

An Expert System for Diagnosing Cough Problem Using CLIPS

Tanseem N. Abu-Jamie, Mohammed A. Alkahlout, Samy S. Abu-Naser

Department of Information Technology,
Faculty of Engineering and Information Technology,
Al-Azhar University, Gaza, Palestine

Abstract: *Background :* A cough is an automatic (reflex) muscle action that forces air up and out of your lower airways (lungs) and upper airways (windpipe, nose and mouth). Everyone will cough occasionally to 'clear their throat'. The cough reflex protects the airways of your lungs. You may cough if the airways are partially blocked by mucus (when you have a cold or chest infection for example). You may cough if you choke on food and it enters your windpipe instead of going down the food pipe (oesophagus). Or you may need to cough if you breathe in chemicals or smoke that irritate your airways. **Objectives:** This paper will solve the problems of treatment of cough through correct diagnosis and treatment. **Methods:** In this research, we provide an expert system for the diagnosis of cough which will help doctors to explore everything related to the problems of cough. We look forward to providing simplified answers to cough.[1]

Keywords: Artificial Intelligence, Expert Systems, cough problem, clips.

1- INTRODUCTION:

A cough is your body's way of responding when something irritates your throat or airways. An irritant stimulates nerves that send a message to your brain. The brain then tells muscles in your chest and abdomen to push air out of your lungs to force out the irritant.

An occasional cough is normal and healthy. A cough that persists for several weeks or one that brings up discolored or bloody mucus may indicate a condition that needs medical attention.

At times, coughing can be very forceful. Prolonged, vigorous coughing can irritate the lungs and cause even more coughing. It is also exhausting and can cause sleeplessness, dizziness or fainting, headaches, urinary incontinence, vomiting, and even broken ribs.[2]

Doctors divide cough symptoms as follows:

- Acute, meaning it lasts for less than three weeks.
- Subacute, if it lasts for three to eight weeks.
- Chronic, meaning it lasts for longer than eight weeks.

Cough affects us all if we need to clear our airways. Acute cough usually improves after one week. The most common cause is a viral infection which causes a runny nose and cough. Viral infections can affect anyone. However, young children commonly have 5-6 viral infections a year, especially in the winter months. Chronic cough is common. 1-2 adults in 10 are affected.

What causes cough?

- ✓ Common causes of acute cough (lasting less than three weeks)

Upper respiratory tract infections: These are the most common cause of acute coughs. They are caused by infection with a germ (virus). They almost always get better within a week, without specific treatment. Symptoms may go on for up to three weeks.

Lower respiratory tract infections: These are less common; they can lead to more serious lung infections such as bronchitis or pneumonia. These conditions may be caused by infection with germs (viruses, bacteria or fungi).

- ✓ Common causes of subacute cough (lasting three to eight weeks)

Airways that are slow to settle down after an infection. In this case the germ has gone, but your airways are still swollen and irritable, causing you to keep coughing. This is called airway hyper-responsiveness.

- ✓ Common causes of chronic cough (lasting more than eight weeks)

Postnasal drip. This is a condition where mucus in the nose drips down the back of the throat when you lie down. It can be caused by anything which causes your nose to produce more mucus. This includes allergies, hay fever and nasal polyps as well as infections. Acid reflux. Acid reflux. Acid in the stomach washes up the food pipe and spills into the airways. Asthma.

Undiagnosed or under-treated asthma causes cough.

Side-effects of medication. For example, angiotensin-converting enzyme (ACE) inhibitor medicines, which are used to treat high blood pressure, can cause cough.

Lung disease caused by smoking - chronic obstructive pulmonary disease (COPD). Lung damage causes cough and breathlessness to get steadily worse. This mainly affects smokers.

Irritants such as cigarette smoke. This may be your own cigarette smoke, or from being in contact with other people's smoke (passive smoking).

2. EXPERT SYSTEM:

An expert system is computer software that attempts to act like a human expert on a particular subject area. Expert systems are often used to advise non-experts in situations where a human expert is unavailable (for example it may be too expensive to employ a human expert, or it might be a difficult to reach location).

How Do Expert Systems Work?

An expert system is made up of three parts:

- a. A user interface - This is the system that allows a non-expert user to query (question) the expert system, and to receive advice. The user-interface is designed to be as simple to use as possible.
- b. A knowledge base - This is a collection of facts and rules. The knowledge base is created from information provided by human experts
- c. An inference engine - This acts rather like a search engine, examining the knowledge base for information that matches the user's query [4].

