

Silicosis Expert System Diagnosis and Treatment

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Abstract: **Background** Silicosis (particularly the acute form) is characterized by shortness of breath, cough, fever, and cyanosis (bluish skin). It may often be misdiagnosed as pulmonary edema (fluid in the lungs), pneumonia, or tuberculosis. Silicosis resulted in 46,000 deaths globally in 2013 down from 55,000 deaths in 1990. **Objectives** The main goal of this expert system is to get the appropriate diagnosis of disease and the correct treatment by presenting suggestions on Silicosis disease to the user by asking about symptoms. **Methods** SL5 Object Expert System language was used for designing and implementing the proposed expert system. **Results** The results obtained from the system were evaluated whether the patient was infected with the disease or not through specialists in lung diseases. The results were satisfactory at a very good rate compared to the basic symptoms of the disease.

Keywords: Artificial Intelligence, Expert Systems, SL5, Silicosis disease.

1. INTRODUCTION

An expert system incorporates a knowledge base containing accumulated experience and an inference or rules engine a set of rules for applying the knowledge base to each particular situation that is described to the program. The system's capabilities can be enhanced with additions to the knowledge base or to the set of rules. Current systems may include machine learning capabilities that allow them to improve their performance based on experience, just as humans do [2].

Any person who works in industries with exposure to inhaled silica should get regular health checkups and be monitored for signs and symptoms of lung disease. In addition, if you have a cough, phlegm, or breathing difficulty that is not improving, you should be closely evaluated by your doctor. Some people with acute silicosis also have fever, weight loss, and fatigue [3].

This process requires an expert to identify the disease, describe the methods of treatment and protection. Identifying the treatment accurately depends on the method that is used in diagnosing the diseases. Expert systems help a great deal in identifying those diseases and describing methods of treatment to be carried out taking into account the user capability in order to deal and interact with expert system easily and clearly (as shown in Fig1).

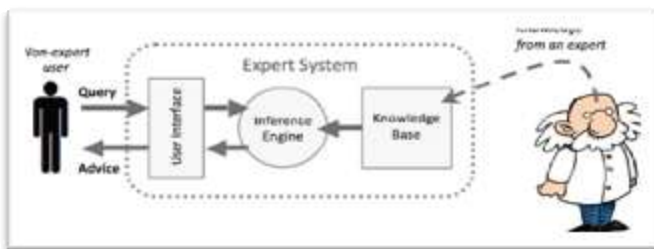


Figure 1: The figure presents the Main Components of an Expert System.

2. SILICOSIS

Silicosis is a lung disease caused by breathing in tiny bits of silica, a mineral that is part of sand, rock, and mineral ores such as quartz. It mostly affects workers exposed to silica dust in occupations such as mining, glass manufacturing, and foundry work. Over time, exposure to silica particles causes scarring in the lungs, which can harm your ability to breathe.

There are three types of silicosis:

- Acute silicosis, which causes cough, weight loss, and fatigue within a few weeks or years of exposure to inhaled silica.
- Chronic silicosis, which appears 10 to 30 years after exposure and can affect upper lungs and sometimes cause extensive scarring.
- Accelerated silicosis, which occurs within 10 years of high-level exposure.

Silicosis can develop within a few weeks to even decades after exposure. When people breathe silica dust, they inhale tiny particles of the mineral silica. This silica dust can cause fluid buildup and scar tissue in the lungs that cuts down your ability to breathe. This can lead to lung scarring and cough, weight loss, and fatigue.

2.1 How Silicosis Affects our Bodies

Silicosis affects the lungs by damaging the lining of the lung air sacs. Once this begins, it leads to scarring and, in some situations, to a condition called progressive massive fibrosis. This condition happens when there is severe scarring and stiffening of the lung, which makes it difficult to breathe.

People with acute silicosis experience cough, weight loss, tiredness, and may have fever or a sharp chest pain. You may also have shortness of breath over time, especially with chronic silicosis. Your healthcare provider might hear crackles or wheezing when they listen to your lungs. Having

silicosis increases the risk of other problems, such as tuberculosis, lung cancer, and chronic bronchitis.

