



## CHEST X-RAY IN HUMAN IMMUNODEFICIENCY VIRUS (HIV) INFECTED-PEDIATRICS: A CASE SERIES REVIEW

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### Abstract

In 2017, Indonesia had 4.950 new cases of HIV infection in pediatrics. In HIV, a chest x-ray is generally used to determine the Opportunistic Infections (OIs) to accelerate treatment. There are differences in the projections and the typical features on chest x-ray in each OI. The research aims to study the projections and the role of pediatric chest x-ray examination in HIV. This is a descriptive qualitative research design with a case series. In this series, 5 pediatric patients with HIV infection are described with tuberculosis, pneumonia, and bronchiectasis. A chest x-ray in pediatrics is the most accessible investigation for respiratory disease and has an important role in the initial assessment and the follow-up of respiratory disease in HIV-infected children. It is recommended that a pediatric chest x-ray should be carried out with PA projection to obtain more optimal results. Pediatrics with clinical HIV infection can employ chest x-rays to find typical features of bilateral hilar adenopathy in cases of TB, focal and multifocal parenchymal abnormalities in cases of pneumonia, or dilated and thickened airways that appear as ring shadows or tramways in bronchiectasis.

**Keywords:** chest x-ray; HIV; pediatrics; opportunistic infections

### 1. Introduction

Human Immunodeficiency Virus (HIV) is the virus that causes Acquired Immune Deficiency Syndrome (AIDS). The disease is characterized by infection and destruction of CD4+ T lymphocytes, and severe immunodeficiency leading to opportunistic infections, secondary neoplasms, and neurologic manifestations. Opportunistic infections that occur include mucous candidiasis pneumonia, disseminated Cytomegalovirus (CMV) infection, severe oral and perianal herpes simplex, and disseminated infections of Mycobacterium tuberculosis and atypical Mycobacterium (Mycobacterium avium intracellulare). HIV transmission occurs due to the exchange of blood or body fluids containing the virus or virus-infected cells, such as sexual contact, parenteral injections, and transmission of the

virus from an infected mother to a newborn child (Kumar, Abbas, and Aster, 2013).

An estimated 2.1 million (1.7-2.6 million) children were living with HIV globally in 2016, with less than 50% of these children receiving antiretroviral therapy (ART). Although continuing to decline, in 2016 there were still 160,000 new infections and 120,000 deaths in children (Penazzato et al, 2018). According to data from WHO, Indonesia ranks as the seventh-highest pediatric HIV population, with an estimated 4,950 new pediatric infections occurring annually, or about 3% of the total number of pediatric new infections worldwide (WHO, 2017).

A chest x-ray is the most accessible investigation for respiratory disease and has an important role in the initial assessment and the follow-ups of respiratory disease in HIV-infected children (Pitchers, Beningfield, and Zar, 2015). A chest x-ray is useful for evaluating structural or post-infectious changes, parenchymal opacities, nodules, hyperinflation, or extensive

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bronchiectasis. However, this examination is not sufficient for diagnosing small airway diseases for which High-Resolution Computed Tomography (HRCT) can be used (du Plessis, Andronikou and Zar, 2020).

Covering the area between the neck and abdomen, the chest encloses the great vessels, heart, and lungs and allows structures to pass between the head and neck superiorly and the abdomen, pelvis, and lower legs inferiorly (Hansen, 2019). Lungs are the main organs in the respiratory system, which aim to oxygenate the blood. The oxygen in the air reaches the lungs by passing through a series of respiratory tracts that also function to remove carbon dioxide released from the blood (Seshayyan, 2016).

A pediatric chest x-ray examination is done on subjects aged 0 to 14 years old (y.o.) to assess the condition of the lungs, thorax bones, and soft tissues of the chest wall (Lampignano and Kendrick, 2018). Pediatric ages are categorized into infants (0-1 y.o.), children (1-10y.o.), and adolescents (11-19y.o.) (Hardin and Hackell, 2017); (WHO, 2013). Pediatric radiography is an examination that requires careful handling. Pediatric chest x-ray examination can be performed with anteroposterior (AP), posteroanterior (PA), and lateral projections (Lampignano and Kendrick, 2018); (Wei, Tsai, and Wu, 2016); (Oninla *et al.*, 2016); (Jouego *et al.*, 2018); Nguyen *et al.* (2018); (Shrestha *et al.*, 2013).