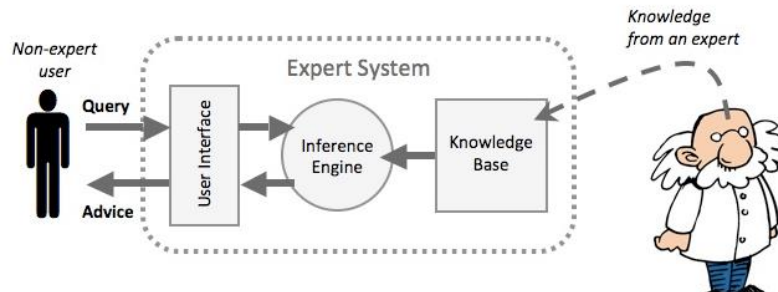


Figure 1: Expert Systems Work

2. LITERATURE REVIEW

There is a lot of Expert System that were designed to diagnose human and Plant Diseases [15-65] such as Problems of Teeth and Gums, Skin Diseases, cough and other types of Illness.. But there is no specialized expert system for diagnosis of cough diseases available free and Use a language CLIPS. This expert system was characterized to be easy to use by specialists and user concerned. This is due to the coordinated application interface. we have built up this expert system to help specialists doctor in diagnosing cough so as to prescribe the suitable treatment. Symptoms of a cough disease can vary depending on the cause.

Expert system is a computer application of Artificial Intelligence (AI) [14].

3. MATERIALS AND METHODS

The aim expert system performs diagnosis for cough diseases by presenting all symptoms. The aim expert system will ask the user to choose the type of symptoms. At the end expert system provides diagnosis, illness and recommendations for the user.

