DIAGNOSING PULMONARY TUBERCULOSIS IN CHILDREN UNDER THE AGE OF FIVE IN SOUTH AFRICA

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ABSTRACT

A quantitative, non-experimental, descriptive design was used to investigate the challenges of diagnosing pulmonary tuberculosis (PTB) in children under the age of five at 19 primary healthcare (PHC) clinics in the Ethekwini Health District in KwaZulu-Natal province of South Africa. A questionnaire was used to collect data from 38 respondents and descriptive statistics were used to analyse and summarise the data.

The results showed PHC nurses did not have adequate knowledge to effectively diagnose PTB in children, and that PHC clinics were not adequately equipped to effectively diagnose PTB in children.

Recommendations included regular in-service training programmes on the diagnosis and management of PTB in children, regular audits of tuberculosis records by clinic supervisors, supply of standard equipment for diagnosis of PTB in children, simplifying of protocols for diagnosis and management of PTB in children and the inclusion of the management of PTB in children in the curriculum of professional nurses' training.

KEYWORDS: Bacillus Calmette Guerin (BCG), diagnosis, paediatric tuberculosis, primary health care (PHC), pulmonary tuberculosis (PTB), South Africa, tuberculin skin test

INTRODUCTION

South Africa is one of 22 countries with the highest tuberculosis (TB) infection rates in the world. In South Africa, the centre of attention of the National Tuberculosis Programme is adults with smear positive tuberculosis while childhood TB receives little

attention. Yet childhood TB constitutes 15–20% of all TB cases in developing countries (Zar, 2007:983).

The diagnostic tests that are often used to diagnose TB in children are neither consistent nor validated – in addition, there is no standard clinical case definition of childhood TB. Diagnosis is based on a combination of factors and the chances of over/under-diagnosis are thus high (Shingadia & Novelli, 2003:624). Signs and symptoms of PTB in children are non-specific, which make diagnosing PTB in children more difficult than in adults (WHO, 2003:62). Most children with PTB, traced through infected adults, do not show clinical symptoms of PTB and diagnosis is based on x-rays and positive tuberculin skin tests.

Definitions of key concepts

Bacillus Calmette Guerin (BCG) is the vaccine that gives protection against TB infection (Nzimande, 2003:153).

Diagnosis refers to determining the nature of a disease (Weller, 2000:120). In the context of the study, diagnosis refers to determining the nature of PTB in children under the age of five.

Paediatric tuberculosis is any person between infancy and puberty (Weller, 2000:146) diagnosed with TB. In the context of this study a child is any person under the age of five who has been diagnosed with TB.

Primary healthcare nurse (PHC) is a clinical nurse practitioner, with the additional qualification in diagnostic skills and techniques, who normally works in the clinic or health centre and deals mainly with the curative aspects of PHC (De Haan, 2005:27). In this study, the term refers to PHC nurses rendering PHC services at the clinics in the Ethekwini district.

Pulmonary Tuberculosis (PTB) is the chronic or acute, inflammatory notifiable disease affecting the lungs, caused by mycobacterium tubercles and spread through droplet infection (Nzimande, 2003:34).

Tuberculin skin test is the injection solution of purified protein derivative made from human bacillus that is used in the diagnosis of TB (Nzimande, 2003:34).

STATEMENT OF THE PROBLEM

The research problem concerns the ability and knowledge of the PHC nurse to effectively diagnose PTB in children. The PHC nurse is the first contact in the health system for the child who is infected with PTB. The inability of the PHC nurse to effectively diagnose PTB in children can result in misdiagnosis. According to the Department of Health more than 50% of children have been put on anti-TB treatment drugs unnecessarily resulting in high costs, resistance to such treatment and exposing children to lengthy

and often unpleasant treatment (Department of Health, 2000:32). The research problem led to the following questions: Do PHC nurses have adequate knowledge and skills to effectively diagnose PTB in children under the age of five? Are the PHC settings in the Ethekweni Health District in the Umlazi area equipped to diagnose PTB in children?

