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BYSSINOSIS, AN OCCUPATIONAL LUNG DISEASE: DIAGNOSIS AND MANAGEMENT

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Abstract: Byssinosis, An Occupational Lung Disease: Diagnosis And Management. *Byssinosis is an occupational lung disorder mainly caused by exposure of cotton dust during manufacturing. Over the years, it is well known as "Brown lung disease" and "cotton worker's lung". Byssinosis is characterized by respiratory symptoms such as cough, shortness of breath, chest tightness, and airway obstruction. The pathogenesis is still unclear. Despite the exposure to cotton dust, endotoxin release that resides in gram-negative in cotton dust also plays an important role in mediating byssinosis. Specify that supporting examination is not yet available. Thus, it is encouraging to relate the history of cotton dust exposure and the symptoms. In byssinosis, medication is given based on the symptoms that occur.*
Keywords: *Byssinosis, Occupational lung disorders, Workers*

Abstract: Bisinosis, Penyakit Paru Akibat Kerja: Diagnosis dan Tatalaksana
Bisinosis adalah salah satu penyakit paru kerja yang disebabkan karena paparan debu kapas yang terhirup ke saluran nafas. selama proses pengerjaannya. Dikenal dengan sebutan *"Brown lung disease"* dan *"cotton worker's lung",* penyakit ini memiliki gejala-gejala respiratorik berupa batuk, sesak nafas, dada terasa tertekan dan obstruksi saluran nafas. Mekanismenya patogenesisnya belum dapat dimengerti sepenuhnya, selain ada peran paparan terhadap debu kapas, pengeluaran endotoksin pada bakter gram negative yang ada pada debu kapas juga memediasi tercetusnya bisinosis. Pemeriksaan penunjang yang spesifik saat ini belum ada, oleh karenanya diperlukan kesesuaian antara riwayat paparan juga gejala. Pada pasien bisinosis diberikan pengobatan sesuai gejala yang muncul.
Kata kunci: bisinosis, penyakit paru kerja

INTRODUCTION

Occupational exposure significantly contributes to the global burden of disease. The International Labour Organization estimates that 2 million out of 2-5 billion workers die annually from workplace accidents or occupational illnesses (Cullinan et al., 2017). Exposure can have immediate effects, such as acute inhalation injuries, but some effects may appear months or years later, such as sensitizer-induced occupational asthma, even after the worker has left that particular job (Hoy & Brims, 2017).

Byssinosis is one such occupational lung disease. It's a collection of respiratory symptoms caused by exposure to non-synthetic textile dust during manufacturing.

Byssinosis is an occupational lung disease affecting the airways due to the inhalation of cotton dust. Characteristic symptoms include cough, shortness of breath, chest tightness, and airway obstruction (Patel et al., 2024). Byssinosis is also known as "Brown lung disease" and "cotton worker's lung." Brown lung is a type of pneumoconiosis caused by cotton dust. Inhaled dust stimulates the release of histamine, which can cause airway constriction and breathing difficulties (Ekambaram et al., 2022).

The entry of dust particles into the respiratory system depends on their aerodynamic diameter, the individual's respiratory rate, and the air velocity in the environment. Fine inhaled cotton dust particles accumulate in the gas exchange areas of the lungs, where airflow is relatively slow. These small particles become trapped in the respiratory bronchioles in the mid-acinus. The duration of cotton dust exposure, the type of dust, its concentration, and particle size all affect its impact on the lungs (Ekambaram et al., 2022).

ETIOLOGY

The main cause of byssinosis is generally exposure to inhaled cotton dust during processing, as well as exposure to rami and linen dust (Kalasuramath et al., 2015). Other studies identify that the release of endotoxins from bacterial cell walls in textile fibers also contributes to byssinosis (Christiani, 2021). Raw cotton contains bacterial contamination from the plant, especially gram-negative bacteria and their endotoxins. In addition to cotton dust, these bacteria and endotoxins are part of the textile mill work environment and are inhaled by exposed workers (Kalasuramath et al., 2015).