Each type of silicosis affects the body somewhat differently:

- In acute silicosis, the lungs become very inflamed and can fill with fluid, which causes severe shortness of breath and low blood oxygen levels.
- In chronic silicosis, the silica dust causes areas of swelling in the lungs and chest lymph nodes, which makes breathing more difficult.
- In accelerated silicosis, swelling in the lungs and symptoms occur faster than in chronic silicosis.

Over time, lung capacity decreases, and people with silicosis may need support with oxygen and other devices to help them breathe.

2.2 Symptoms of Silicosis

Symptoms of silicosis can appear from a few weeks to many years after exposure to silica dust. Symptoms typically worsen over time as scarring in the lungs occurs.

Cough is an early symptom and develops over time with exposure to silica that is inhaled.

In acute silicosis, you may experience fever and sharp chest pain along with breathing difficulty. These symptoms can come on suddenly.

In chronic silicosis, you may only have an abnormal chest X-ray in the beginning and then slowly develop a cough and breathing difficulty. More than a third of people with silicosis have phlegm production and cough. Chronic bronchitis-like symptoms may occur, and the lungs have additional sounds called wheezes and crackles. As extensive scarring progresses over time, you may see signs of chronic lung disease such as leg swelling, increased breathing rate, and bluish discoloration of the lips.

2.3 Causes of Silicosis

Silicosis is caused by exposure to crystalline silica, which comes from chipping, cutting, drilling, or grinding soil, sand, granite, or other minerals. Any occupation where the earth's crust is disturbed can cause silicosis. A long list of occupations are known that expose workers to crystalline silica that is inhaled. These include:

- Various forms of mining, such as coal and hard rock mining
- Construction work
- Tunnel work
- Masonry
- Sand blasting
- Glass manufacturing
- Ceramics work
- Steel industry work
- Quarrying
- Stone cutting

2.4 Risk Factors of Silicosis

Breathing crystalline silica causes silicosis and the main risk factor is exposure to silica dust.

You can prevent silicosis by limiting exposure. There are national guidelines on exposure limits over a lifetime of working.

If you work in a job that exposes you to silica dust, your employer must, by law, give you the correct equipment and clothing you need to protect yourself. You are responsible for using it—always—and for taking other steps to protect yourself and your family as you leave your job site and head home. NIOSH also recommends that medical examinations occur before job placement or upon entering a trade, and at least every 3 years thereafter.

Patients with silicosis have an increased risk of other problems, such as tuberculosis, lung cancer, and chronic bronchitis. If you are a smoker, quitting may help, as smoking damages the lungs.

2.5 When to See Your Doctor

Any person who works in industries with exposure to inhaled silica should get regular health checkups and be monitored for signs and symptoms of lung disease. In addition, if you have a cough, phlegm, or breathing difficulty that is not improving, you should be closely evaluated by your doctor. Some people with acute silicosis also have fever, weight loss, and fatigue.

2.6 Diagnosing and Treating Silicosis

If you work or have worked in an occupation with exposure to inhaled silica and have a cough, phlegm, or breathing difficulty, you should be evaluated for silicosis.

It may take multiple doctor's visits and tests to diagnose silicosis. Once diagnosed, expect long-term monitoring and follow-up. You will also need to take measures to avoid further exposure.

How It's Diagnosed

Having worked in an at-risk industry is the best clue for your doctor, and a chest X-ray is crucial to diagnose the type of silicosis. Your visit will include a physical examination - your health-care provider will listen to your lungs - and a chest X-ray. Your chest X-ray may be normal, or you may have a lot of scarring in the lungs. There may be a series of tests, such as:

- Breathing tests
- High resolution CT scan of the chest
- A bronchoscopy to evaluate the inside of the lungs
- A biopsy of the lungs

Additional tests, such as mucus (sputum) evaluation, may be needed to assess for associated diseases, such as tuberculosis (TB).

How Silicosis Is Treated

There is no cure for silicosis. Prevention is still the best way to avoid the disease. Once silicosis has developed, your doctor will assess the degree of lung damage with tests. Some people may need urgent treatment with oxygen and support for breathing. Others may need medicines to decrease sputum production, such as inhaled steroids. Some may need inhaled bronchodilators, which relax the air tubes.

