is a common and important disease in South Africa.
- Know how tuberculosis is spread.
- Know the presenting symptoms of tuberculosis.
- Know that treatment takes many months and that adherence is very important.
- Know that tuberculosis can be cured.

5-23 How can the community be educated about the dangers of tuberculosis?

- Via the print (magazines, newspapers) and electronic (radio, television, internet) media.
- By inclusion in the school curriculum.

- Through community organisations (trade unions, church groups).
- At healthcare clinics (posters, information sheets, discussion groups, individual counselling).
- Using peer educators (previous TB patients who have been trained as community workers).

5-24 What are traditional beliefs about tuberculosis?

In most communities there are many misunderstandings and incorrect beliefs about tuberculosis.

- Tuberculosis is caused by bewitchment.
- Tuberculosis is a punishment for some sin committed.
- Tuberculosis is an inherited condition.
- Tuberculosis cannot be cured.
- BCG immunisation prevents all forms of tuberculosis.

These false beliefs often cause a lot of unnecessary suffering. They can only be corrected by community education.

CONTROLLING THE SPREAD OF HIV INFECTION

5-25 How would controlling the spread of HIV infection reduce the prevalence of tuberculosis?

In South Africa the HIV epidemic has greatly increased the number of both adults and children with tuberculosis. HIV infection lowers the immunity and thereby increases the risk of TB infection progressing to tuberculosis, especially extrapulmonary tuberculosis. A greater number of adults with tuberculosis increases the chance that children in the family and community will be infected with TB bacilli. In addition, more women with tuberculosis increases the risk of vertical transmission to infants (mother-to-child transmission).

Reducing the spread of HIV and tuberculosis in the community is, therefore, essential if the number of children with tuberculosis is to be decreased.

CASE STUDY 1

A newborn infant is given BCG immunisation before discharge home from a obstetric care clinic. A month later the mother notices a lump at the site of the immunisation. On examination, the nurse notices mildly enlarged axillary lymph nodes. The child is generally well and thriving.

1. What is BCG?

A weakened (attenuated) form of TB bacilli.

2. What are the benefits of BCG immunisation?

It induces an immune response which reduces the risk that TB infection will progress to tuberculosis, especially disseminated and miliary tuberculosis in young children. However it does not reduce the risk of TB infection.

3. How is BCG immunisation given?

By injection into the skin (intradermal) of the right upper arm (deltoid area). It is important that BCG is stored and mixed correctly. BCG immunisation should be given directly after birth.

4. Would you be worried about the swelling at the immunisation site and the enlarged lymph nodes.

No, as this is a normal response to BCG.

5. What could cause severe adverse effects to BCG?

HIV infection. These infants have a weakened immune system which can result in local BCG abscesses or even disseminated BCG.

6. What is BCG IRIS?

IRIS (immune reconstitution inflammatory syndrome) due to BCG may present with markedly enlarged axillary lymph nodes a few weeks after antiretroviral treatment is started. It is due to the recovery of the immune system.

CASE STUDY 2

An unemployed man is diagnosed with pulmonary tuberculosis. He lives with his family, including a four-year-old son, in an overcrowded house. He is concerned that his son may be at risk of developing tuberculosis. Clinically the child is well and not malnourished.

1. What should be the management of this child?

He should be screened for tuberculosis as he is a 'contact' and therefore at high risk of infection.

2. What investigations are needed?

A Mantoux skin test and a chest X-ray must be done. A sputum test must be done if the chest X-ray suggests tuberculosis.

3. Should this child be treated for tuberculosis?

Only if there is good evidence to suggest that he developed tuberculosis (a positive Mantoux test and abnormal chest X-ray). If he appears well and his Mantoux skin test is negative or intermediate, he should be given TB prophylaxis.

4. What is TB prophylaxis?

INH 10 mg/kg daily for six months.

5. What other children should receive TB prophylaxis?

In addition to well children under five years of age who have been in contact with an adult

with pulmonary tuberculosis, children with a positive Mantoux skin test and children with HIV infection should receive INH prophylaxis if they are TB contacts.

6. How can adults with tuberculosis reduce the risk of spreading the infection to their children?

By practising correct cough behaviour (cough etiquette) and taking their medication correctly.

CASE STUDY 3

Tuberculosis is common in a small rural community. The headmaster of the primary school wants to involve the whole community in reducing the risk of children developing tuberculosis.