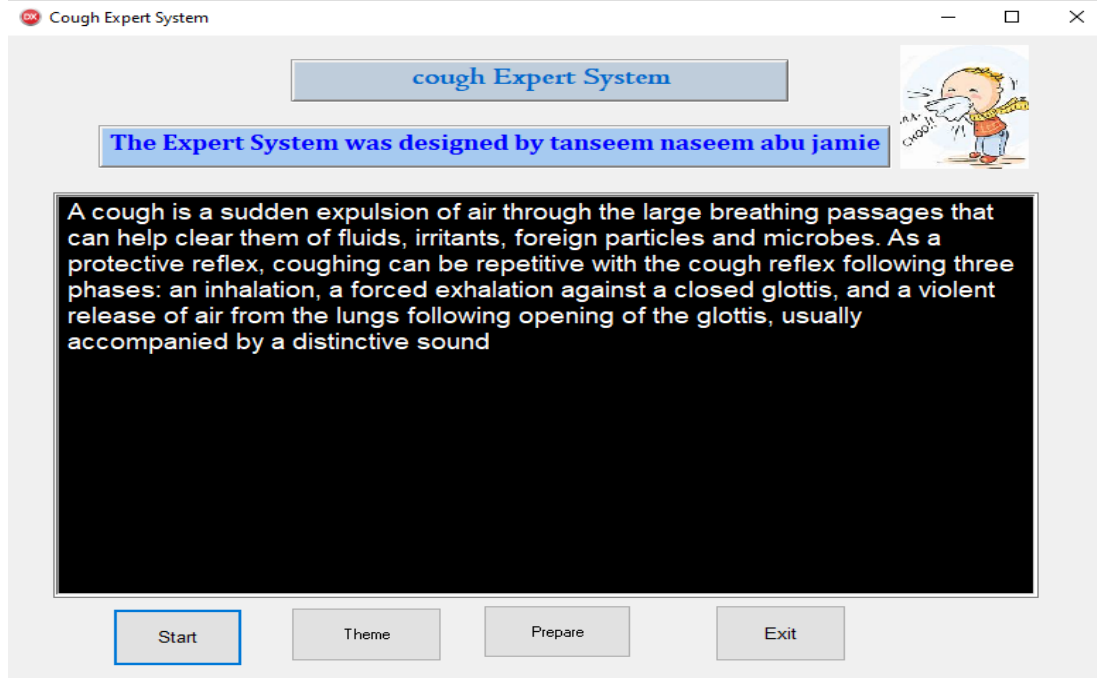


Figure 2: shows the main interface of the system

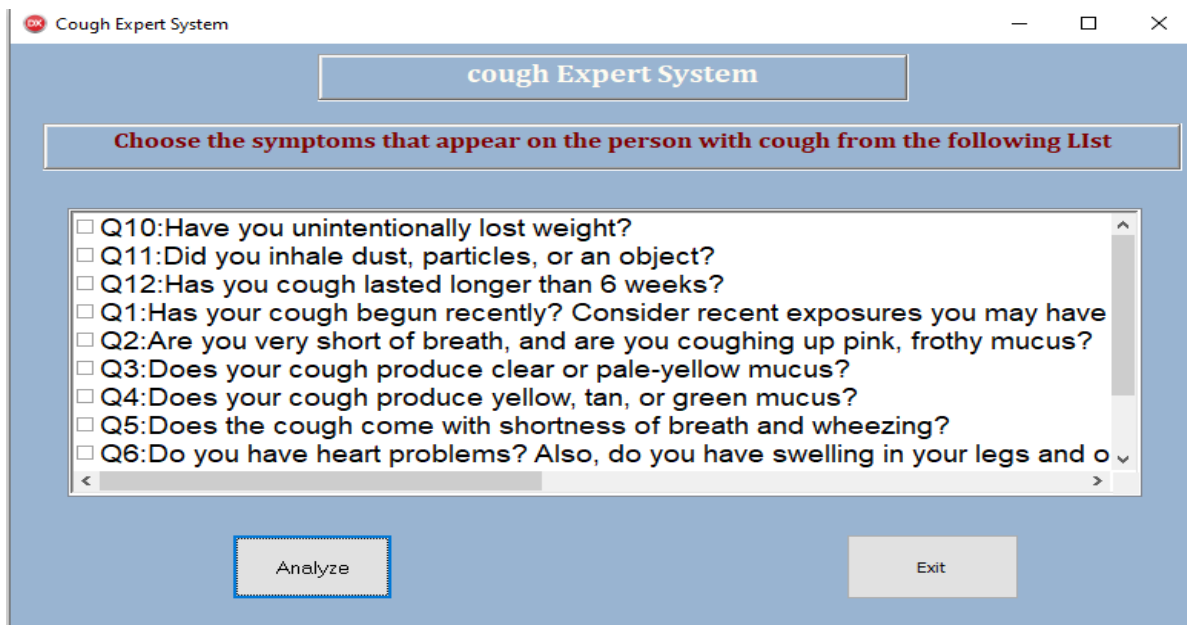


Figure 3: Dialogue between the expert system and the user

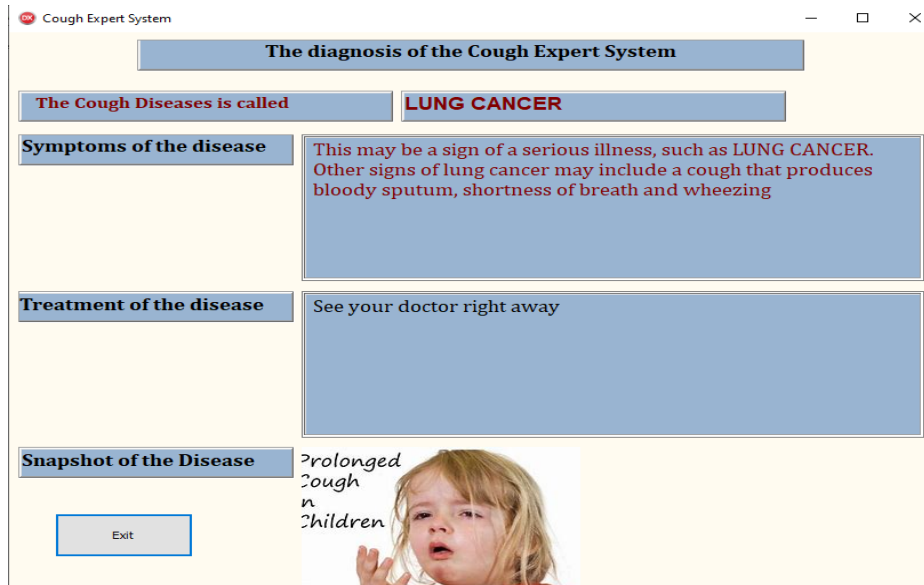


Figure 4:Diagnosis and recommendation

4. What Is a Knowledge Representation?

Perhaps the most fundamental question about the concept of knowledge representation is, What is it? We believe that the answer is best understood in terms of **the five fundamental roles that it plays:**

- Role 1: A Knowledge Representation Is a Surrogate Knowledge representation and reasoning
- Role 2: A Knowledge Representation Is a Set of Ontological Commitments
- Role 3: A Knowledge Representation Is a Fragmentary Theory of Intelligent Reasoning
- Role 4: A Knowledge Representation Is a Medium for Efficient Computation
- Role 5: A Knowledge Representation Is a Medium of Human Expression[5]

Knowledge Representation in AI describes the representation of knowledge. Basically, it is a study of how the beliefs, intentions, and judgments of an intelligent agent can be expressed suitably for automated reasoning. One of the primary purposes of Knowledge Representation includes modeling intelligent behavior for an agent.

Knowledge Representation and Reasoning (KR, KRR) represents information from the real world for a computer to understand and then utilize this knowledge to solve complex real-life problems like communicating with human beings in natural language. Knowledge representation in AI is not just about storing data in a database, it allows a machine to learn from that knowledge and behave intelligently like a human being.

The different kinds of knowledge that need to be represented in AI include:

- Objects
- Events
- Performance
- Facts
- Meta-Knowledge
- Knowledge-base

Now that you know about Knowledge representation in AI, let's move on and know about the different types of Knowledge.[5]



Figure 5:kinds of knowledge

Here some overview about above DIAGNOSIS :

- a. **PULMONARY EDEMA:** Pulmonary edema is a condition caused by excess fluid in the lungs. This fluid collects in the numerous air sacs in the lungs, making it difficult to breathe.