Once the disease advances, the management is similar to many other chronic lung diseases and needs a multidisciplinary or team approach. To keep the disease from getting worse, it is important to stay away from any additional sources of silica and other lung irritants, such as indoor and outdoor air pollution, allergens and smoke. You may consider counseling to discuss changing occupations.

Acute silicosis may need to be treated with steroids, and a lung transplant may need to be considered.

2.7 Living with Silicosis

Patients with silicosis need to maintain their health by leading an active lifestyle and avoiding further exposure. Quitting smoking, getting adequate exercise, managing your weight, and monitoring for complications are all important.

Many people with silicosis have chronic symptoms and a decrease in lifespan. However, over the last few decades, supportive care and earlier detection have improved survival significantly.

Managing the Disease

Appropriate diagnosis and treatment will make life with silicosis easier. Using the proper medications and seeing an experienced specialist are important to managing the disease. Here are a few tips to manage silicosis:

- Quit smoking
- Get yearly vaccinations, such as pneumococcal and influenza
- Be vigilant about watching for the development of TB or other infections
- Avoid further exposure to silica
- Educate yourself about the disease
- Consider enrolling in clinical trials
- Have a plan to manage flare-ups of the disease.

Oxygen support or other ways to manage chronic lung failure, like the use of noninvasive ventilator devices, may be needed.

3. MATERIALS AND METHODS

The proposed Expert System for Silicosis Diagnosis was implemented using, SL5 Object language which stands for Simpler Level 5 Object. It is a forward chaining reasoning expert system that can make inferences about facts of the world using rules, objects and take appropriate actions as a

result. The SL5 Object engine is implemented in Delphi Embarcadero RAD Studio XE6. SL5 Object executes any Expert System looks like frames. It's easy for the knowledge engineer to build the Expert System and for the end users when they use the system.

Figure 2 shows a sample dialogue between the expert system and the user about the Symptoms. Figure 3 shows how the users get the diagnosis and recommendation.

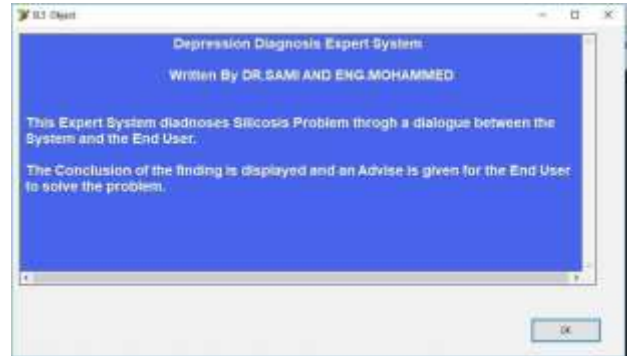


Figure 2: The figure presents main screen of the expert system

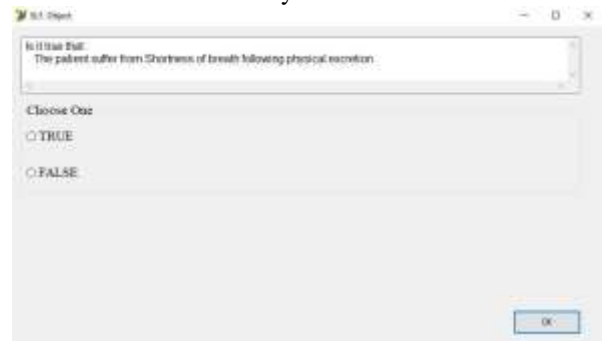


Figure 3: The figure presents shows when the system asks the user.

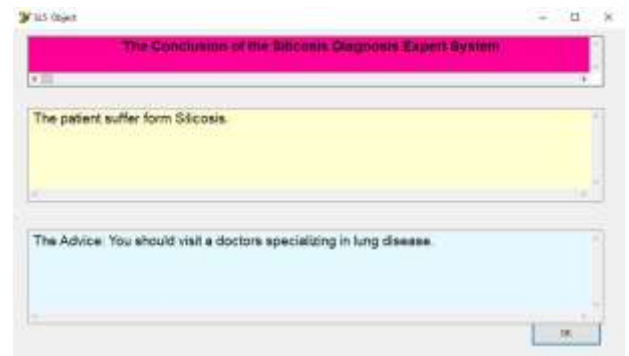


Figure 4: The figure shows diagnosis and recommendation of the expert system

4. LITERATURE REVIEW

There are many systems that have talked about diagnosing diseases whether they are related to humans, animals or even plants. However, the most important factor in the diagnosis of diseases was the analysis of the apparent picture of the

disease. For this system, it has been developed for a disease of lung disease, which has symptoms such as coughing and breathing, which is based entirely on the dialogue between the user and the system to determine whether the user has the disease or Not based on basic symptoms. Here are a few of Expert Systems that were designed to diagnose human diseases:

- An Expert System for Depression Diagnosis [12] to get the appropriate diagnosis of disease and the correct treatment and give the appropriate method of treatment through several tips that concern the disease and how to treat it.
- Knowledge Based System for Diabetes Diagnosis Using SL5 Object [50] to get the appropriate diagnosis of the illness, dealing with it quickly, and tips for permanent treatment whenever possible is given out.
- Hepatitis Expert System Diagnosis Using S15 Object [35] diagnoses the patient's condition and provides the appropriate solution.
- Knowledge Based System for Long-term Abdominal Pain (Stomach Pain) Diagnosis and Treatment [61] was made to aid internist physicians in diagnosing numerous of the abdomen diseases for example: gastritis, hiatal hernia, ulcer or heartburn; the proposed expert system offers a summary about abdomen diseases are given, the cause of diseases are drew and the cure of disease when possible is shown up.
- Expert System for Problems of Teeth and Gums [41] assist people with teeth and gums problems to diagnose their problems and receive a recommendation for the treatment. This knowledge based system was developed using SL5 Object language.
- Ear Diseases Diagnosis Expert System Using SL5 Object [37] swiftly diagnoses patient's condition and proposes a appropriate answer for the problem.
- An expert system for feeding problems in infants and children [40] to diagnose feeding problems in infants and children.
- Detecting Health Problems Related to Addiction of Video Game Playing Using an Expert System [43] to assist users in getting the correct diagnosis of the health problem of video game addictions that range from (Musculoskeletal issues, Vision problems and Obesity). Furthermore, this expert system delivers information about the problem and tells us how we can solve it.
- An expert system for men genital problems diagnosis and treatment [49] to assist men diagnose their genital problems and give them the suitable treatment. Genital problems and injuries usually occur through: recreational activities (such as: Basketball, Football, Hooky, Biking), work-related tasks (such as: contact to irritating chemicals), downhill drop, and sexual activities. SL5 Object expert system language was used to develop this expert system.
- An Expert System for Genital Problems in Infants [56] diagnoses genital problems in infants which is one of the most common problems that need quick intervention in the newly born stage.
- An expert system for nausea and vomiting problems in infants and children[59] to aid users in getting the right diagnosis of problems of nausea and vomiting in infants and children (Gastro-esophageal reflux, Gastroenteritis, Systemic Infection, Bowel obstruction, Tumors, A bleeding disease, tonsillitis, and Hepatitis pharynx). Additionally, this expert system offers information about the disease and how to deal with it.
- A Ruled Based System for Ear Problem Diagnosis and Treatment [52] was used to classify ear problems into three main sets: a- Inflammation of the inner ear b- Middle ear problems c- External ear problems.
- Lower Back Pain Expert System Diagnosis and Treatment [45] can be used to positively diagnose low back pain concentration.
- A Proposed Expert System for Foot Diseases Diagnosis [55] diagnoses eighteen foot problems of all phases of the human life beginning with baby to the grownup by examining with yes/no questions.
- A Knowledge Based System for Neck Pain Diagnosis [51] can diagnose seven neck diseases of different phases of the human life beginning by asking the user many questions according to their pain symptoms.
- An expert system for shoulder problems using CLIPS [62] can help in diagnosing shoulder problems.
- Expert system urination problems diagnosis [66] can diagnose some of the Urination diseases (Pyelonephritis, Kidney Stone, Bladder infection, Prostatitis, Urethritis, Gonorrhoea, Interstitial cystitis, Stress incontinence, Trauma in kidney or bladder).
- A Proposed Rule Based System for Breasts Cancer Diagnosis [54] was developed to help people in preventing and early detecting breast cancer; since it is known that this disease does not have medication or cure yet.
- A Proposed Expert System for Skin Diseases Diagnosis [68] was developed using CLIPS(C Language Integrated Production System) to help user diagnose the following skin diseases (Psoriasis, Eczema, Ichthyosis, Acne, Meningitis, Measles, Scarlet Fever, Warts, Insect Bites and Stings).

