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Diagnosis of Pulmonary Tuberculosis in Children

by

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Abstract

1. *A definite diagnosis of tuberculosis can only be established on the basis of the finding of the tubercle bacilli.*
2. *The isolation of the mycobacterium tuberculosis from a child is subject to difficulties:*
   a. *the necessity of gastric lavage for 3 consecutive days, which is difficult to perform ambulatory.*
   b. *the necessity of the proper facilities of a microbiologic laboratory.*
   c. *the outcome is often not sufficiently high.*
3. *It is concluded that at the moment making of the bacteriological diagnosis of child tuberculosis is not practical, so that we are forced to depend on the clinical diagnosis.*
4. *The tuberculin test is very important in establishing the diagnosis. It is recommended to perform this test routinely on every child once a year and also that every medical doctor as well as specialist performs this test to detect a case of TBC at the earliest possible moment.*

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5. *It is greatly recommended to improve the tuberculin solution by the administration of a buffered solvent and Tween 80 which are already commonly used abroad.*

6. *Another recommendation is the finding of the source of infection in all adults with whom the child with TBC associates. Also the examination of all children who come into contact with a TBC patient is recommended.*

7. *It is advisable to perform a routine check-up once a year on all adults whose activities are closely related to children, e.g. teachers, nurses, trainers, etc.*

8. *BCG vaccination complicates the interpretation of a tuberculin test.*

9. *Due to the fact that source of infection at this moment is still prevalent and BCG is administered directly, there is still the possibility of tuberculosis in children with a BCG scar, even though BCG was administered during the neonatal period.*

Introduction

Tuberculosis is classified into two types

a. Primary tuberculosis: primary effect/complex with its complications.

b. Post primary tuberculosis.

Primary tuberculosis is most common found in children, but post primary TBC is more rarely seen in children. In this paper primary tuberculosis will be further discussed. There is a significant difference between primary TBC and post primary TBC. In primary TBC a hematogenous dissemination process to other parts of the body might occur in the very beginning; it could even happen before the development of a hypersensitivity to tuberculin. In post primary TBC the process is more restricted to the lungs, where the distribution is bronchogenous. It is for this reason that primary TBC as a disease, which is not without danger, necessitates the establishment of a diagnosis at the earliest possible moment. Moreover, primary TBC is never to be underestimated even if there are indications minimal or no abnormalities on the chest roentgenogram. This, because of the possible occurrence of complications, is not determined by the severity of the lung abnormalities.

Review of diagnostic elements

A. Anamnesis

B. Evidence of the source of infection

C. Physical examination

D. Mantoux test

E. Roentgenogram

F. Bacteriological examination

A. Anamnesis. The diagnosis of TBC is made by assumption, that complaints commonly encountered are : long-lasting fever, chronic cough, loss of weight, loss of energy, etc. These symptoms point to TBC but they are not pathognomonic. Haemoptoe is rare among children. Our patients showed only 0.7% with haemoptoe.

B. Evidence of the source of infection. Since we are dealing with primary TBC the source of infection should have occurred several months before, so that during the examination no source of infection could be determined. The evidence of the source of infection is very helpful in determining the diagnosis, so that it is very important to examine every adult with whom the child has been in close contact. Also all children who have been in contact with a known adult TBC patient have to be examined. It is not uncommon to find children with TBC, whose parents are treated at BP4 or at Puskesmas (Public Health Centers), while their children have never been examined or vaccinated. It is worthwhile to perform a routine check-up once a year on all adults who have a close con-

tact with children, for instance teachers, nurses, servants, etc.

Finding the source of infection has two significances:

1. important in determining the diagnosis, and
2. necessary for the success of the therapy (it should be isolated and treated simultaneously).

C. Physical examination. Primary TBC is mostly asymptomatic; its symptoms are usually rather obscure. When symptoms are manifest, usually the process is already far advanced or complications have already appeared, such as pneumonia, emphysema, atelectasis, pleural effusion, etc. These abnormalities are not pathognomonic for Koch Pulmonum, because they can be caused by various reasons. As primary TBC can disseminate very easily, we have to look in physical examination for extrathoracic tubercular lesions, e.g. scrophuloderma, glandular enlargement, cold abscess, TBC of the bones and joints, serous meningitis, tubercle in the choroid plexus of the eye, conjunctivitis phlyctaenularis, etc.