In most cases, heart problems cause pulmonary edema. But fluid can collect in the lungs for other reasons, including pneumonia, exposure to certain toxins and medications, trauma to the chest wall, and traveling to or exercising at high elevations.

Pulmonary edema that develops suddenly (acute pulmonary edema) is a medical emergency requiring immediate care. Pulmonary edema can sometimes cause death. The outlook improves if you get treated quickly. Treatment for pulmonary edema varies depending on the cause but generally includes supplemental oxygen and medications[6].

Symptoms:

Pulmonary edema signs and symptoms may appear suddenly or develop over time. The signs and symptoms you have depends on the type of pulmonary edema

Causes:

The causes of pulmonary edema vary. Pulmonary edema is grouped into two categories, depending on where the problem started.

- If a heart problem causes the pulmonary edema, it's called cardiogenic pulmonary edema. Most often, the fluid buildup in the lungs is due to a heart condition.
- If pulmonary edema is not heart related, it's called noncardiogenic pulmonary edema.
- Sometimes, pulmonary edema can be caused by both a heart problem and a non-heart problem.
- Understanding the relationship between your lungs and your heart can help explain why pulmonary edema may occur[6].

- b. **INFLUENZA (FLU) :**is a contagious respiratory illness caused by influenza viruses. It can cause mild to severe illness.

Serious outcomes of flu infection can result in hospitalization or death. Some people, such as older people, young children, and people with certain health conditions, are at high risk of serious flu complications. There are two main types of influenza (flu) virus: Types A and B. The influenza A and B viruses that routinely spread in people (human influenza viruses) are responsible for seasonal flu epidemics each year[7].

Symptoms:

- fever* or feeling feverish/chills
- cough
- sore throat
- runny or stuffy nose
- muscle or body aches
- headaches
- fatigue (tiredness)
- some people may have vomiting and diarrhea, though this is more common in children than adults[8].

Causes:

Influenza viruses travel through the air in droplets when someone with the infection coughs, sneezes or talks. You can inhale the droplets directly, or you can pick up the germs from an object such as a telephone or computer keyboard and then transfer them to your eyes, nose or mouth.

People with the virus are likely contagious from about a day before symptoms appear until about five days after they start.

Children and people with weakened immune systems may be contagious for a slightly longer time.

Influenza viruses are constantly changing, with new strains appearing regularly. If you've had influenza in the past, your body has already made antibodies to fight that specific strain of the virus. If future influenza viruses are similar to those you've encountered before, either by having the disease or by getting vaccinated, those antibodies may prevent infection or lessen its severity. But antibody levels may decline over time.

Also, antibodies against influenza viruses you've encountered in the past may not protect you from new influenza strains that can be very different viruses from what you had before[9].

c. **CHRONIC BRONCHITIS:**

Bronchitis is inflammation of the breathing tubes. These are the airways called bronchi. This inflammation causes too much mucus production and other changes. There are different types of bronchitis. But the most common are acute and chronic.

Chronic bronchitis is long-term inflammation of the bronchi. It is common among smokers. People with chronic bronchitis tend to get lung infections more easily. They also have episodes of acute bronchitis, when symptoms are worse.

Symptoms:

- Cough, often called smoker's cough
- Coughing up mucus (expectoration)
- Wheezing
- Chest discomfort

Causes:

- Disability
- Frequent and severe infections that affect your airways
- Narrowing and plugging of your breathing tubes (bronchi)
- Trouble breathing

d. **ASTHMA:**

is a condition in which your airways narrow and swell and may produce extra mucus. This can make breathing difficult and trigger coughing, a whistling sound (wheezing) when you breathe out and shortness of breath.

For some people, asthma is a minor nuisance. For others, it can be a major problem that interferes with daily activities and may lead to a life-threatening asthma attack.

Symptoms:

- Shortness of breath

- Chest tightness or pain
- Wheezing when exhaling, which is a common sign of asthma in children
- Trouble sleeping caused by shortness of breath, coughing or wheezing
- Coughing or wheezing attacks that are worsened by a respiratory virus, such as a cold or the flu

Causes:

It isn't clear why some people get asthma and others don't, but it's probably due to a combination of environmental and inherited (genetic) factors[10].

e. TUBERCULOSIS:

Tuberculosis (TB) is a potentially serious infectious disease that mainly affects the lungs. The bacteria that cause tuberculosis are spread from person to person through tiny droplets released into the air via coughs and sneezes.

Once rare in developed countries, tuberculosis infections began increasing in 1985, partly because of the emergence of HIV, the virus that causes AIDS. HIV weakens a person's immune system, so it can't fight the TB germs. In the United States, because of stronger control programs, tuberculosis began to decrease again in 1993. But it remains a concern.