PURPOSE AND OBJECTIVES OF THE STUDY

The aim of the study was to identify and describe the challenges of diagnosing PTB in children. The objectives of the study were to determine whether PHC nurses in the Ethekwini district have adequate knowledge to effectively diagnose PTB in children and whether the PHC clinics are sufficiently equipped to diagnose PTB in children.

Significance of the study

The findings of this study could have major policy and training implications for PHC nurses in KwaZulu-Natal. This may result in early diagnosis and treatment with improved levels of care to children with PTB. Moreover, the findings could also lead to more effective notification of PTB in children.

LITERATURE REVIEW

Guidelines available to assist with the diagnosis of PTB in children

The Department of Health supplies all the healthcare facilities with copies of Tuberculosis: a Training Manual for Health Workers (DoH, 1998) and the South African Tuberculosis Control Programme: Practical Guidelines (DoH, 2000; 2004; 2008) to help healthcare workers with the management of TB. The Communicable Disease Control Coordinators in the various health districts are responsible for ensuring that health facilities have the supportive materials.

History of symptoms and history of contact

There are no definite physical symptoms on physical examination that can authenticate PTB in children. PTB should always be suspected if the child coughs or wheezes for more than three weeks with chest pain, fails to recover from a chest infection after a course of antibiotics, fails to gain weight despite correct nutrition, has diarrhoea and vomiting, lives in a household with a PTB source case, has an audible wheeze that does not respond to broncho-dilators and has two or more episodes of fever without any obvious cause (DoH, 2004:47).

Physical examination

On physical examination a child with TB may present with fever, tachycardia, signs of wasting or weight loss, an audible wheeze, cyanosis, swelling and tenderness of the lymph nodes, enlargement of other body organs, particularly the liver or spleen, clearly

visible ribs due to wasting, unequal chest movements if one of the lungs has collapsed and failure to gain weight (DoH, 2000:32). Other physical signs that necessitate additional investigations to rule out extra-pulmonary TB in children are meningitis that does not respond to antibiotic treatment, with increased intracranial pressure, pleural effusion, pericardial effusion, distended abdomen with ascites, non-painful enlarged joints and signs of tuberculin hypersensitivity for example phlyctenular conjunctivitis (presenting with small vesicles on the conjunctiva) (WHO, 2006:1093).

Skin testing for TB

The tuberculin skin test measures the body's immune response to tuberculin purified protein derivative. The tuberculin test should be interpreted within the context of clinical features, chest X-rays and the possibility of exposure to PTB infection. There are two types of tuberculin skin tests, the Mantoux and the Mono or Tine tests (DoH, 1998:85).

The Mantoux test is the tuberculin skin test that is commonly used in the PHC settings at Ethekwini Health District. It is injected intradermally into the anterior aspect of the forearm. The results are read within 48–72 hours after the injection. The positive result of the test is determined by the diameter of the skin in-duration at the site of the injection which is measured in millimetres across the arm at the widest point of the raised thickened area in-duration (DoH, 2008:64).

The Mono and Tine tests are tools that are impregnated with purified protein derivative and are only pressed into the skin of the fore-arm. The results of the Tine test are measured by the amount of blistering. The results of the Mono tests are measured by the diameter of the reaction across the arm at the widest point of the in-duration and are recorded in millimetres.

Sensitivity of the tuberculin skin test is low in children with active PTB and even lower in children with severe forms of disseminated TB, malnutrition or HIV infection and other infections like measles, rubella and whooping cough and when the child is on immuno-suppressive drugs such as steroids and cancer treatment. The health worker needs skills to perform and interpret the test results of the tuberculin skin test, which are available 48–72 hours after the test. Children need to revisit the health facility within 72 hours for reading the tuberculin skin test results (Liberschuetz, Bamber, Ewer, Deeks, Pathan and Lalvani, 2004:2197). According to Shingadia and Novelli (2003:28) the tuberculin skin test is not recommended for children under the age of 6 years who were previously vaccinated with BCG because of the likelihood of false positive results.