Endotoxin levels can be measured to show that byssinosis is more prevalent among workers exposed to rami dust compared to those exposed to jute dust. One study hypothesized that this may be due to the higher endotoxin content in various parts of the rami plant and processed rami dust. Therefore, endotoxin measurements were used to investigate specific components of rami plants. Since air sampling filters for endotoxin analysis were unavailable, dust samples were collected from a nearby workshop because the rami factory wasn't processing rami at the time. Endotoxin measurements were performed on processed and unprocessed rami plants, as well as on rami dust. Endotoxin concentrations in the dust were measured using the Limulus Amebocyte Lysate test (QCL-1000 LAL Assay, Lonza, Inc.). Samples were extracted into pyrogen-free water, shaken for 60 minutes at room temperature, and tested against a Control Endotoxin Standard (US FDA EC-6) (Er et al., 2016). Other factors also influence the occurrence of byssinosis, such as the use of personal protective equipment (PPE), smoking status, and workplace location.

EPIDEMIOLOGY

Byssinosis is frequently found in individuals working in the textile industry, where cotton fabrics are manufactured. Byssinosis remains a serious problem in developing countries, with a high prevalence rate ranging from 30% to 50%. It is common in countries with substantial cotton industries, such as India, Pakistan, Nepal, Sri Lanka, and Bangladesh. It's also prevalent in developing nations. Despite modernization and improvements in workplace environments, byssinosis remains common in several countries, including Pakistan, India, Indonesia, Ethiopia, Turkey, and Sudan (Kalasuramath et al., 2015).

In India, 20 million workers are involved in the manufacturing of textiles. The incidence of byssinosis in WOMEN working in cotton mills in India was 41%, with the majority (28%) of women being in the middle class (Kalasuramath et al., 2015). A study in Indonesia found that 70% of workers inhaling dust and 14% of those inhaling cotton dust suffered from lung impairment (Perdana et al., 2024).

RISK FACTOR

Exposure to cotton dust is a major risk factor for various respiratory conditions, including byssinosis. The duration of employment directly influences an individual's exposure level, impacting lung function. Longer working periods increase the risk of lung impairment. Furthermore, the use of personal protective equipment, such as masks, plays a crucial role in reducing inhaled and retained dust, thereby minimizing the risk of decreased lung function (Larasati et al., 2018).

Smoking is another significant risk factor for byssinosis, contributing approximately 1% to its occurrence. Marginal effects analysis reveals that each additional cigarette smoked daily increases the likelihood of developing byssinosis: by 0.5% for grade 1/2, by 0.2% for grade 1, and by 0.2% for grade 2 or 3 (Khan et al., 2024).

PATHOPHYSIOLOGY

The exact etiology of byssinosis remains unclear. It's not simply a direct response to dust alone. Studies have shown that even washed cotton, despite having a high dust concentration, doesn't cause changes in lung function. Pollution in the work environment from biological and microbiological agents may trigger pulmonary reactions.

Early immunological mechanisms include IgE antibody activation, immune complex allergic reactions, and complement activation, often cited as contributing to the disease pathogenesis. While IgE mechanisms are considered plausible components of the antigen-dust and contaminant interaction, some studies don't show a link between atopy and this disease. Elevated IgG antibody levels are also seen in cotton workers, peaking early in their employment. However, dust challenges haven't induced changes in lung function, failing to support this theory. Complement activation has also been described, but the mechanism remains incompletely understood.