Symptoms:

- Coughing for three or more weeks
- Coughing up blood or mucus
- Chest pain, or pain with breathing or coughing
- Unintentional weight loss
- Fatigue
- Fever
- Night sweats
- Chills
- Loss of appetite

Causes:

Tuberculosis is caused by bacteria that spread from person to person through microscopic droplets released into the air. This can happen when someone with the untreated, active form of tuberculosis coughs, speaks, sneezes, spits, laughs or sings.

Although tuberculosis is contagious, it's not easy to catch. You're much more likely to get tuberculosis from someone you live or work with than from a stranger. Most people with active TB who've had appropriate drug treatment for at least two weeks are no longer contagious[11].

f. LUNG CANCER:

is a type of cancer that begins in the lungs. Your lungs are two spongy organs in your chest that take in oxygen when you inhale and release carbon dioxide when you exhale. Lung cancer is the leading cause of cancer deaths worldwide.

People who smoke have the greatest risk of lung cancer, though lung cancer can also occur in people who have never smoked. The risk of lung cancer increases with the length of time and number of cigarettes you've smoked. If you quit smoking, even after smoking for many years, you can significantly reduce your chances of developing lung cancer.

Symptoms:

- A new cough that doesn't go away
- Coughing up blood, even a small amount
- Shortness of breath
- Chest pain
- Hoarseness
- Losing weight without trying
- Bone pain
- Headache

Causes:

Smoking causes the majority of lung cancers both in smokers and in people exposed to secondhand smoke. But lung cancer also occurs in people who never smoked and in those who never had prolonged exposure to secondhand smoke. In these cases, there may be no clear cause of lung cancer[12].

g. IRRITATION OF THE AIRWAYS:

Airway infections are common both among adults and children. In fact it is the most common type of acute illness that affects every person quite frequently in life. However, many people still confuse infections affecting different parts of the airways. Although all parts of the airways serve the same primary function – the movement of air to and from the lungs – each part may have additional functions. Therefore understanding the terms related to these parts of the airways with different names is important in order to understand how the symptoms may vary when an infection sets in[13].

Symptoms:

- chronic cough
- cough after eating
- hoarseness
- frequent throat clearing
- asthma or breathing problems
- sore throat
- ear pain
- enamel erosion
- frequent belching
- aggravation of other respiratory diseases
- swallowing problems (dysphagia)
- feeling of a lump in the throat
- recurrent flu-like infections.

Causes:

Acid is often thought to be the cause of any kind reflux damage, but in the case of airway reflux, acid represents only one part of the equation.

When gaseous reflux rises into the throat and airways, it takes along with it pepsin. Pepsin is an enzyme from the stomach that plays an essential role in digestion because it breaks down proteins. Without pepsin, we would not be able to digest the protein from the meals we eat.

h. A CHRONIC COUGH:

is a cough that lasts eight weeks or longer in adults, or four weeks in children.

A chronic cough is more than just an annoyance. A chronic cough can interrupt your sleep and leave you feeling exhausted. Severe cases of chronic cough can cause vomiting, lightheadedness and even rib fractures.

While it can sometimes be difficult to pinpoint the problem that's triggering a chronic cough, the most common causes are tobacco use, postnasal drip, asthma and acid reflux. Fortunately, chronic cough typically disappears once the underlying problem is treated.

Symptoms:

- A runny or stuffy nose
- A feeling of liquid running down the back of your throat (postnasal drip)
- Frequent throat clearing and sore throat
- Hoarseness
- Wheezing and shortness of breath
- Heartburn or a sour taste in your mouth
- In rare cases, coughing up blood

Causes:

- Postnasal drip
- Asthma

- Gastroesophageal reflux disease (GERD)
- Chronic obstructive pulmonary disease (COPD)