The scoring system

The paediatric PTB score chart is recommended by the World Health Organization to improve the diagnosis of PTB in children. It is a screening tool used in developing countries where diagnostic tests, like the tuberculin skin test and chest x-rays are not widely available to identify children with suspected PTB for further diagnostic investigations. Features such as weeks of illness, low weight for age percentage, family

history of TB, tuberculin test, unexplained fever and night sweats are ranked and assigned scores on the score sheet for each child. A score of 7 or more indicates a high likelihood of PTB in children (Sant'Anna, Santos & Franco, 2004:308)

Radiological examinations

A chest X-ray is not a reliable diagnostic tool for active PTB (De Villiers, Andronikou & Van der Westhuizen, 2004:148). X-rays are easily misinterpreted; the person reading the X-ray needs to have expertise and X-rays are not always available in high burden countries like South Africa. The use of a computerised tomography scan is reported to be of benefit for improving the diagnosis of PTB in children. The limitation of computerised tomography scans is that they are expensive and their use has not been validated (Zar, 2007:983). Computerised tomography scans can clearly show adenopathy, which is easily misinterpreted in children. In KwaZulu-Natal the computerised tomography scan is available in most referral hospitals but is not used to diagnose PTB in children.

Laboratory tests

Different bacteriological tests for confirmation of TB can be done. The **acid-fast bacilli** or sputum microscopy is the test done to identify mycobacterium tuberculosis in the sputum by means of staining**.** PTB in children is usually smear negative because PTB in children is paucibacillary (produces few micro-organisms and this leads to both over- and under-reporting of PTB in children (Oludiran, Eziuka, Mayowa, Ajani & Kikelemo, 2008:129).

The **TB culture** is a diagnostic test in which the bacterium is grown in a sputum specimen on a special medium in the laboratory. The TB culture detects more TB cases than the smear microscopy because it needs few micro-organisms to yield positive test results. The limitation of the TB culture is that the results are only available after four weeks (Ndjeka, Matji and Ogunbanjo, 2008:46).

The **Polymerase Chain Reaction** can be used to rapidly detect mycobacterium tuberculosis in children because children produce fewer mycobacterium tuberculosis bacilli than adults. Specimens suitable for polymerase chain reaction are sputum, gastric washings, cerebrospinal fluid, blood, tissue biopsies, saliva, urine, and stools. Polymerase chain reaction detects fewer TB cases than cultures and can yield false positive results (Zar, 2007:895).

Sputum induction is a procedure by which children are nebulised with sterile water for about 15 minutes. Thereafter physiotherapy is done in order to loosen the respiratory secretions. Sputum is then obtained by either expectoration or suctioning through the naso-pharynx or oro-pharynx using a mucous extractor (Theart, Marais, Gie, Hesseling & Beyers, 2005:1212).

In **naso-pharyngeal aspiration** sputum is obtained after stimulating the cough reflex by placing a mucous extractor at the oro-pharynx level. The bronchial secretions are

then drawn into the mucous extractor before the child swallows. Naso-pharyngeal aspirations are seldom performed in resource-poor countries because they require access to mycobacterium culture techniques that are not widely available (Adams 2004:687).

Other tests include urine and stool specimens but these are rarely used. The urine and stool specimens can either be tested for TB microscopy or TB culture. The polymerase chain reaction can be used to detect mycobacterium tuberculosis in stools (Oludiran et al., 2008:127).

Clinical Algorithms

Different clinical algorithms can be used to improve the diagnosis of PTB in children (Nelson & Wells, 2004:632). According to the flow chart for the diagnosis of PTB in children (see figure 1), if the child has a fever and/or coughs for more than three weeks, with or without loss of weight or no weight gain, and has a history of contact with suspected or diagnosed cases of active TB, suspect TB and do a tuberculin skin test. If the tuberculin skin test is positive, commence TB treatment. If the clinical picture of the child does not improve after one month, refer the child to hospital for further investigations (DoH, 2000:32). If the tuberculin skin test is negative, give a course of antibiotics and review the child after 7--10 days. If the child's condition does not improve, refer the child to hospital for X-rays. At the hospital, if the X-ray is suggestive of TB, give TB treatment even if the tuberculin skin test is negative (DoH, 2000:32).

Any ill child with a history of contact with a confirmed case of PTB, not regaining normal health after measles or whooping cough, with weight loss, cough, and wheeze not responding to antibiotic therapy for respiratory infection, with painless swelling of superficial lymph nodes (Shingadia & Novelli, 2003:628) is classified as a suspected TB case (see figure 2).