Radiographic features of HIV-positive chronic lung diseases in pediatrics and adolescents on ART include 1) bronchiolitis obliterans (marked by hyperinflation), 2) bronchiectasis (characterized by ring and tram densities with and without thickening of the bronchial walls), 3) asthma (characterized by hyperinflation in the acute setting), Tuberculosis (characterized by perihilar and/or mediastinal lymphadenopathy), 4) Chronic Obstructive Airway Disease (COAD) (characterized by hyperinflation and increased bronchovascular signs), and 5) pneumonia (characterized by focal and multifocal parenchymal abnormalities) (du Plessis, Andronikou and Zar, 2020). Current

knowledge about the characteristics of chest x-ray for chronic respiratory disease in HIV-infected children can assist in the clinical management of children (Pitchers, Beningfield, and Zar, 2015).

In terms of pediatrics with HIV, a chest x-ray examination can be used to see the typical figure of TB (Oninla *et al.*, 2016; Jouego *et al.*, 2018; Nguyen *et al.*, 2018), visualize its typical features of pneumonia (Nguyen *et al.*, 2018; Wei, Tsai, and Wu, 2016), and also its bronchiectasis characteristic (Shrestha, Basnet, and Kanskar, 2013). Based on the previous findings, the authors are interested in studying more deeply chest x-ray projections, their role in pediatrics with clinical HIV infection, and the characteristics of each HIV OIs.

## 2. Method

This research is a descriptive qualitative research design with a case series review. The keywords in this study using "Chest X-Ray", "CXR", "diagnosis finding", "case report", "HIV infected", "radiographic features" and "children". The database or search engine is from Google Scholar, PubMed, ProQuest, ScienceDirect, and BMC. The inclusion criteria used are full-text articles published in English between 2011-2021, the pediatric age range of 0-14 years, and HIV in pediatrics with respiratory or pulmonary infection or disease. The exclusion criteria are literature review, letters to the editors, and articles that were the result of research using ultrasound, CT, and MRI modalities.

## 3. Result and Discussion

In this case series, we describe five pediatric patients who are infected with HIV and develop tuberculosis, pneumonia, and bronchiectasis. A chest x-ray in pediatrics is the most accessible investigation for respiratory disease and has an important role in the initial assessment and the follow-up of respiratory disease in HIV-infected children.

**Table 1.** The summary of clinical presentations of 5 patients with human immunodeficiency virus (HIV)-infected pediatrics

| Title  | Author   | Year of publication | Journal  | Patient age  | Chest x-ray projection |
|--|--|---------------------|--|--------------|------------------------|
| Tuberculosis in an HIV-infected Child in a Developing Country: A Case Report of Diagnosis Challenges         | Samuel O. Oninla, Olusola A. Oyedeji, Olumayowa A. Oninla and Olamide V. Kayode                        | 2016                | British Journal of Medicine & Medical Research | 7 years old  | PA                     |
| Pediatric multidrug Resistant Tuberculosis and HIV co-infection in a resource-limited setting: a case report | Christelle G enevi eve Jouego, Valirie Ndip Agbor, Juergen Noeske, Ndo Akono Manuel and Leo Njock Ayuk | 2018                | BMC Research Notes                             | 6 years old  | AP                     |
| TB Presenting as Recurrent Pneumonia in an HIV-Infected Infant in Central Viet Nam                           | Phuong Nguyen, Son Nguyen, Thinh Nguyen and Ben Marais   | 2018                | MD   | 6 months old | AP                     |
| Adolescent onset of vertically transmitted untreated AIDS: A report of one case                              | Hsi-Hsien Wei, Li-Ping Tsai, and Ping-Sheng Wu   | 2016                | Tzu Chi Medical Journal                        | 12 years old | PA and AP              |
| Bronchiectasis in a positive HIV child: a child case report  | Shrestha L, Basnet S and Kanskar P   | 2013                | Journal of Institute of Medicine Nepal         | 7 years old  | AP                     |

*Case presentations*



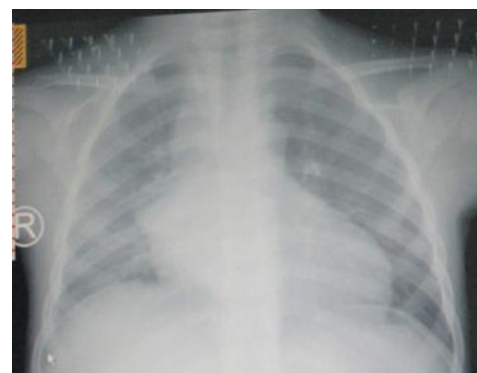
**Figure 1.** Radiographs show bilateral hilar adenopathy with scattered reticulonodular shadows (case 1) (Oninla et al, 2016)