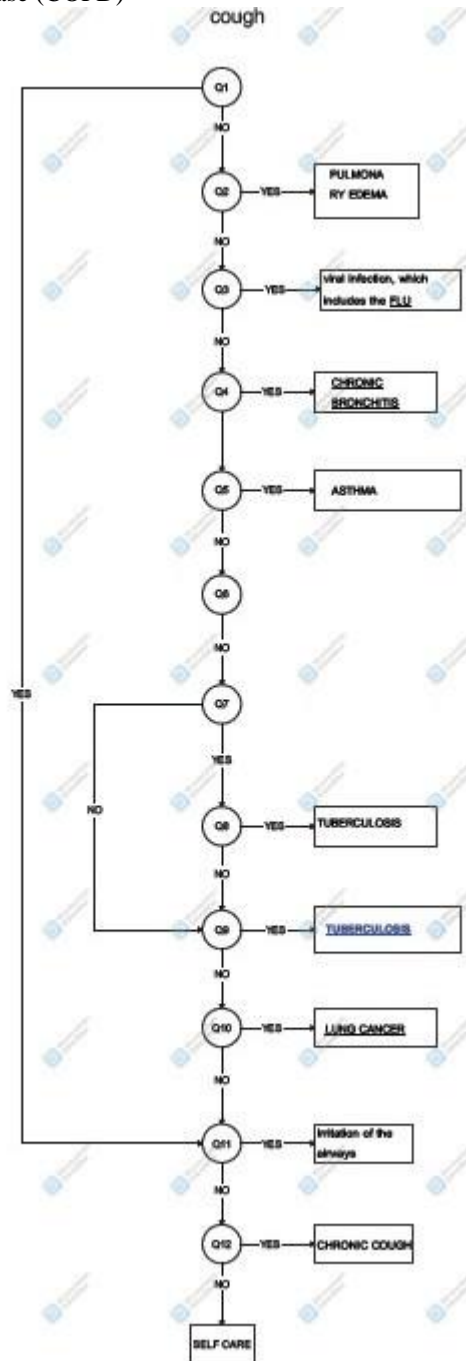


Figure 6: Decision Tree

- | |
|---|
| 1- Has your cough begun recently? Consider recent exposures you may have experienced, including new pets, new environments, new medications, etc. |
| 2- Are you very short of breath, and are you coughing up pink, frothy mucus? |
| 3- Does your cough produce clear or pale-yellow mucus? |

4-	Does your cough produce yellow, tan, or green mucus?
5-	Does the cough come with shortness of breath and wheezing?
6-	Do you have heart problems? Also, do you have swelling in your legs and/or shortness of breath when you are active or after you have been lying down?
7-	Have you recently started coughing up blood or bloody sputum?
8-	Have you recently started having sharp chest pain, rapid heartbeat, swelling of the legs and sudden shortness of breath?
9-	Do you have a fever, chills and night sweats along with chest pain when you cough or take a deep breath?
10-	Have you unintentionally lost weight?
11-	Did you inhale dust, particles, or an object?
12-	Has your cough lasted longer than 6 weeks?

Table 1: Questions that were used in the expert system

5. FUNCTION OF THE SYSTEM

The proposed system performs many functions. It will conclude the cough problems diagnosis based on answers of the user to specific question that the system asks the user. The questions provide the system for explanation for the symptoms of the patient that helps the expert system for diagnosis the disease by inference engine. It stores the facts and the conclusion of the inference of the system, and the user, for each case, in data base. It processes the data base in order to extract rules, which complete the knowledge base.

6. LIMITATIONS

There were 12 questions, and every question for cough only through which the patient was diagnosed, and one of the following diseases was decided Influenza (flu) , chronic bronchitis , Asthma ,tuberculosis ,Lung cancer , Irritation of the airways and a chronic cough.

7. CONCLUSION

In this paper, a proposed expert system is presented to help doctor and people with cough problems to diagnose the problem with twelve different possible questions of cough problems. This system enables the user to obtain a diagnosis quickly and more accurately than a traditional diagnosis. It is also easy to use and does not require any training before use. It was developed using clips Expert System language. An initial evaluation of the expert system was carried out and a positive feedback was received from the users. As future work we will constitute the expert system to cover all cough problems.

