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BYSINOSIS: OCCUPATIONAL LUNG DISEASE IN THE TEXTILE INDUSTRY AND CHALLENGES IN ITS MANAGEMENT

Vicennia Serly, Deddy Herman, Dessy Mizarti, Masrul Basyar
Fakultas Kedokteran Universitas Andalas, Padang, Sumatera Barat, Indonesia
Email: vicenniaserly@gmail.com

ABSTRACT

Byssinosis, also known as brown lung disease or Monday fever/Monday dyspnea, is a form of respiratory symptoms caused by exposure to raw non-synthetic textile materials during the production process in the industrial sector and is considered as a form of occupational lung disease. An increase in the prevalence of occupational lung diseases has been found in developing countries, particularly in South Asia. The etiology of byssinosis is the exposure to cotton dust in the textile industry, caused by exposure to endotoxins from the cell walls of gram-negative bacteria found in the dust of various plant fibers, including cotton. Diagnosing byssinosis requires taking a medical history, performing a physical examination, and conducting supporting examinations such as chest X-ray, high-resolution chest CT scan, and pulmonary function tests. In pulmonary function testing using spirometry, a decrease in the FEV1/FVC ratio may be observed. Based on clinical symptoms and lung function tests, the severity of byssinosis can be assessed using Schilling criteria. Inhalation medications such as short-acting and long-acting beta-agonists are choices for pharmacological management of byssinosis. Inhaled corticosteroids can be used in severe clinical conditions.

KEYWORDS *byssinosis; textile industry; pulmonary dysfunction*

INTRODUCTION

Occupational lung disease is an abnormality in the lungs caused by exposure to irritants inhaled while doing certain jobs. (Jumat et al., 2021) Bisinosis is a form of occupational lung disease. Epidemiologically, bisinosis has a fairly high prevalence in developing countries and countries with many textile industries. Bisinosis occurs due to exposure to particles with a size of 1-5 micrometers for a long period of time, which is about 10 years or more. Workers who are exposed to dust, especially during the processing of cotton, hemp, or burlap materials in textile mills, are at risk of developing bisinosis. (Chadha et al., 2019) Early clinical symptoms of bisinosis include fever, chronic cough, tightness in the chest, shortness

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of breath sometimes accompanied by wheezing, joint pain, chills, or fatigue. Bisinosis that has occurred chronically can be found with clubbing finger and muscle wasting. People with bisinosis usually show worse symptoms at the beginning of the week or after acute exposure when returning to work, which is why the disease is also known as "Monday fever/Monday dyspnea". (Ekambaram et al., 2022; Lane, 2024) Biscinosis that occurs can cause fibrosis or irreversible erosion of lung tissue. If not treated optimally, bisinosis can also become a complication of chronic obstructive pulmonary disease. (Matyga et al., 2023).

Bisinosis is a collection of respiratory symptoms caused by exposure to raw non-synthetic textile materials during the production process, this disease is also known as lung disease in cotton textile workers, brown lung disease and Monday fever/Monday dyspnea. (Nafees et al., 2023) Bisinosis is a form of occupational lung disease. Occupational lung disease is a preventable disease caused by exposure to irritants inhaled while doing work. (Hinson et al., 2016) In low- and middle-income countries, the textile industry has an important role to play in economic growth. Bisinosis is a chronic respiratory condition that causes shortness of breath, appears when returning to work after a holiday and is caused by exposure to cotton dust in textile workers. This condition can inhibit lung function. (Dangi & Bhise, 2017).

An increase in the prevalence of occupational lung disease is found in developing countries. The prevalence of bisinosis in Indonesia is 35.6%. (Saha et al., 2018) In developing countries and the largest cotton textile producers in South Asia such as India and Pakistan, bisinosis can be found, and most of the population in these countries is smokers, which can aggravate the clinical symptoms that occur, as cigarettes are one of the risk factors for bisinosis. (Matyga et al., 2023) Nearly 30 million people are at risk of occupational lung disease in the United States, and there are approximately 30,000 deaths every year. In the United Kingdom, the prevalence of bisinosis is 4%. (Menon et al., 2018) A study of cotton textile workers in Pakistan, found that the prevalence of bisinosis was assessed using the WHO criteria of 3%, and when assessed using the Schilling criteria, the figure was 4%.6 Although no detailed epidemiological data is available, the CDC (Centers for Disease Control and Prevention) reported a significant decrease in the number of deaths attributed to bisinosis from 1979 until 2010. (Sadia et al., 2023).