Any child with a positive tuberculin skin test and chest x-ray suggestive of TB or any child with an abnormal x-ray but not diagnostic of TB and a positive tuberculin test or history of close contact with an adult PTB case, is classified as a probable TB case. Any child with a positive mycobacterium tuberculosis by culture or microscopy in the body fluids or tissues is classified as a confirmed TB case (Shingadia & Novelli, 2003:628; Donald, Fourie & Grange, 1999:157).

If the chest x-ray is abnormal but the tuberculin test is negative and there is no close contact with the PTB case, the child is treated with antibiotics. X-rays are repeated after one month. If the x-ray is still persistently abnormal, trial therapy or referral is considered for special investigation. If the x-ray is normal, the tuberculin test is negative and the child is not a contact, the child is classified as probably not TB. The child is, however, kept under surveillance and trial therapy is considered if the illness persists (Donald et al., 1999:157).

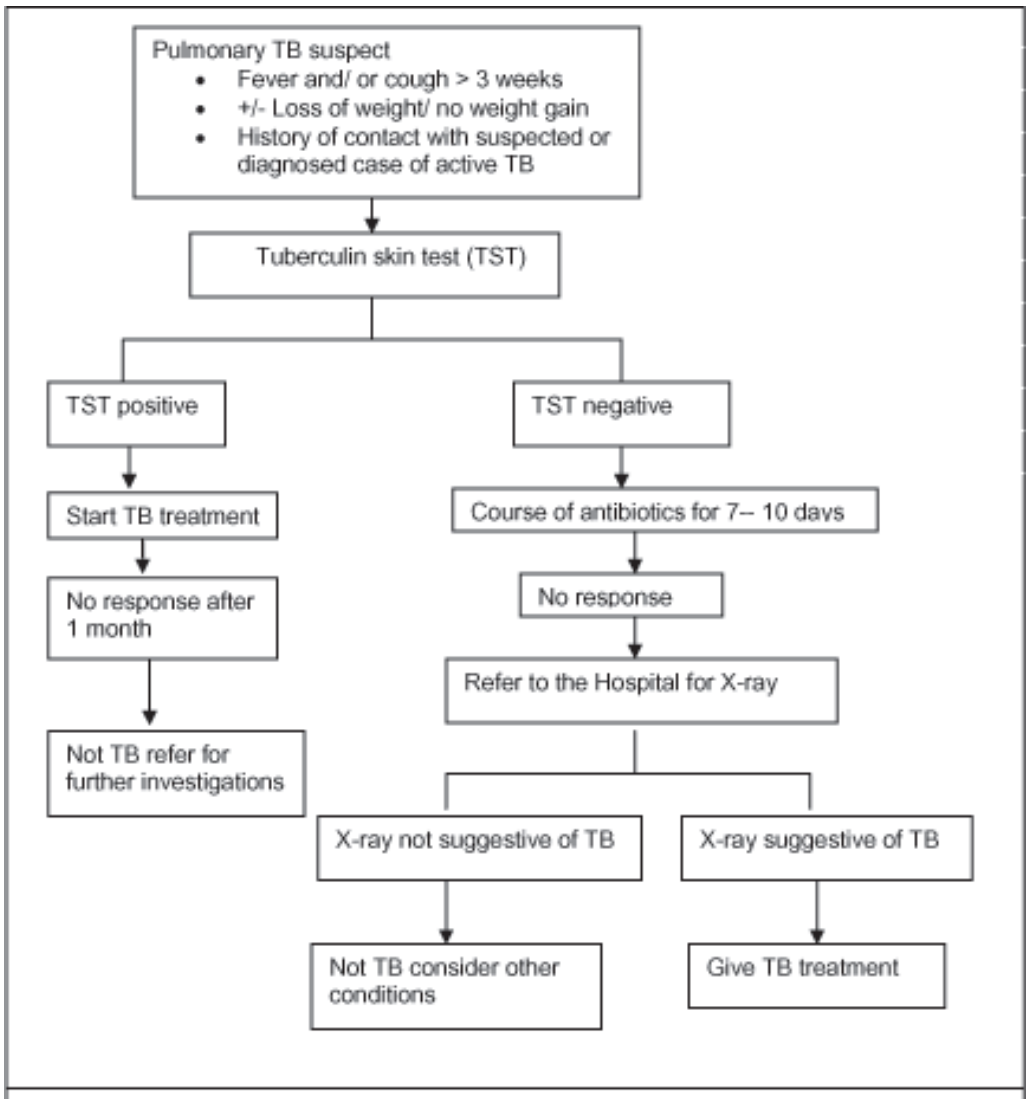

Figure 1: Flow chart for the diagnosis of PTB in children diagnostic pathways

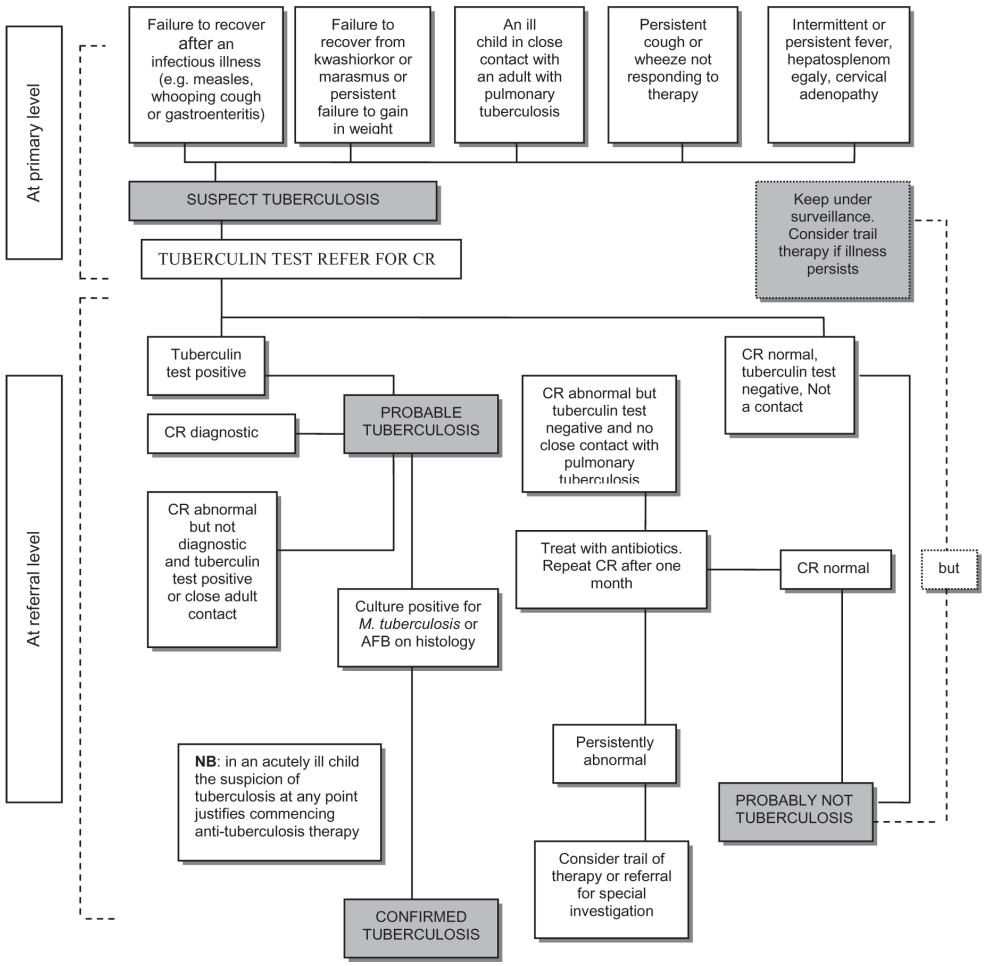

Figure 2: Diagnostic pathways (source: Donald et al., 1999:157).

RESEARCH DESIGN AND METHODOLOGY

Research design

A quantitative, non-experimental, descriptive design was used to solicit information from the population under study regarding the challenges PHC nurses encounter when they diagnose PTB in children. This type of design involves a clear description of a phenomenon within a specified population (Johnson & Christensen, 2004:302).