D. Mantoux test. The Mantoux test is very important in determining the diagnosis of tuberculosis in children. In performing the Mantoux test routinely, TBC in children can be detected at the earliest possible moment. As a standard PPD 5 TU or OT 0.1 is used.

Interpretation of the results of the Mantoux test:

a. Induration of 10 mm or more = positive reaction.
   Clinically it means that a person is or has been infected by the M. tuberculosis.

b. Induration of 5 mm to 9 mm = doubtful reaction.

   Clinically it means a possible error or an infection by M. tuberculosis or a cross reaction with an atypical mycobacterium, or post BCG vaccination. It is necessary to repeat the test with the same concentration. If the second reaction becomes 10 mm or more than it means an infection by the M. tuberculosis. If it remains 6-9 mm it means a cross reaction or post BCG vaccination; if it is 6-9 mm but accompanied by other clear indications of TBC then it has to be regarded as a possible infection by M. tuberculosis.

c. Induration of 0 to 4 mm = negative reaction.
   Clinically it means that there is no infection by the M. tuberculosis; repetition is unnecessary, except if there is a strong suspicion of the presence of tuberculosis.

   The use of OT 1 mg or PPD 250 TU is considered to be very useful especially for the need of mass case-finding, despite the possibility of a non-specific reaction

(Liem Tjai Tie, 1955). A positive Mantoux test usually indicates TBC in the present or in the past. A positive Mantoux test indicates an active infection of TBC if:

a. the patient is less than 3 years of age and has not receive a previous BCG vaccination and anti TBC therapy. This is based on the assumption that the process of primary TBC will clinically recover in 3-5 years.

b. there is a conversion of the Mantoux test from negative to positive during the last year and the patient has neither received any BCG vaccination nor anti TBC drugs. The interpretation of conversion is actually also difficult. Generally if a negative Mantoux test becomes positive it is considered as a conversion. But when a Mantoux test of 9 mm changes into 10 mm, is it then considered as a conversion? This should be considered because of the possibility of error in reading the Mantoux reaction which ranges between 1 - 2 mm. Griep (1960) found that a Mantoux conversion only becomes significant if the first Mantoux test produced an induration of 0 to 2 mm, and has increased at least 10 mm. Generally, after finding a positive Mantoux test, we have to determine whether the process is active or non-active by observing the signs of activity of the TBC process, which are the presence of acid-fast bacilli, infiltration or swelling of the glands on the X-ray photo, longlasting-fever which is not caused by other processes, loss of weight, a high BSR, and loss of energy.

The following must also be kept in mind:

— False positive reaction: a positive Mantoux test reaction without any previous infection of TBC; it can be found in infections by an atypical mycobacterium, or after BCG vaccination.
— False negative reaction: a negative Mantoux reaction even if there is or has been an infection of TBC; it can be found in the following conditions:
  * pre-allergic period: 2-10 weeks
  * severe TBC: meningitis, miliary TBC
  * severe malnutrition (kwashiorkor)
  * dehydration
  * morbilli, lasting from 10 days to 6 weeks
  * pertussis
  * morbilli vaccination, also lasting from 10 days to 6 weeks
  * severe rubella, for 1-3 weeks
  * typhus abdominalis

* diseases accompanied by high fever
* administration of corticosteroid
* administration of immunosuppressive drugs

Due to the presence of a pre-allergic period lasting about 2-10 weeks, a person is said to be free of infection if the repetition of his Mantoux test produces a negative results as early as 10 weeks after separation from the source of infection (Kendig, 1972). A tuberculin test can only be well evaluated if it is performed according to some specific requirements.

Storage and delivery of tuberculin materials must be in a refrigerated condition. For Alt tuberculin PN Biofarma Bandung recommends storage in a temperature of about 4°C. But unfortunately enough the delivery of this material from Bandung to Surabaya has been done in plain cartons and carried on trucks so that protection from the heat of the sun was unlikely. The use of a proper solvent must also be observed : isotonic phosphate buffered saline with a pH of 7.38; and the utilization of stabilizer Tween 80 (0.0005% of polyoxyethylene sorbitan monooleate) to prevent the lowering of tuberculin concentration due to the absorption of the glass or plastic container (Landi et al., 1971).