1. How can the community help reduce the prevalence of tuberculosis?

Everyone must be educated about tuberculosis and understand the cause, clinical presentation, how it is spread and the importance of good adherence. They should understand that BCG immunisation, regular weight checks and good nutrition are important for children.

2. How can the community be educated about tuberculosis?

Via the print media (books, newspapers) and electronic media (radio and TV) as well as community organisations.

3. What can be done at the school?

Include tuberculosis in the school curriculum. Education about tuberculosis can also be given to teacher and parent groups.

4. Why should children with tuberculosis be recorded and reported?

So that the prevalence and spread of tuberculosis in the community can be

documented. This will help with planning both prevention and treatment.

5. What are the Millennium Development Goals?

These are a set of goals aimed at improving the living conditions of people in developing countries. One of the goals in South Africa includes halving the prevalence of tuberculosis by 2015.

6. Are traditional beliefs about tuberculosis helpful?

Some traditional beliefs lead to misunderstanding and suffering. For example, in some communities people with tuberculosis are believed to be bewitched or are being punished for some sin. It is important for the community to understand the true cause of tuberculosis and know that it can be cured with early diagnosis and correct treatment.

THE FIVE MOST IMPORTANT 'TAKE-HOME' MESSAGES

1. BCG immunisation reduces the risk of tuberculous meningitis and disseminated tuberculosis in young children.
2. INH prophylaxis should be given to children who are under five years of age or HIV infected and have been exposed to an adult with pulmonary tuberculosis or have a positive Mantoux skin test.
3. All cases of childhood tuberculosis must be recorded and reported
4. Community education about tuberculosis is important in the fight to control the spread of the disease.
5. Controlling the HIV epidemic is essential to reduce the incidence of tuberculosis.

Tests

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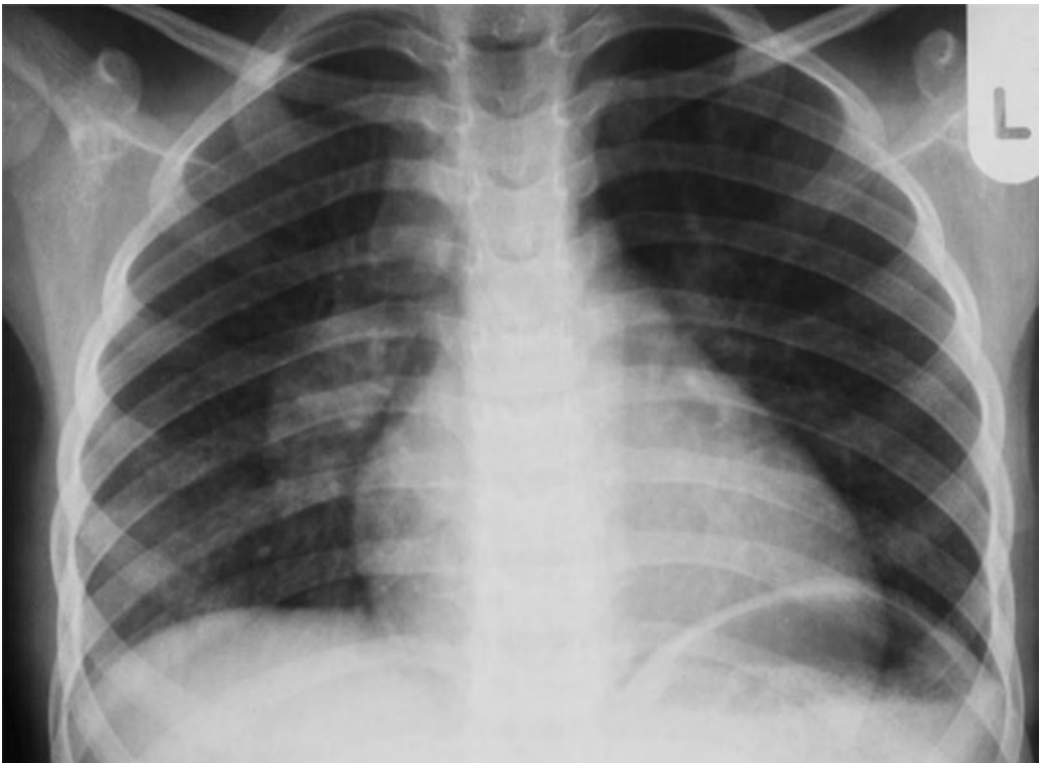


Figure 1: Enlarged hilar lymph nodes on the right hand side. The lungs appear normal. This is the commonest form of childhood TB.