Quantitative research involves the collection of measurable data using structured data collection instruments (Polit & Beck, 2004:30). In non-experimental designs the manipulation of variables and random assignment to groups are excluded (Johnson

& Christensen, 2004:15). According to Polit and Beck (2008:274) "the purpose of descriptive research is to observe, describe and document aspects of a situation as they naturally occur".

Population and sample

The target population for this study comprised all PHC nurses and the accessible population was PHC nurses working at 19 clinics in the Ethekwini Health District in KwaZulu-Natal where TB patients are treated. A convenient, non-probability sampling technique was used which means selection of respondents using non-random methods. These methods permit the use of the readily available subjects which means that elements are included in the study because elements happen to be available at the place and time of data collection (Johnson & Christensen, 2004:174; Gerrish & Lacey, 2006:261).

Eligibility criteria refer to the criteria the researcher uses to include respondents in the study (Polit & Beck, 2004:290). In this study 38 professional nurses, providing PHC services at clinics in the Ethekwini Health District in KwaZulu-Natal province, were included.

Data collection

Polit and Beck (2004:354) explain a structured data collection approach as the collection of data using standardised instruments, showing what type of data should be collected with predetermined response options. In this study a questionnaire and a checklist were used as standardised data-collection instruments. A questionnaire consisting of closed-ended questions was chosen because anonymity could be ensured. A checklist is a standardised data-collection instrument consisting of questions having the same response format (Polit & Beck, 2004:354).

Research instruments

A questionnaire and a checklist were designed after exploring the available literature about the diagnosis of TB in children. The questionnaire, consisting of closed-ended questions ensured that the objectives of the study were covered. A questionnaire was used to explore the challenges faced by professional nurses when diagnosing PTB in children under the age of five. The checklist was used to gather information indicating whether the PHC settings at Ethekweni Health District's 19 clinics under Prince Mshiyeni hospital were well equipped to effectively diagnose PTB in children under the age of five. The checklist covered the availability and use of supportive material guidelines and equipment used in the diagnosis of PTB in children and was completed by the PHC nurses working at the 19 clinics involved in the research.

Validity and reliability

Reliability refers to the consistency of a data collection instrument (Gerrish & Lacey, 2006:376). Validity refers to the extent to which the instrument measures what is intended to measure (Gerrish & Lacey, 2006:375). The questionnaire and checklist were

pre-tested on professional nurses providing PHC in the hospital who were excluded from participation in the actual study.

Data analysis

Descriptive statistics were used to analyse and summarise data using ordinal and nominal scales. Frequency distributions in the form of graphic presentations were used to present data (Mare, 2007:191).

ETHICAL CONSIDERATIONS

Permission was obtained from the Provincial Department of Health in KwaZulu-Natal and ethical approval was obtained from the University of South Africa to conduct research. Informed consent was obtained from each respondent. Participation in the study was voluntary and respondents had the right to withdraw from the study at any time. Questionnaires were identified with code numbers to ensure anonymity.

DISCUSSION OF RESEARCH FINDINGS

PHC nurses' knowledge to diagnose PTB in children

Respondents had varying levels of knowledge regarding the diagnosis of PTB in children. Only 44.7% (n=17) of the respondents had received training regarding TB during the past four years. The majority of the respondents (86.8%; n=33) knew that the diagnosis of TB revolves around clinical features, chest X-rays, tuberculin skin tests and history of contact with a smear-positive adult PTB person.

Of the respondents, only 39.5% (n=15) knew that an audible wheeze that does not respond to bronchodilators is suggestive of TB in children and about 60% (n=22) knew that fever, failure to recover from a recent infection despite a course of antibiotics, and malnutrition are suggestive of PTB infection in children.

With regard to the risk of PTB in children, 63.2% (n=24) of the respondents knew that the risk of PTB infection in children in a given population depends on the number of infected TB cases in the population and on the degree of overcrowding; 36.8% (n=14) knew that the risk depends on the extent of exposure to infectious droplet nuclei, and 13.2% (n=5) knew that the risk depends on the number of children under the age of five in the given population.