Byssinosis pathogenesis involves not only cotton dust, but also endotoxin levels in the work environment (Christiani, 2021). Endotoxins are lipopolysaccharides found in the outer membrane of gram-negative bacteria present in cotton dust. Inhaling endotoxins can cause bronchoconstriction and inflammatory responses, including the release of polymorphonuclear leukocytes. Exposure to endotoxins can mediate respiratory illness in workers, supported by studies showing reduced FEV1 (forced expiratory volume in one second) in workers exposed to endotoxins (Mittal et al., 2016). Oxidative stress is another factor involved in byssinosis. The duration of exposure is a significant factor. Prolonged exposure to cotton dust can lead to the migration of macrophages or neutrophils into the airspaces, resulting in the production of reactive oxygen species through opsonization (Dangi & Bhise, 2017).

PATHOLOGY

The pathological picture of byssinosis remains unclear. Many studies have reported mucosal hyperplasia and mild hypertrophy of bronchial smooth muscle, along with neutrophil infiltration; however, these are not specific changes unique to byssinosis. In fatal cases, findings consistent with chronic bronchitis, emphysema, and chronic cor pulmonale have been observed alongside byssinosis. There haven't been sufficient biopsy or Broncho Alveolar Lavage (BAL) studies on individuals definitively diagnosed with byssinosis to fully characterize the pathology. However, in byssinosis cases, BAL typically reveals an increased number of cells, particularly neutrophils and lymphocytes (Davidson et al., 2020).

PAST HISTORY AND PHYSICAL EXAMINATION FOR DIAGNOSIS

The strongest indicator is the patient's report of symptoms appearing or worsening on the first day of the work week (Monday), hence the term "Monday disease," and improving when away from the work environment.

The initial stages of thread preparation generate substantial dust.

Therefore, the closer to the beginning of the process, the higher the dust exposure and the greater the risk of pulmonary response (Ekambaram et al., 2022). Initially, symptoms may manifest as frequent coughing, chest tightness, shortness of breath, and sometimes wheezing, especially within hours of exposure (or re-exposure) (Er et al., 2016). With repeated exposure and lung irritation, patients may no longer experience recurring acute symptoms but instead develop chronic byssinosis.

In these cases, symptoms such as cough with sputum production can occur, potentially leading to misdiagnosis as chronic obstructive pulmonary disease (COPD) or bronchitis (Er et al., 2016).

Initial physical examination may reveal no abnormalities. In later stages, when symptoms appear, findings may include wheezing, moist crackles, prolonged expiration, and chest wall retraction during inspiration. Cardiac examination may reveal coronary artery disease and congestive heart failure. Other physical findings may include obesity and clubbing of the fingers (indicative of a neuromuscular condition) (Salawati, 2019).

SUPPORTING INVESTIGATIONS

Currently, there's no definitive diagnostic test for byssinosis. However, several investigations can aid in diagnosis:

Blood Tests

Acute exposure to cotton dust may cause leukocytosis (increased white blood cell count). Acute exposure to organic dust in humans is known to trigger cell infiltration and increased cytokine production involving TLR signaling. This is characterized by increased numbers of neutrophils, monocytes, and basophils in the blood and nasal lavage fluid after 3 hours of exposure to pig dust. Furthermore, there is an increased expression of monocyte TLR2 and TLR4. This response is reduced after the use of a fine particle separator (Poole et al., 2024).

Chest X-Ray

Chest X-rays can help rule out other pathological conditions. A small percentage of patients may exhibit fine, moist crackles in the lower lung bases. X-rays may reveal hyper lucency, flattened diaphragms, diffuse haziness, and a ground-glass appearance in the lower lung fields (Er et al., 2016). Further X-Ray Findings of thickening of the bronchial walls and air trapping in the lungs may also be seen on chest X-rays, leading to airflow obstruction and respiratory symptoms (Mansouri et al., 2016).