Unfortunately, these two substances are not distributed along with tuberculin available here. To cope with the tuberculosis problems mentioned above we only use fresh tuberculin solution and only for approximately 4 hours (8 to 12 a.m.). Examination of the Mantoux test should be done routinely by every doctor on every child in order to detect TBC as early as possible, starting at the age of 6-8 months and afterwards repeated once a year. When there is a contact with an infectious source a Mantoux test should be performed immediately, and if the result is negative it must be repeated after 10 weeks; and if the subject remains in close association with the source then a Mantoux test is to be repeated every three months.

TABLE I : *Mantoux test performed on 857 children with TBC at the Dr. Soetomo Hospital, Surabaya (1971 - 1974).*

	Total patients	Miliary TBC	Meningitis	Bone & joint TBC
Positive Mantoux test	809 (94.4%)	45 (52.9%)	73 (85.9%)	97 (99.0%)
Negative Mantoux test	48	40	12	1

The above table shows that 94.4% of the patients had a positive Mantoux test. Only 52.7% of the patients with miliary TBC had a positive test due to the severe TBC and most of them were also malnourished.

The interpretation of the Mantoux test of children who have had BCG vaccination is a difficult problem. It is known that the measurement of the induration of a Mantoux test post BCG vaccination is variable (Raju, Mehta, 1970). For the sake of establishing a diagnosis, it is necessary to know whether a Mantoux test post BCG vaccination can still be used to determine whether there is an active infection of M. tuberculosis or just a BCG vaccination. Kendig (1972) stated that BCG generally produces an induration between 5 - 9 mm. If the induration exceeds 15 mm the presence of an active infection should be suspected. Lotte (1971) carried out investigations in several European countries and found that if the difference of the measurements of post-BCG Mantoux induration exceeds 18 mm, it indicates an active infection.

Hasan and Han Sik Liang (1964) in a sample survey carried out in the Malang district found that 65% of Mantoux test post-BCG gave an induration of 10-15 mm, whereas 35% gave an induration larger than 15 mm. According to Blicker (1966), a post-BCG Mantoux test produced a variability of indurations ranging from 0 - 20 mm. They formed a unimodal curve so that it was impossible to differentiate between positive and negative or between a M. tuberculosis infection and BCG. Azuma (1972) also said that the measurements of indurations of post-BCG Mantoux tests were variable, i.e. causing difficulties to evaluate the tests after BCG vaccination. There were 115 TBC patients with a BCG scar.

TABLE 2 : *BCG scar on tuberculosis patients*

	No. of patients	Miliary TBC	Meningitis	Bones & joints TBC
BCG scar +	115 (13.4%)	8 (9.4%)	5 (5.9%)	19 (19.44%)
BCG at neonatal period	7	0	0	0
BCG scar —	742	77	80	79
T o t a l	857	85	85	98

This table - 2 shows that the presence of a BCG scar in a child does not exclude the possibility of the diagnosis of TBC, even severe complications might be found as well. A BCG vaccination during the neonatal period could also not exclude the diagnosis of TBC. This is due to the fact that BCG is performed directly without any pretesting. So there is the possibility that the child may have been suffering from TBC before vaccination or is in the incubation period or that during the incubation period of BCG the child gets infected by the M. tuberculosis. This might happen to anyone who have already been vaccinated in the neonatal period. Our 7 patients with neonatal BCG have their source of infection from the homes where they were cared for. Besides there is the possibility that the BCG vaccination has not been effective.

TABLE 3 : *Mantoux test performed on 115 TBC patients with BCG scar.*

Mt	—			3
Mt	0.1 mg	10-14	mm	14
		⩾ 15	mm	88
		⩾ 20	mm	59
Mt	1 mg	10-14	mm	3
		⩾ 15	mm	7
		⩾ 20	mm	3

From table-3 it appears that the post-BCG Mantoux test performed on children with Koch Pulmonum, for the greater part had an induration larger than ⩾ 15 mm, and many of them even ⩾ 20 mm. Unfortunately we have been unable to find the results of their Mantoux test before they got BCG vaccination.