*Case 1*

A 7-year-old is presented with progressive abdominal distension for 5 years, worsening breathing difficulties for one year, and dry cough for 6 months, in addition to dyspnea at rest, orthopnea, and fatigue without cyanosis, excessive sweating, and associated weight loss despite good appetite and food intake. The patient had a recurrent febrile illness, which involved repeated blood transfusions. The father is an HIV seropositive patient. The patient was assessed as having pulmonary TB on HIV. The patient was also identified as having kidney

failure, pneumonia, chronic otitis media, and stunting. The results of the PA thorax radiography showed cardiomegaly and pulmonary edema.

There are two options available for diagnosing pulmonary TB in children if culture is not possible. The first is a positive acid-fast bacillus (AFB) test, the second is two or more of the following criteria: (a) a history of contact with an adult TB patient, (b) a cough for more than two weeks, (c) radiographic findings consistent with TB, (d) response to anti-TB therapy and (e) reactive TST.



**Figure 2.** AP chest radiograph shows bilateral micro-nodular interstitial opacities associated with bilateral hilar adenopathy (case 2) (Jouego et al., 2018)

### Case 2

A 6-year-old baby boy was diagnosed with HIV 3 years ago. The patient was suspected of being infected with pulmonary TB based on a history of coughing up phlegm for 10 days, nocturnal fever, and abdominal pain. The patient's mother was treated with a case of multi-drug resistant (MDR) TB. Sputum sample analysis performed was positive for acid-fast bacilli. The AP chest x-ray shows bilateral micro-nodular interstitial opacities associated with bilateral hilar adenopathy.



**Figure 3.** AP radiograph on admission to ICU (case 3) (Nguyen et al, 2018)



**Figure 4.** PA chest radiograph shows reticulonodular changes (case 3) (Wei, Tsai, and Wu, 2016)

### Case 3

At the age of 3.5 months, a baby girl had a cough with fever and was diagnosed with pneumonia. When the baby is 6 months old, he has recurrent severe pneumonia. On physical examination he had extensive white plaques in his mouth, indicating thrush, and hepatosplenomegaly. Her mother is infected with HIV and her grandmother has a chronic

cough, possibly TB. The radiograph shows a perihilar appearance with a diffuse infiltration and opacity seen in the right upper lobe. This case illustrates that children with recurrent pneumonia should be screened for TB and HIV because TB is one of the causes of pneumonia.



**Figure 5.** AP radiograph 10 days before the patient is admitted to the ICU (case 4) (Nguyen et al, 2018)

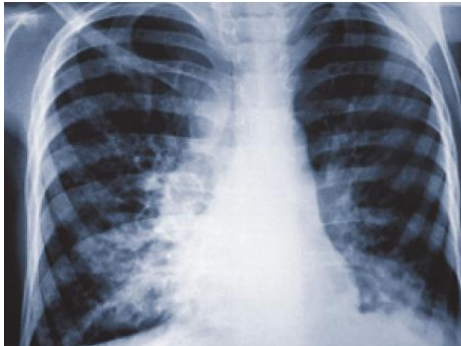


**Figure 6.** Chest radiograph AP shows left-sided pneumothorax (case 4) (Wei, Tsai, and Wu, 2016)

### Case 4

A 12-year-old girl was admitted to the emergency room for a high fever up to 40° C with cough with phlegm and shortness of breath for 4 days. The patient had thrush that persisted for one year and pneumonia of unusual severity. Laboratory tests showed the patient was severely infected with HIV and AIDS. It is known that the patient's mother also had HIV and had died several years ago, confirming that she was a case of a vertically transmitted HIV patient who had recently developed AIDS. The radiograph showed a left-sided pneumothorax. Vertical transmission of HIV can occur at any time during pregnancy and childbirth, as well as through breast milk in the postpartum period.

More than 95% of HIV-infected children worldwide contract the virus through vertical transmission.