- Male Infertility Expert System Diagnoses and Treatment [47] for male infertility diagnosis which helps men to explore everything related to the problems of infertility and infertility diseases such as: Azoospermia, O.T.A syndrome which mean oligo-terato-astheno spermia, Aspermia and Sexual transmitted disease.
- An Expert System for Mouth Problems in Infants and Children [60] ask the user to answer the questions about the symptoms of the patient and end up with some information about the disease and some advices telling the user how to deal with the baby.
- Knowledge Management in ESMDA: Expert System for Medical Diagnostic Assistance [10] deals with the design of a prototype expert system that assists patients to diagnose their diseases and offer them the suitable advice.
- Expert System for the Diagnosis of Seventh Nerve Inflammation (Bell's palsy) Disease [11] diagnosis the seven nerve inflammation which will help doctors to explore everything related to the problems of seventh nerve inflammation. We look forward to providing simplified answers to seven nerve inflammation.
- Knowledge Based System for the Diagnosis of Dengue Disease [9] to help doctors and patients in diagnosing Dengue Disease and give them the information of how to prevent Dengue Disease and to be able to understand the signs and symptoms of Dengue Disease.
- An Expert System for Arthritis Diseases Diagnosis Using SL5 Object[7] to help Orthopedist in diagnosing Arthritis disease through its symptoms such as: pain on pressure in a joint, Inflammation indicated by joint swelling, Stiffness.
- A Proposed Expert System for Diagnosing Skin Cancer Using SL5 Object [65] quickly diagnose patient's condition and propose a suitable solution for the problem.
- Knowledge Based System for Ankle Diseases Diagnosis [48] recognized seven ankle diseases: Ankle Sprain, Fracture (of Fibula), Rheumatoid Arthritis, Rheumatoid Fever, Gout, and Osteoarthritis (Degenerative Joint) and they developed the expert system for those ankle diseases using SL5 Object Expert System Language.
- An Expert System for Diagnosing Shortness of Breath in Infants and Children [39] for diagnosing infants and children patients with twelve various shortness of breath in infants and children diseases.
- Polymyalgia Rheumatic Expert System [6] outlined an expert system for classification criteria for PMR,

recent advances of diagnostic and therapeutic procedures.

- Expert System for Chest Pain in Infants and Children [55] to assist doctors, parents, and care giver in diagnosing chest pain in infants and children.
- Rickets Expert System Diagnoses and Treatment [44] assist doctors to discover everything connected to the problems of rickets.
- Expert System for Hair Loss Diagnosis and Treatment [67] for diagnosing eleven diverse hair loss diseases of the human stages from childhood to adults by asking questions with a Yes or No answer.

There is no specialized expert system for the diagnosis of lung disease available free and use SL5 Object language. This expert system is easy to use by doctors and patients. This is due to the coordinated application interface.

5. KNOWLEDGE REPRESENTATION

The main sources of the knowledge for this expert system are websites for Silicosis. The captured knowledge has been converted into SL5 Object Knowledge base syntax (Facts, Rules and Object). Currently the expert system has 40 rules which cover Silicosis disease [4].

6. LIMITATIONS

The current proposed expert system is specialized in the diagnosis only the following four Symptoms for Silicosis, Shortness of breath following physical exertion, Severe and chronic cough, Fatigue, loss of appetite and Chest pains and fevers.

7. SYSTEM EVALUATION

We asked for help from some doctors to evaluate the performance of this system, namely Ziad Abdel Rahman and Walid Dawod, who are specialists in lung diseases.

Where the results were highly satisfactory and closely matched to the actual results according to the basic symptoms given.

8. CONCLUSION

In this system, a system of experts based on dialogue with the user about the possible symptoms of tuberculosis has been developed and gives accurate results for the patient whether he is infected with the disease or not and advises him if possible.

This system has made a great effort both from the perspective of the disease and from the doctor's point of view

This expert system does not need intensive training to be used; it is easy to use and has user friendly interface. It was developed using SL5 Object Expert System language.

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