Occupational lung disease caused by airborne particles produced during the processing of non-synthetic textiles, especially cotton, hemp, and burlap materials, is known as bisinosis. Exposure to inhalation of these particles can cause chronic respiratory symptoms and impaired lung function (Wong et al., 2016). The etiology of bisinosis is exposure to cotton dust in the textile industry caused by exposure to endotoxins from the cell walls of gram-negative bacteria found in the dust of various plant fibers, including cotton, flax, and burlap. Risk factors that can cause the onset of bisinosis include the following:

a. Long-term cotton dust exposure, cotton dust exposure in the textile industry is a major risk factor. This exposure can cause lung damage and respiratory symptoms that persist chronically.

b. Smoking, workers who smoke have a greater chance of developing bisinosis. Smoking was found to have a significant association with bisinosis.6 Smokers had more severe respiratory and bisinosis symptoms compared to non-smokers.
c. History of asthma or allergies, people who have a history of asthma or allergies are more sensitive to dust particles so they have a greater potential to experience bisinosis.
d. Genetic predisposition, there is a possibility that people with genetic predisposition will be more susceptible to exposure to cotton dust.
e. People who work in industries that have high exposure to textile dust such as textile mills, cotton processing plants, and factories that produce burlap or hemp. The duration of work in the textile industry is also associated with an increased likelihood of disease development. People who have worked in cotton mills for more than 15 years are at greater risk of developing bisinosis.9 Workers in the textile industry, especially those working in spinning mills, are exposed to high levels of cotton dust. Workers in the mill spinning section have a higher risk of bisinosis compared to workers in the weaving section.6 Research by Ekambaram, et al suggests that the duration of cotton dust exposure among cotton industry workers in India ranges from 5 years to more than 10 years, with the majority having exposure for more than 10 years.
f. The risk of bisinosis can increase if protective measures such as adequate ventilation and dust control are not properly implemented by workers.
g. Some people may be more susceptible to the effects of cotton dust exposure due to factors such as age over 40, gender, or general health conditions.

Cotton dust is a complex mixture of various components including crushed plant matter, cotton fibers, bacteria, fungi, soil, and pesticides (Van der Sluijs & Hunter, 2017). These contaminants can accumulate during the planting, harvesting, processing, and storage of cotton (Wang & Memon, 2020). The process of bisinosis is initially caused by bacterial endotoxins contained in cotton materials. The endotoxins contained in cotton dust can trigger persistent inflammation. (Feng et al., 2017)

Developing countries, especially in the South Asian region such as India, which is one of the world's textile industrial countries, have a hot and humid climate, so this condition supports the growth of bacteria. Endotoxins are lipopolysaccharides in the outer membrane of gram-negative bacteria present in cotton dust. Endotoxin releases nitric oxide, which then reacts with superoxide and causes an inflammatory response and causes fibrosis.3 Endotoxin exposure lowers FEV1, so this exposure is thought to be a major mediator in occupational respiratory diseases.

Oxidative stress can cause respiratory distress, especially in workers working in cotton mills. The effect increases with the duration of high exposure. During long-term exposure to cotton dust, macrophages and neutrophils migrate and cause the production of ROS (reactive oxygen species). This oxidative stress also causes persistent inflammation and causes damage to the respiratory system. The inflammatory process causes the release of histamine which narrows the airways, as a result of which people with bisinosis will find it difficult to breathe. Bisinosis causes dust to accumulate in the lungs for a long time and causes a characteristic

discoloration of the lungs, therefore this disease is also known as brown lung disease.

RESEARCH METHODS

Research Design

This study would employ a quantitative research design, focusing on observational cohort study methods. The cohort would consist of textile workers exposed to cotton dust, and the study would aim to track the development of byssinosis over time.

Population and Sampling

Population: Workers in the textile industry, particularly those in cotton mills, who are at risk for byssinosis due to long-term exposure to cotton dust.

Sampling: A stratified random sampling approach could be used, ensuring that different segments of the workforce (e.g., those with varying years of exposure) are adequately represented. Inclusion criteria would include workers with at least one year of exposure to cotton dust.

Data Collection Methods

Medical History and Questionnaire: Data will be gathered through self-reported medical histories and structured questionnaires to assess lifestyle factors (e.g., smoking habits, history of respiratory conditions like asthma).

Physical Examinations: Workers would undergo clinical assessments for respiratory symptoms such as chronic cough, dyspnea, and chest tightness.