**Figure 7.** AP chest radiograph shows bilateral bronchiectasis changes in both lower lungs (case 5) (Shrestha, Basnet, and Kanskar, 2013)

#### Case 5

A 7-year-old boy was diagnosed with HIV after a 15-day history of dry cough accompanied by a 7-day fever. There was no history of chest pain, shortness of breath, cyanosis, and hemoptysis. There was no history of decreased appetite or significant weight loss in the last 15 days. At the age of 2 years, this child was diagnosed with TB with a history of fever and recurrent cough. Both parents are infected with HIV and are not on ART therapy. This child has also been diagnosed with pneumonia. The results of the radiographic examination showed bilateral bronchiectasis changes in both lower lungs.

Chest x-ray at the onset of infection may be normal or may show nonspecific features such as focal pneumonitis, diffuse irregular opacities, and atelectasis. However, at a later stage, the chest radiograph appears to be more specific for bronchiectasis with dilated and thickened airways appearing as ring-like shadows or tram lines.

#### Projection of examination

Chest x-ray examination according to the article written by Wei, Tsai, and Wu, (2016) was performed with PA and AP projections, or PA projection only (Oninla *et al.*, 2016). Meanwhile, Jouego, et al (2018), Nguyen et al (2018), and Shrestha, Basnet, and Kanskar (2013) stated that the AP projection was performed for that examination. The selection of projections in the article is following Lampignano and Kendrick

(2018) who stated that a pediatric chest x-ray was performed with anteroposterior (AP), posteroanterior (PA), and lateral projections.

AP and PA projections are the main projections needed for a chest x-ray in pediatrics with clinical HIV infection, while the lateral projections are additional projections used to view perihilar and subcarinal lymphadenopathy in clinical TB in HIV. PA projection produces radiographs with better quality than AP projection, because in PA projection, the heart image appears close to its original size, in addition to PA projection, the scapula image can be adjusted so that it is not superimposed with the lungs. Although the PA projection is superior in the quality of the resulting radiograph, the AP projection is still performed for pediatric patients, and when the patient is uncooperative for PA projection (Lampignano and Kendrick, 2018).

Chest x-ray examination for pediatric patients is a special examination where good communication is needed with the patient and different examination techniques are needed from adult patients including the use of immobilization devices such as the tam-em board for supine AP projection and pig-g-o stat for PA and lateral projections. In pediatric patients, choosing a short examination time is also necessary to reduce unsharpness of movement, besides that radiation protection equipment is also needed considering that in pediatrics the body's cells are still actively dividing (Lampignano and Kendrick, 2018)

#### The Role of Chest X-Ray Examination

HIV is a disease characterized by infection and destruction of CD4+ T lymphocytes, and severe immunodeficiency leading to opportunistic infections, secondary neoplasms, and neurologic manifestations. Opportunistic infections are infections due to viruses, bacteria, fungi, or parasites that occur in people with weakened immune systems (Kumar, Abbas, and Aster, 2013). Opportunistic infections in HIV-infected pediatrics include:

##### a) Tuberculosis

Pediatric chest x-ray examination can be used to diagnose TB in HIV which is characterized by the presence of bilateral hilar adenopathy associated with diffuse reticulonodular shadows (Oninla *et al.*, 2016).

The results of the chest x-ray examination also revealed the presence of cardiomegaly and pulmonary edema. A chest x-ray also shows bilateral micro-nodular interstitial opacities associated with bilateral hilar adenopathy (Jouego *et al.*, 2018). The radiographic examination showed a perihilar appearance with diffuse infiltration and visible opacity in the right upper lobe (Nguyen *et al.*, 2018). A typical description of TB in HIV based on the 3 journals according to the opinion of du Plessis, Andronikou, and Zar (2020) which stated that the typical features of TB in HIV were the presence of perihilar and/or mediastinal lymphadenopathy, Cavitory consolidation, Miliary pulmonary nodules, Post-infective apical fibrocystic scarring.

The diagnosis of TB in HIV is important because pediatric patients with HIV are more susceptible to TB and with TB in HIV, the patient's condition will deteriorate and may not even be cured. The diagnosis of TB in pediatrics with clinical HIV infection can be made by chest x-ray. On chest x-ray, HIV-infected TB patients are usually characterized by bilateral hilar adenopathy (Oninla *et al.*, 2016).