8. EXPERT SYSTEM SOURCE CODE

```
(defrule disease1
(Q1:Has your cough begun recently? Consider recent exposures you may have experienced, including new pets, new)
(Q11:Did you inhale dust, particles, or an object?)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "1" crlf)
)

(defrule disease2
(Q2:Are you very short of breath, and are you coughing up pink, frothy mucus?)
(not (disease identified))
=>
(assert (disease identified))
```

```
(printout fdatao "2" crlf )  
)
```

```
(defrule disease3  
(Q3:Does your cough produce clear or pale-yellow mucus?)  
(not (disease identified))  
=>  
(assert (disease identified))  
(printout fdatao "3" crlf )  
)
```

```
(defrule disease4  
(Q4:Does your cough produce yellow, tan, or green mucus?)  
(not (disease identified))  
=>  
(assert (disease identified))  
(printout fdatao "4" crlf )  
)
```

```
(defrule disease5  
(Q5:Does the cough come with shortness of breath and wheezing?)  
(not (disease identified))  
=>  
(assert (disease identified))  
(printout fdatao "5" crlf )  
)
```

```
(defrule disease6  
(Q6:Do you have heart problems? Also, do you have swelling in your legs and or shortness of breath when you are active?)  
(not (disease identified))  
=>  
(assert (disease identified))  
(printout fdatao "6" crlf )  
)
```

```
(defrule disease7  
(Q7:Have you recently started coughing up blood or bloody sputum?)  
(Q8:Have you recently started having sharp chest pain, rapid heartbeat, swelling of the legs and sudden shortness of breath?)  
(not (disease identified))  
=>  
(assert (disease identified))  
(printout fdatao "7" crlf )  
)
```

```
(defrule disease8  
(Q9:Do you have a fever, chills and night sweats along with chest pain when you cough or take a deep breath?)  
(not (disease identified))  
=>  
(assert (disease identified))  
(printout fdatao "8" crlf )  
)
```

```
(defrule disease9  
(Q10:Have you unintentionally lost weight?)  
(not (disease identified))
```

```
=>
(assert (disease identified))
(printout fdatao "10" crlf )
)

(defrule disease11
(Q12:Has you cough lasted longer than 6 weeks?)
(not (disease identified))
=>
(assert (disease identified))
(printout fdatao "11" crlf )
)

(defrule endline
(disease identified)
=>
(close fdatao)
)

(defrule readdata
(declare (salience 1000))
(initial-fact)
?fx <- (initial-fact)
=>
(retract ?fx)
(open "data.txt" fdata "r")
(open "result.txt" fdatao "w")

(bind ?symptom1 (readline fdata))
(bind ?symptom2 (readline fdata))
(bind ?symptom3 (readline fdata))
(bind ?symptom4 (readline fdata))
(bind ?symptom5 (readline fdata))
(bind ?symptom6 (readline fdata))
(bind ?symptom7 (readline fdata))
(bind ?symptom8 (readline fdata))
(bind ?symptom9 (readline fdata))
(bind ?symptom10 (readline fdata))
(bind ?symptom11 (readline fdata))
(bind ?symptom12 (readline fdata))

(assert-string (str-cat "(" ?symptom1 "))")
(assert-string (str-cat "(" ?symptom2 "))")
(assert-string (str-cat "(" ?symptom3 "))")
(assert-string (str-cat "(" ?symptom4 "))")
(assert-string (str-cat "(" ?symptom5 "))")
(assert-string (str-cat "(" ?symptom6 "))")
(assert-string (str-cat "(" ?symptom7 "))")
(assert-string (str-cat "(" ?symptom8 "))")
(assert-string (str-cat "(" ?symptom9 "))")
(assert-string (str-cat "(" ?symptom10 "))")
(assert-string (str-cat "(" ?symptom11 "))")
(assert-string (str-cat "(" ?symptom12 "))")

(close fdata)
)
```