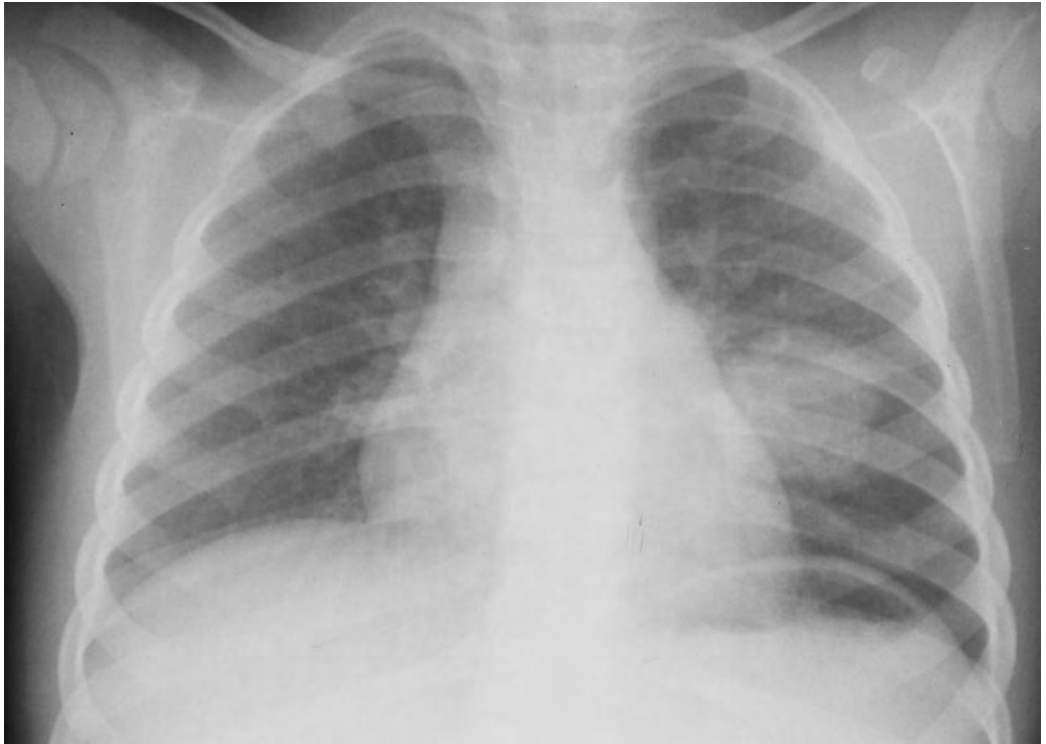


Figure 2: Primary TB infection of the left lower lobe

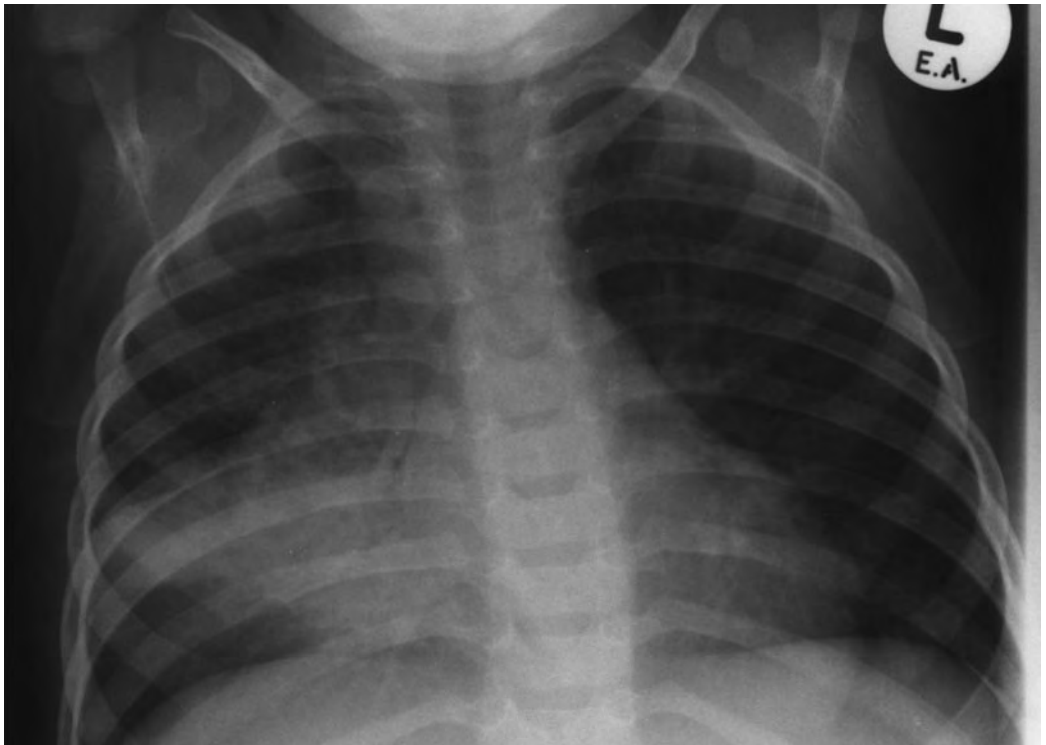


Figure 3: Enlarged hilar and paratracheal lymph nodes with TB pneumonia of the right middle lobe. On careful inspection narrowing of the right bronchus can be seen.

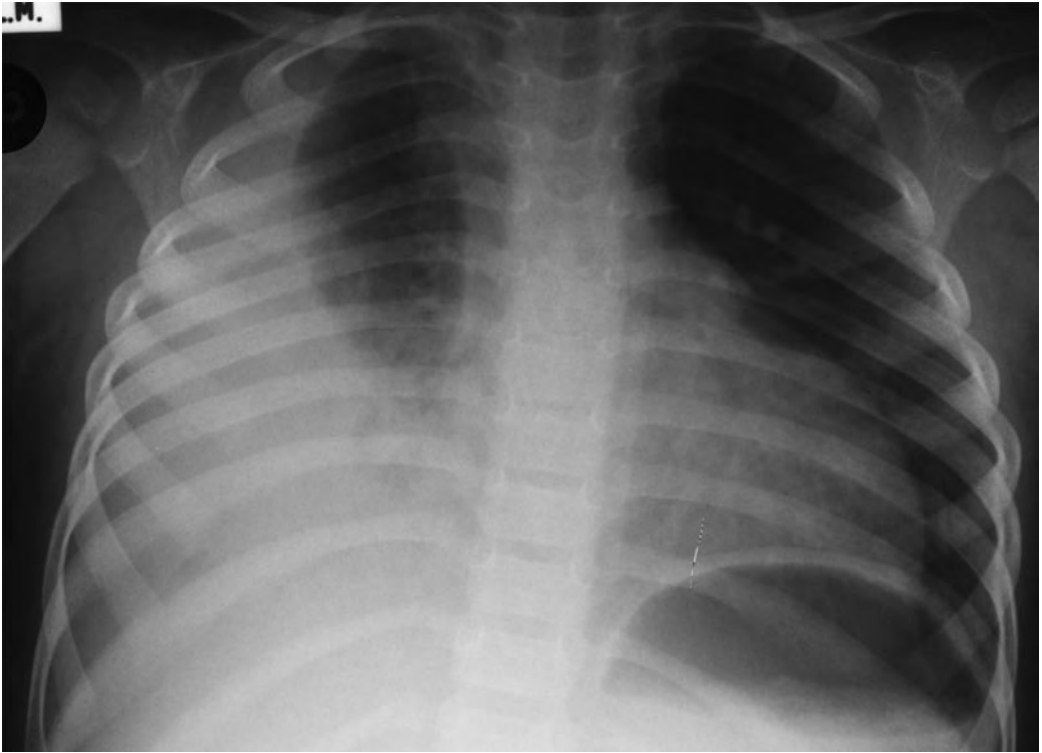


Figure 4: A large right sided pleural effusion seen in an older child



Figure 5: Severe TB in an adolescent with scattered areas of pneumonia and cavities in both upper lobes. This highly infectious form of TB is usually seen in adults.



Figure 6: A typical example of miliary TB with fine nodules visible in all the lobes of both lungs

A more comprehensive Atlas on the diagnosis of Intrathoracic tuberculosis in children can be downloaded free of charge from the following website www.theunion.org.

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