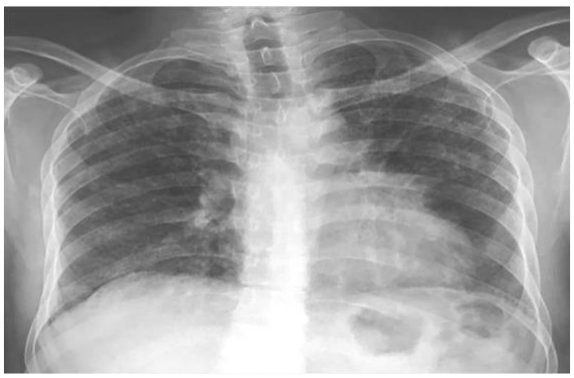

Figure 1. Chest X-Ray postero-anterior shows diffuse, ill-defined haziness, predominantly in lower lobes

Chest CT Scan

A chest CT scan may be performed if the diagnosis is unclear or to rule out other possibilities. While characteristic findings for byssinosis are rare, one case report describes a 36-year-old male smoker

who worked in a cotton factory for 8-10 hours/day for 6 years (making mattresses and blankets). His high-resolution CT scan (lung window) showed thickened intralobular and interlobular lines, hazy areas of increased attenuation, bilateral small cysts predominantly in the peripheral and subpleural regions, associated traction bronchiectasis, and areas of ground-glass attenuation (Menon et al., 2018).

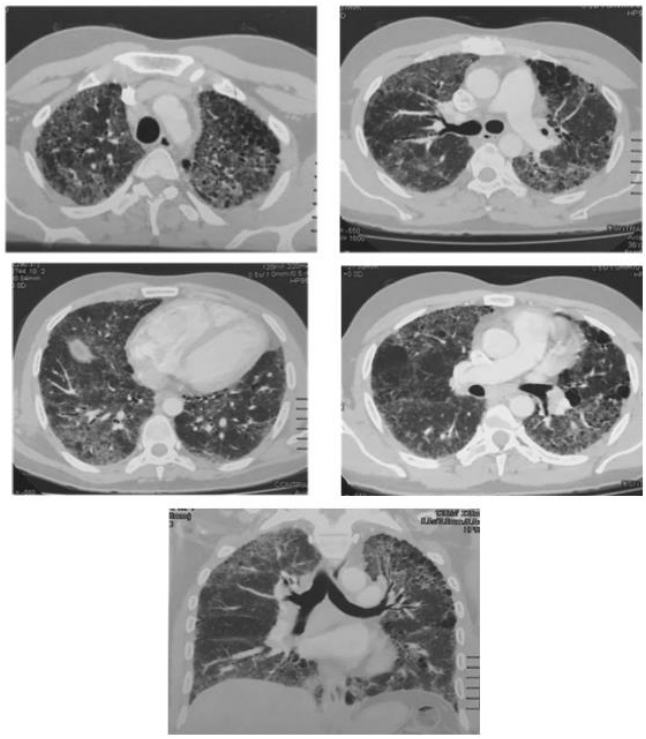

Figure 2. High-resolution CT scan (lung window) showed thickened lines, hazy areas, bilateral small cysts, traction bronchiectasis, and ground-glass attenuation

Spirometry

Pulmonary function testing can help demonstrate a reduction in forced expiratory volume in 1 second (FEV1) to below 80% of the predicted value. Alternatively, a decrease in FEV1 greater than 5% between work shifts and non-work periods may also be observed (Mittal et al., 2016). Acute effects from cotton dust exposure can be classified based on changes in Forced Expiratory Volume (FEV1) before and after exposure, according to the Bouhuys, Gibson, and Schilling classification (Kosasih et al., 2021).

DIAGNOSIS AND DIFFERENTIAL DIAGNOSIS

Byssinosis diagnosis is made using a scoring system from the World Health Organization (WHO) and Schilling's criteria, considering both symptoms and affected workdays. Disease severity is strongly correlated with the rate of decline in pulmonary function.