The chest x-ray figure of HIV-positive TB patients is different from that of HIV-negative TB patients. TB in HIV-negative individuals usually involves the upper lobes of the lungs and is unilateral, whereas in HIV-positive patients it usually involves both lungs. But sometimes the diagnosis of TB in HIV is quite difficult to identify because sometimes, clinical and radiological features may not help differentiate TB from other HIV-associated pulmonary pathologies. The radiographs showing the presence of cardiomegaly in a journal written by Oninla, et al (2016) may be related to the patient's history of heart failure.

#### b) Pneumonia

Radiographic examination of a pediatric patient with clinical pneumonia in HIV showed a perihilar appearance with diffuse infiltration and visible opacity in the right upper lobe (Nguyen *et al.*, 2018). pediatric radiographic examination in clinical pneumonia in HIV is characterized by characteristic features, namely focal and multifocal parenchymal abnormalities (Pitcher, Beningfield, and Zar, 2015). Radiographic examination of a pediatric patient with clinical pneumonia in HIV also showed a left-sided

pneumothorax and showed reticulonodular changes (Wei, Tsai, and Wu, 2016).

The diagnosis of pneumonia in HIV needs to be done because many cases of HIV are accompanied by pneumonia. Pneumonia in HIV is usually a type of pneumocystis carini pneumonia (PCP). PCP usually occurs in patients with a CD4 positive T set of fewer than 200 cells/ $\mu$ L. The diagnosis of pneumonia in HIV can be made by examining a chest radiograph. Chest x-ray in pediatrics with clinical pneumonia is characterized by the characteristic features of focal and multifocal parenchymal abnormalities. Parenchymal abnormalities can be in the form of consolidation (alveoli filled with fluid), emphysema (lung parenchyma contains more air than it should), and cavitation (damage to lung tissue to form an air cavity) (Pitcher, Beningfield and Zar, 2015).

The appearance of reticulonodular images on patient radiographs occurs because clinically pneumonia occurs because of an infection that causes inflammation of the air sacs. Meanwhile, the appearance of opacity in the right upper lobe occurs due to the increasingly severe inflammation of the air sac in the right upper lobe. Then the figure of pneumothorax occurs because the PCP pneumothorax is a complication that often occurs (Wei, Tsai, and Wu, 2016)

#### c) Bronchiectasis

A pediatric chest x-ray can be used to diagnose bronchiectasis in HIV, which is characterized by a dilated and thickened airway that appears as a shadow, such as rings (on the airways visible at the end) or tram lines (on the airways perpendicular to the x-ray beam). This is following Pitcher, Beningfield, and Zar (2015) who said that the typical feature of bronchiectasis in HIV is the presence of ring and tram densities with and without thickening of the bronchial walls and bronchial dilatation (Shrestha, Basnet, and Kanskar, 2013).

Bronchiectasis is a disease that can infect patients with HIV. The diagnosis of bronchiectasis needs to be made early because if not treated quickly it can cause permanent damage to the bronchial walls and surrounding tissue. The diagnosis of bronchiectasis in pediatrics with HIV can be made by examining a chest x-ray which is characterized by the presence of a characteristic figure of ring and tram densities with and without bronchial wall

thickening and bronchial dilatation. This characteristic appearance arises because in bronchiectasis there is permanent damage to the bronchi, which widens and thickens their walls (Shrestha, Basnet, and Kanskar, 2013).

#### 4. Conclusion and Suggestions

Chest x-ray in pediatrics is the most accessible investigation for respiratory disease and has an important role in the initial assessment and follow-up of respiratory disease in HIV-infected children. The role of chest x-ray in pediatrics with clinical HIV infection can be used for TB, pneumonia, and bronchiectasis in HIV with AP and PA projections with characteristic features of bilateral hilar adenopathy in TB, focal and multifocal parenchymal abnormalities in pneumonia, dilated and thickened airways that appear as ring shadows or tramways in bronchiectasis.

It is recommended that pediatric patients with clinical HIV infection with respiratory tract complaints such as cough and shortness of breath should immediately undergo a chest x-ray to be able to diagnose opportunistic infections in HIV so that treatment can be carried out immediately. Pediatric chest x-ray examination should be carried out with PA projection to obtain more optimal radiographic results, but for pediatric patients in the infants and children category under 5 years and if the patient is uncooperative it is not possible to do PA projection, it can be done with AP projection. Further research recommendations can be carried out about the role of chest x-ray in the case of covid-19 pneumonia in an HIV-infected pediatric.

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