References

1. <https://patient.info/chest-lungs/cough-leaflet>
2. <https://searchio.techtarget.com/definition/knowledge-based-syd-systems-KBS>
3. <https://www.healthgrades.com/right-care/skin-hair-and-nails/facial-rash>
4. [IGCSE ICT - Expert Systems | IGCSE ICT](#)
5. <https://www.javatpoint.com/knowledge-representation-in-ai>
6. [Pulmonary edema - Symptoms and causes - Mayo Clinic](#)
7. [About Flu | CDC](#)
8. [Flu Symptoms & Complications | CDC](#)
9. [Influenza \(flu\) - Symptoms and causes - Mayo Clinic](#)
10. [Asthma - Symptoms and causes - Mayo Clinic](#)
11. [Tuberculosis - Symptoms and causes - Mayo Clinic](#)
12. [Lung cancer - Symptoms and causes - Mayo Clinic](#)
13. [Chronic cough - Symptoms and causes - Mayo Clinic](#)
14. Science News For Students Website <https://www.sciencenewsforstudents.org/article/behavior-genes-could-identify-type-infection>, , date visited MAY 2, 2021.
15. Akkila, A. N., et al. (2008). A Proposed Expert System for Skin Diseases Diagnosis. INSInet Publication. Journal of Applied Sciences Research, 4(12), 1682- 1693.
16. <http://familydoctor.org> visited 1-3-2021.
17. Abu Ghali, M. J., et al. (2017). Expert System for Problems of Teeth and Gums. International Journal of Engineering and Information Systems (IJEAIS), 1(4), 198-206.
18. Al Rekhawi, H. A., et al. (2017). Rickets Expert System Diagnoses and Treatment. International Journal of Engineering and Information Systems (IJEAIS), 1(4), 149-159.
19. El Agha, M., Jarghon, A., et al. (2017). Polymyalgia Rheumatic Expert System. International Journal of Engineering and Information Systems (IJEAIS), 1(4), 125-137.
20. Al-Dahdooh, R., et al. (2010). Knowledge management in ESMDA: expert system for medical diagnostic assistance. AIML Journal, 10(1), 31-40.
21. AbuEl-Reesh, J. Y., et al. (2017). A Knowledge Based System for Diagnosing Shortness of Breath in Infants and Children. International Journal of Engineering and Information Systems (IJEAIS), 1(4), 102-115.
22. El Haddad, I., et al. (2016). An Expert System for Genital Problems in Infants. World Wide Journal of Multidisciplinary Research and Development (WWJMRD), 2(5).
23. Almurshidi, S. H., et al. (2018). EXPERT SYSTEM FOR DIAGNOSING BREAST CANCER. Al-Azhar University, Gaza, Palestine.
24. Alawar, M. W., et al. (2016). An expert system for feeding problems in infants and children. International Journal of Medicine Research, 1(2), 79-82.
25. Nabahin, A., et al. (2017). Expert System for Hair Loss Diagnosis and Treatment. International Journal of Engineering and Information Systems (IJEAIS), 1(4), 160-169.
26. AlDahdooh, R. M., et al. (2016). Lower Back Pain Expert System Diagnosis and Treatment. Journal of Multidisciplinary Engineering Science Studies (JMESS), 2(4), 441-446.
27. Alhabbash, M. I., et al. (2016). Male Infertility Expert system Diagnoses and Treatment. American Journal of Innovative Research and Applied Sciences, 2(4).
28. Khella, R., et al. (2017). Rule Based System for Chest Pain in Infants and Children. International Journal of Engineering and Information Systems, 1(4), 138- 148.
29. Al-Hanjori, M. M., et al. (2016). An expert system for men genital problems diagnosis and treatment. International Journal of Medicine Research, 1(2), 83-86.
30. AlMurshidei, S. H., et al. (2016). A Knowledge Based System for Neck Pain Diagnosis. World Wide Journal of Multidisciplinary Research and Development (WWJMRD), 2(4), 12-18.
31. Mrouf, A., et al. (2017). Knowledge Based System for Long-term Abdominal Pain (Stomach Pain) Diagnosis and Treatment. International Journal of Engineering and Information Systems (IJEAIS), 1(4), 71-88.
32. Bastami, B. G., et al. (2016). A proposed rule based system for breasts cancer diagnosis. World Wide Journal of Multidisciplinary Research and Development, 2(5), 27-33.
33. Hasanein, H. A. A., et al. (2016). Ear Diseases Diagnosis Expert System Using SL5 Object. World Wide Journal of Multidisciplinary Research and Development, 2(4), 41-47.
34. El-Najjar, A. E. A., et al. (2016). An expert system for nausea and vomiting problems in infants and children. International Journal of Medicine Research, 1(2), 114-117.
35. Qwaider, S. R., et al. (2017). Expert System for Diagnosing Ankle Diseases. International Journal of Engineering and Information Systems (IJEAIS), 1(4), 89-101.
36. Hamed, M. A., et al. (2016). An Expert System for Mouth Problems in Infants and Children. Journal of Multidisciplinary Engineering Science Studies (JMESS), 2(4), 468-476.
37. Mahdi, A. O., et al. (2016). A proposed Expert System for Foot Diseases Diagnosis. American Journal of Innovative Research and Applied Sciences, 2(4), 155-168.
38. Ola, A. Z. A., et al. (2008). AN EXPERT SYSTEM FOR DIAGNOSING EYE DISEASES USING CLIPS. Journal of Theoretical & Applied Information Technology, 4(10).
39. Shaath, M. Z., et al. (2016). Expert system urination problems diagnosis. World Wide Journal of Multidisciplinary Research and Development, 2(5), 9-19.
40. El-Hissi, H., et al. (2010). An expert system for endocrine diagnosis and treatments using JESS. Journal of Artificial Intelligence; Scialert, 3(4), 239-251.
41. El-Jerjawi, N. S., et al. (2018). Diabetes Prediction Using Artificial Neural Network. International Journal of Advanced Science and Technology, 121, 55-64.
42. El-Mashharawi, H. Q., et al. (2019). An Expert System for Arthritis Diseases Diagnosis Using SL5 Object. International Journal of Academic Health and Medical Research (IAHMR), 3(4), 28-35.
43. Mansour, A. I., et al. (2019). Knowledge Based System for the Diagnosis of Dengue Disease. International Journal of Academic Health and Medical Research (IAHMR), 3(4), 12-19.
44. Mettleq, A. S. A., et al. (2019). Expert System for the Diagnosis of Seventh Nerve Inflammation (Bell's palsy) Disease. International Journal of Academic Information Systems Research (IJAISR), 3(4), 27-35.
45. Alshawwa, I. A., et al. (2019). An Expert System for Depression Diagnosis. International Journal of Academic Health and Medical Research (IAHMR), 3(4), 20-27.
46. Elsharif, A. A., et al. (2019). Hepatitis Expert System Diagnosis Using SL5 Object. International Journal of Academic Information Systems Research (IJAISR), 3(4), 10-18.
47. Dheir, I. M., Mettleq, A. S. A., Elsharif, A. A., Al-Qumboz, M. N. A., et al. (2019). Knowledge Based System for Diabetes Diagnosis Using SL5 Object. International Journal of Academic Pedagogical Research (IJAPR), 3(4), 1-10.
48. Al-Shawwa, M. O., et al. (2019). A Proposed Expert System for Diagnosing Skin Cancer Using SL5 Object. International Journal of Academic Information Systems Research (IJAISR), 3(4), 1-9.
49. Samhan, L. F., et al. (2021). An Expert System for Knee Problems Diagnosis. International Journal of Academic Information Systems Research (IJAISR), 5(4), 59-66.