E. Roentgenograms. Chest X-ray photo should be made in PA and Lateral projection on the first examination, and this procedure should be done technically with the best possible methods. There could be different kinds of abnormalities in the X-ray photos, depending on the type of the primary TBC, such as: pneumonia, swelling of the glands, atelectasis, emphysema, pleural effusion, etc. From the X-ray photos we could have a strong suspicion of the presence of TBC, only if there is a miliary spread or swelling of the paratracheal gland with or without infiltration. Other X-ray abnormalities are not specific, they could be caused by TBC, virus, non-specific microorganisms, or fungi. So generally a diagnosis of TBC cannot be established based on the roentgenogram alone. Even a normal X-ray photo will not exclude the possibility of the presence of TBC.

Zarabi (1971) found that 43% of his meningitis patients showed normal chest X-ray photos. Normal X-ray photos were also found in 8% of our meningitis patients. Emery (1950) discovered that only one-third of the patients with miliary TBC (on autopsy) had

shown a miliary spread on their X-ray photos. Unfortunately many people in practice still think that they can establish the diagnosis of TBC based on abnormalities in the chest X-ray photos alone. High (1969) said that a roentgenogram is a valuable aid in establishing the diagnosis of TBC, but it can also cause confusions if not accompanied with more complete data.

F.Bacteriology. A definite diagnosis of TBC can only be established if acid-fast bacilli have been found. The examination of sputum on children is not successful, mainly because the sputum is directly swallowed and the amount of microorganisms in children is usually not large. This necessitates gastric lavage to be carried out in the morning for 3 consecutive days. Cultivation of the microorganisms is required, since a direct smear is not sufficient. Therefore proper facilities of a bacteriologic laboratory are needed, which require a lot of expenses. Nevertheless the results of the cultivation are also unsatisfactory.

Kendig (1972) found that through the best laboratory facilities 50-90% positive results could be made, whereas with moderate laboratory facilities only 25-35% were found. This means that when using the criteria of positive acid-fast bacilli to declare that a child is suffering from TBC, we might loose some 10-75% of TBC patients in children. To make a diagnosis of primary TBC bacteriologically will be unpractical. Thus the criteria of a TBC case employed by a TBC control program cannot be applied at random on child patients. Therefore, establishing a clinical diagnosis is most important, even if this type of diagnosis has its disadvantages.

These basic principles for TBC diagnosis can be used as a standard. Conditions which could indicate the presence of TBC, but which have not yet fulfilled the requirements, are often encountered. In such a case a follow-up of the patients is very important; a repeated evaluation is necessary after some time.

Survey on 857 children treated in the Pediatric Department of Dr. Soetomo Hospital, Surabaya, 1971 - 1974 :

Source of infection present	55%
Physical TBC	39%
Positive Mantoux test	94%
X-ray photo: — glandular enlargement with or without infiltration	70%
— infiltration	28%
— normal	2%

Bacteriology: not routinely done

This table shows that the Mantoux test and the roentgenogram are very important and are adequate in establishing a diagnosis. The source of infection is found to be only 55% positive. This may still be improved if

exploration of the family is carried out more intensively. In our department bacteriological examination has not yet become a routine procedure, due to the fact that the facilities of our bacteriologic laboratory are still inadequate for serving this purpose.

TABLE 4 : *The basic principles for the diagnosis of tuberculosis*

1. acid-fast bacilli	+	active TBC
2. Mantoux test	+	active TBC
X-ray photo	+	
symptoms	+/—	
3. Mantoux test	+	infected by TBC
X-ray photo	—	
symptoms	—	
⩽ 3 years old and/or conversion		
4. Mantoux test	—	active TBC
X-ray photo: miliary spread paratracheal gland	>	
symptoms	+	
contact person	+	
5. Mantoux test	+	non-active TBC
X-ray photo	—	
contact person	+	
symptoms	—	
> 3 years old		
6. BCG	+	active TBC
acid-fast bacilli	+/—	
Mantoux test	+	
X-ray photo: miliary spread paratracheal gland	>	
symptoms	+	
contact person	+	

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