Although 94.8% (n=36) of the respondents, performed a tuberculin skin test when they suspected PTB in children, which is correct according to the Department of Health (1998:86), most of the respondents showed gross knowledge deficits regarding the interpretation of the tuberculin skin test in diagnosing PTB in children. Of the respondents, 55.3% (n=21) knew that HIV infection could give false negative results; 47.4% (n=18) knew that malnutrition, steroids, cancer treatment and disseminated

TB suppressed the tuberculin skin test. Of the respondents, 94.8% (n=36) referred all children with a doubtful tuberculin skin test to the hospital for diagnosis.

There is a risk of under-reporting of childhood PTB because only 34.2% (n=13) of the respondents used the TB register to record child PTB cases. Of the respondents, 84.2% (n=32) did not use the paediatric flow chart; 8% (n=6) could effectively use a score chart. Of the respondents, 89.5% (n=34) evaluated children who were not gaining weight for PTB; 92% (n=35) knew that TB is associated with overcrowded living conditions, and 89% (n=34) knew that TB is associated with malnutrition.

BCG immunisation was the only TB prevention strategy familiar to 78.9% (n=30) of the respondents; 39.5% (n=15) knew about chemoprophylaxis of child contacts of infectious TB cases, a functional TB control programme and treating smear-positive TB adult cases can effectively prevent PTB infection in children. Of the respondents, 73.7% (n=28) knew that children could not produce sputum; 23.6% (n=10) knew that sputum results are often negative in children, and 21.1% (n=8) performed sputum induction/ gastric washing.

PHC clinics' equipment to diagnose PTB in children

A cough register, which could make it easy for the PHC nurses to identify children with chronic coughs so that these children could be further investigated for PTB, was available in only 57.9% (n=11) of the clinics. Only 52.6% (n=10) of the clinics had a fast lane for coughing patients. In 26.3% (n=5) of the clinics, home visits to identify and treat child contacts of adult smear-positive TB cases were not done.

Of the clinics, 94.7% (n=18) had the South African TB Control Programme Practical Guidelines (DoH, 2000/4) while only 57.9% (n=11) had the Training Manual for Health Workers (DoH, 1997/8). None of the clinics used the paediatric TB flow chart suggesting treatment pathways for children with possible TB (Donald et al., 1999:157).

Of the clinics, only 26.3% (n=5) used the TB score system for the diagnosis of PTB in children even though the system is recommended in the *South African National Guidelines for the Management of TB* and 10.5% (n=2) used the flow diagram to help PHC nurses identify and manage child contacts of adult TB cases.

All the clinics had transport to take sputum specimens to the laboratory and tuberculin skin test kits in stock; none of the clinics had X-ray facilities, only 5.3% (n=1) had all the necessary equipment in stock to perform gastric washing/sputum induction. None had hospital transport to take children to hospital for X-rays. TB medicines for treating PTB in children were rarely out of stock.

CONCLUSION

The PHC nurses did not have sufficient knowledge to successfully diagnose PTB in children and the clinics were not adequately equipped to effectively diagnose PTB in

children. A plan of action by the Department of Health to improve the diagnosis of PTB children in these clinics is required.

RECOMMENDATIONS

Improvement of PTB diagnosis in children

Regular in-service training programmes should be provided on the diagnosis and management of PTB in children to keep PHC nurses abreast of new developments and to ensure that quality care is rendered to children**.** Regular audits of TB records by the clinic supervisors/TB co-ordinators should be done to identify and address shortcomings in the management of PTB in children. Protocols for the diagnosis and management of PTB in children should be simplified, and these should be included in student nurses' curricula.

All PHC clinics should have adequate supplies of standard equipment, surgical supplies and diagnostic materials to diagnose PTB in children.

Recommendations for further research

Improved methods of facilitating the diagnosis of PTB in children should be developed. The evaluation of a TB score system would be useful for diagnosing PTB in children in specific areas of South Africa where the incidence of HIV and/or malnutrition is high.

LIMITATIONS OF THE STUDY

The study focused only on 19 clinics in the Ethekwini district, in KwaZulu-Natal. Therefore, the findings cannot be generalised to the whole Ethekwini district and/or other areas.