Spirometry Tests: Pulmonary function tests would be conducted, focusing on FEV1, FVC, and the FEV1/FVC ratio, to evaluate lung function impairment.

Radiological Examinations: Chest X-rays and high-resolution CT scans would be used to identify characteristic lung damage associated with byssinosis, such as diffuse haziness or fibrosis.

Biomarkers of Exposure: Assessments of the levels of cotton dust in the air at the workplace could be done, using air quality monitoring devices to establish a correlation between exposure levels and health outcomes.

Variables

Independent Variable: Duration and intensity of exposure to cotton dust.
Dependent Variables: Prevalence and severity of byssinosis, measured through clinical symptoms, lung function tests, and radiological findings.

Data Analysis

Descriptive Statistics: To summarize the demographic data of workers, the frequency of respiratory symptoms, and exposure levels.

Inferential Statistics: Regression analysis (e.g., multiple logistic regression) could be used to determine the relationship between exposure duration, intensity, and the development of byssinosis. Chi-square tests could assess associations between categorical variables (e.g., smoking status and symptom development).

Severity Classification: The severity of byssinosis could be classified using established criteria, such as the Schilling criteria and the WHO criteria.

Ethical Considerations

Informed consent would be obtained from all participants, explaining the study's purpose, the procedures involved, and any potential risks.

Confidentiality would be ensured by anonymizing personal health data.

The study would ensure that no participants are exposed to risks without adequate protective measures during the study.

Limitations

Longitudinal Study Limitations: It may be difficult to fully track the development of byssinosis in the long term, especially for workers who may change employment or relocate.

Self-Reporting Bias: There could be bias in the workers' self-reported histories of smoking or respiratory symptoms.

Environmental Factors: While the focus is on cotton dust, other environmental pollutants might contribute to the respiratory conditions.

RESULT AND DISCUSSION

To diagnose bisinosis, anamnesis, physical examination, and supporting examinations such as thoracic X-rays, thoracic CT scans, and pulmonary function tests (spirometry) are required. All patients suspected of having occupational lung disease should undergo a high-resolution CT Scan. During the yarn making process, more cotton dust is produced. Initial symptoms that appear within a few hours or repeated exposure at work include chronic cough, tightness in the chest, shortness of breath, and sometimes accompanied by wheezing. Other symptoms that can be felt include fever, joint pain, chills and fatigue. People with bisinosis usually show worse symptoms at the beginning of the week or after acute exposure when returning to work, which is why this disease is also known as "Monday fever". From the physical examination, if bisinosis has occurred chronically, signs that can be encountered include weight loss and muscle wasting. From the vital signs, it was found that there was an increase in body temperature and tachypnea, then in the examination of pulmonary auscultation can be found fine wet rhonki that is diffuse scattered in the basal part of the lungs. In the extremities, about 50% of patients with chronic bisinosis are found to have clubbing fingers. Supportive examination of thoracic X-rays reveals a diffuse, ill-defined haziness picture, especially in the lower lobes of the lungs.

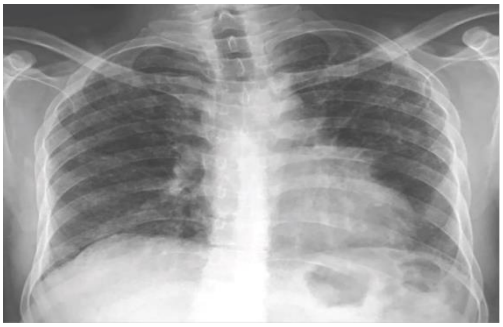

Figure 1. Diffuse, ill-defined haziness especially in the lower lung lobe on thorax bisinosis x-ray

Meanwhile, from the examination of high resolution CT scans, images of ground glass appearance, centrilobular nodules, thickening of the airway walls, as well as water trapping and fibrosis. Histological examination shows peribronchial

thickening, granulomas, and foreign bodies such as threads (cotton fibers), with cellulose detectable by infrared spectrophotometry.