Table 1. Classification According to the Bouhuys, Gibson, and Schilling

Grade	Forced Expiratory Volume in One Second (FEV1)	Effects
F0	No decrease in FEV1	No signs of chronic obstruction
F1/2	FEV1 reduction of 5-10%	Indicating mild acute effects without ventilatory impairment
F1	FEV1 reduction of 10-20%	Indicating moderate acute effects
F2	FEV1 reduction of >20%	Indicating severe acute effects

(Kosasih et al., 2021)

Based on the onset, byssinosis is classified into two types (Menon et al., 2018): Acute Byssinosis This refers to acute airway complaints that appear in individuals upon their first exposure to cotton dust, it's often accompanied by decreased lung function.

Chronic Byssinosis This is the more typical form of byssinosis. It's characterized by chest tightness and shortness of breath that worsen on the first workday of each week. Symptoms usually appear after years (typically more than 10) of cotton dust exposure and are rare in workers with less than a decade of exposure.

Bronchoalveolar lavage (BAL) and lung biopsy are crucial for confirming a diagnosis of byssinosis. Differential cell counts from BAL can help distinguish byssinosis from other conditions, such as hypersensitivity pneumonitis, which is predominantly characterized by lymphocytes (Davidson et al., 2020). Differential diagnoses are considered based on symptoms and occupational risk factors. Conditions such as asthma, chronic bronchitis, pneumoconiosis, asbestosis, farmer's lung, interstitial lung fibrosis, hypersensitivity pneumonitis, sarcoidosis, and silicosis should be considered in the differential diagnosis of byssinosis (Kosasih et al., 2021).

TREATMENT:

Removing the patient from the work environment to reduce exposure can be beneficial. Symptomatic treatment involves short- and long-acting inhaled beta-agonists and possibly inhaled corticosteroids. Management is similar to that of occupational asthma. Bronchodilators may be necessary for several months to improve symptoms. To alleviate symptoms, bronchodilators are typically prescribed, either inhaled (albuterol) or oral (theophylline). In more severe cases, corticosteroids may be used. (Ekambaram et al., 2022).

Once diagnosed, patients should be advised to reduce their exposure to cotton and cotton products, or even consider changing their job or career. Medical rehabilitation may be necessary for patients experiencing long-term effects from exposure. Patients exhibiting classic symptoms and experiencing a ≥10% decrease in FEV1 should be moved to a non-exposure area. Meanwhile, patients with moderate to severe airway obstruction, such as FEV1 less than 60% of the predicted value, should not be further exposed (Salawati, 2019).

Besides medication, risk factor management includes risk assessment and control that must be systematically implemented. This process includes anticipatory, recognition, evaluation, and control steps (Salawati, 2019).

PROGNOSIS:

Most patients improve with treatment, although some may need to avoid cotton exposure entirely. For individuals who remain undiagnosed or untreated, repeated chronic exposure can lead to pulmonary fibrosis and impaired lung function (Ekambaram et al., 2022).

COMPLICATIONS

Progressive bisinosis can lead to chronic airway obstruction (Kosasih et al., 2021). One possible complication is chronic bronchitis, a condition involving

inflammation of the large airways in the lungs, accompanied by excessive mucus production. Continuous dust exposure risks causing end-stage lung disease. Other complications that can arise from bisinosis include pulmonary fibrosis, oxygen dependence, disability, decreased tolerance for physical activity, and premature death (Tarlo, 2020).

CONCLUSION

Byssinosis is an occupational lung disease affecting the airways due to exposure to inhaled cotton or fine rami dust. Initial symptoms may include frequent coughing, chest tightness, shortness of breath, and wheezing, often appearing within hours of exposure (or re-exposure). A key indicator is the worsening of symptoms on the first workday of the week ("Monday disease"), improving when away from work. Currently, there is no definitive diagnostic test for byssinosis. However, using a class assessment based on the Schilling criteria can serve as a diagnostic reference based on symptoms and decreased lung function. Risk factors such as occupational history and duration of exposure can strengthen the diagnosis of byssinosis. Disease severity varies depending on the level and duration of exposure. Treatment aims to alleviate symptoms and improve pulmonary function.

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