REFERENCES

Adams, L.V. 2004. Childhood tuberculosis in the developing world. *Paediatric Annals,* 33 (10):685–691.

De Haan, M. 2005. *The health of Southern Africa*. 9th Edition. Cape Town. Juta.

De Villiers, R.V.P., Andronikou, S. Van der Westhuizen, S. 2004. Specificity and sensitivity of chest radiographs in the diagnosis of paediatric PTB and the value of additional high-kilovolt radiographs. *Australasian Radiology,* 48:148–153.

DoH – see Department of Health of South Africa.

Department of Health.1998. *Tuberculosis: a training manual for health workers.* Pretoria.

Department of Health. 2000. *The South African Tuberculosis control programme: practical guidelines.* Pretoria.

Department of Health. 2004. *The South African Tuberculosis control programme: practical guidelines.* Pretoria.

Department of Health. 2008. *The South African Tuberculosis control programme: practical guidelines.* Pretoria.

Donald, P.R., Fourie, P.B. & Grange, J.M.1999. *Tuberculosis in childhood*. Pretoria: Van Schaik.

Gerrish, K. & Lacey, 2006. *The research process in nursing.* 5th Edition. London: Blackwell.

Johnson, B. & Christensen, L. 2004. *Educational research. Quantitative and qualitative approaches.* 7th Edition. Boston: Allyn & Bacon.

Liberschuetz, S., Bamber, S., Ewer, K., Deeks, J., Pathan, A.A. & Lalvani D.M. 2004. Diagnosis of tuberculosis in South African children with a T-cell based assay: a prospective cohort study. *The Lancet,* 3649(9452):2196–2202.

Mare, K. 2007. *First steps in research.* Paarl: Van Schaik.

Nelson, L.J & Wells, C.D. 2004. Global epidemiology of childhood tuberculosis. *International Journal of Tuberculosis & Lung Diseases,* 8(5):637–647.

Ndjeka, N.O., Matji, R. & Ogunbanjo, G.A. 2008. An approach to the diagnosis, treatment and referral of tuberculosis patients: The family practitioner's role. *South African Family Practitioner,* 50(4):44–50.

Nzimande, P.N. 2003. *Communicable diseases in the African Continent.* 2nd Edition. Durban: Universal Printing.

Oludiran, K.A., Eziuka, O.R., Mayowa, I.O., Ajani, B.R & Kikelemo, O. 2008. Bacteriology of childhood tuberculosis in Ibadan, Nigeria: a five-year review. *Tropical Medicine and Health,* 36(3):127–129.

Polit, DF. & Beck, CT. 2004. *Nursing research: principles and methods.* 7th Edition. Philadelphia: J.B. Lippincott.

Polit, D.F. & Beck, C.T. 2008. *Nursing research: generating and assessing evidence for nursing practice.* Philadelphia: Lippincott Williams & Wilkins.

Sant'Anna, C.C., Santos, M.A.R.C & Franco. R. 2004. Diagnosis of pulmonary tuberculosis by score system in children and adolescents: a trial in a reference center in Bahia, Brazil. *The Brazilian Journal of Infectious Diseases,* 8(4):305–310.

Shingadia, D. & Novelli, V. 2003. Diagnosis and treatment of tuberculosis in children. *The Lancet Infectious Diseases,* 3:624–632

Theart, A.C., Marais, B.J., Gie, R.P., Hesseling, A.C. & Beyers, N. 2005. Criteria used for the diagnosis of childhood tuberculosis in primary health in high burden urban setting. *International Journal of Lung Diseases,* 9(11):1210–1214.

Weller, B.F. (ed). 2000. *Bailliere's nurses' dictionary.* 23rd Edition. London: Baillière Tindall.

WHO – see World Health Organization

World Health Organization. 2003. *Treatment of tuberculosis: guidelines for national programmes.* 3rd Edition. WHO/CDS/TB/2003.313. Geneva.

World Health Organization. 2006. *Guidance for national tuberculosis programmes on the management of tuberculosis in children.* WHO/HTM/TB/2006.371.Geneva.

Zar, H.J. 2007. Diagnosis of pulmonary tuberculosis in children – what's new? *South African Medical Journal,* 97(10):983–5.