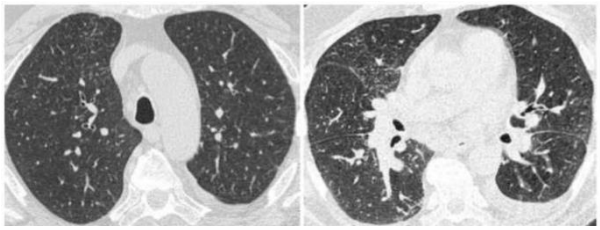

Figure 2. Description of ground glass appearance, centrilobular nodules, thickening of airway walls and water trapping on high resolution thoracic bisinosis scan

Examination of lung function using spirometry, it can be found that the ratio of FEV1/FVC decreases, FEV1 (forced expiratory volume in first second of FVC) decreases by <80% due to increased airway resistance, while FVC (forced vital capacity) decreases due to the occurrence of the water trapping mechanism. Research conducted by Ekambaram, et al found that lung function parameters (FVC, FEV1, FEV1/FVC ratio, FEF 25-75%, PEFR, and MVV) are significantly reduced in female workers in the cotton industry. The study also found that the prevalence of respiratory symptoms, such as dyspnea, cough, and chest tightness, was higher in workers in the cotton industry.4 To assess the grading or severity of bisinosis, two types of criteria can be used, namely the WHO criteria and the Schilling criteria. WHO criteria for assessing bisinosis are based on the presence of clinical symptoms of chest tightness and are categorized into two levels, namely:

a) B1: Symptoms appear on most of the first days after returning to work.
b) B2: Symptoms appear on the first day and other days of the work week.

When viewed based on clinical symptoms and pulmonary function tests, the severity of bisinosis can be assessed using Schilling criteria, including the following:6,7

a) Grade 0 : No symptoms
b) Grade 1/2: Mild symptoms, such as cough and tightness in the chest, with a significant decrease in FEV1 on Monday or after a period away from work
c) Grade 1: Moderate symptoms, such as wheezing and dyspnea, with a significant decrease in FEV1 on Mondays or after periods away from work
d) Grade 2: Severe symptoms, such as significant airflow obstruction and chronic bronchitis, with a significant decrease in FEV1 on Monday or after a period away from work
e) Grade 3: Very severe symptoms, such as severe airflow obstruction and chronic bronchitis, with a significant decrease in FEV1 on Mondays or after a period away from work.

Governance

The pharmacological management of bisinosis includes the use of short acting and long acting inhalation beta agonist drugs. Inhalation corticosteroids can be used in poor clinical conditions. In addition, immunomodulators and

antihistamines can also be used as additional therapy options. Oxygen can be given to patients with hypoxemia. Nebulization therapy may also be given to patients with chronic bisinosis. Patients were educated to consider finding alternative jobs or reducing exposure to the work environment, quitting smoking, and doing breathing exercises every day. This respiratory rehabilitation program involves exercises and techniques to improve lung function, breathing techniques, and education on managing clinical symptoms related to breathing. The most important aspect of the management of bisinosis is to prevent further exposure to cotton dust, involving the role of the work environment to avoid contact with cotton dust. Workers can also implement measures to reduce dust levels in the workplace, such as improving ventilation and implementing appropriate dust control methods. People with bisinosis may need regular monitoring of lung function to assess the progression of the condition and the effectiveness of treatment. Periodic spirometry tests may be performed to evaluate the function of the lungs.

CONCLUSION

Bisinosis is a lung disease caused by exposure to airborne particles produced during the processing of non-synthetic textiles, especially cotton-based materials. Risk factors for bisinosis include long-term exposure to cotton dust in the textile industry, smoking, a history of asthma or allergies, genetic predispositions, and factors such as age over 40 years, gender, or general health conditions. Bisinosis occurs more in smokers compared to non-smokers. Therefore, it is very important for cotton mill workers to reduce the risk of further lung dysfunction. The pathophysiology of bisinosis is influenced by the gram-negative bacterial endotoxin contained in cotton material. Exposure to these endotoxins lowers FEV1, making it considered a major mediator in occupational respiratory diseases such as bisinosis. Based on clinical symptoms and pulmonary function tests, the severity of bisinosis can be assessed using Schilling criteria. Supportive thorax X-ray examination of bisinosis shows a diffuse, ill-defined haziness picture, especially in the lower lobe of the lungs. All patients suspected of suffering from occupational lung disease should undergo a high-resolution CT Scan, from which the examination can be found in patients with business inosis, images of ground glass appearance, centrilobular nodules, thickening of the airway walls, as well as water trapping and fibrosis. Bisinosis has a good prognosis, so it is not a dangerous disease, but if you do not get the right and optimal treatment, this disease has long-term effects such as chronic obstructive pulmonary disease. Chronic exposure to bisinosis can cause irreversible lung damage.

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