

# Thyroid Knowledge Based System

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**Abstract: Background:** Thyroid disease is a group of disorders that affects the thyroid gland. The thyroid is a small, butterfly-shaped gland in the front of your neck that makes thyroid hormones. Thyroid hormones control how your body uses energy, so they affect the way nearly every organ in your body works—even the way your heart beats. Therefore, in this paper will identify what is the thyroid and diseases present in thyroid and detect the symptoms in each disease. **Objectives:** The main objective of this expert system is to obtain appropriate diagnosis of this disease. **Methods:** In this paper, the expert system is designed for the ability of doctors to detect and diagnose disease of thyroid. The proposed expert system presents an overview about thyroid diseases are given, the cause of diseases are outlined and the treatment of disease whenever possible is given out. SL5 Object Expert System language was used for designing and implementing the proposed expert system. **Results:** The expert system in the diagnosis of thyroid diseases was assessed by Medical student and doctors they were satisfied and accepted with its quality of performance. **Conclusions:** The expert system is easy for podiatric physician, patients and people have experience to detect and diagnosis the symptoms that may face this disease.

**Keywords:** Artificial Intelligence, Expert Systems, SL5 Object, Thyroid diseases, Language.

## 1. INTRODUCTION

Thyroid is a small gland, shaped like a butterfly, which rests in the middle of the lower neck. Its primary function is to control the body's metabolism (rate at which cells perform duties essential to living). To control metabolism, the thyroid produces hormones, which tell the body's cells how much energy to use.

A properly functioning thyroid will maintain the right amount of hormones needed to keep the body's metabolism functioning at a satisfactory rate. As the hormones are used, the thyroid creates replacements. The quantity of thyroid hormones in the bloodstream is monitored and controlled by the pituitary gland. When the pituitary gland, which is located in the center of the skull below the brain, senses either a lack of thyroid hormones or a high level of thyroid hormones, it will adjust its own hormone (TSH) and send it to the thyroid to tell it what to do.

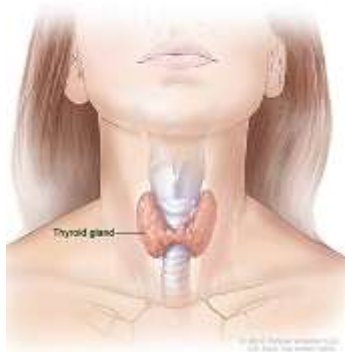


Figure 1: thyroid gland

### What is thyroid disease and whom does it affect?

When the thyroid produces too many hormones, the body uses energy too quickly. This condition is called

Hyperthyroidism. When the thyroid does not produce enough hormones, the body uses too much energy. This condition is called hypothyroidism.

People of all ages can get thyroid disease. However, women are more likely to develop thyroid disease five to eight times.

### What causes thyroid disease?

There are several different causes of thyroid disease. The following conditions cause **Hypothyroidism**:

- Thyroid inflammation is inflammation of the thyroid gland. This can reduce the amount of hormones produced.
- Hashimoto's thyroiditis is a painless disease in the hereditary immune system.
- Postpartum thyroid infection occurs in 5% to 9% of postpartum women. Usually a temporary condition.
- Iodine deficiency is a problem affecting nearly 100 million people around the world. Iodine is used by the thyroid to produce hormones.
- The non-functioning thyroid affects one in every 4,000 newborns. If the problem is not corrected, the child will be delayed physically and mentally.

The following conditions cause **Hyperthyroidism**:

- With Graves' disease, the entire thyroid gland may be overactive and produce a lot of hormones.
- The nodules may be overactive within the thyroid gland.
- Thyroid inflammation, a disorder that can be painful or painless, can also release hormones stored in the thyroid gland causing hyperthyroidism for a few weeks or months. The painless variety often occurs in postpartum women.

- Excessive iodine exists in a number of drugs and may cause thyroid production either to large or very small in some individuals

Each of hypothyroidism and hyperthyroidism have symptoms. The symptoms for hypothyroidism are Fatigue, Frequent, heavy menstrual periods, Forgetfulness, Weight gain, Dry, coarse skin and hair, Hoarse voice, Intolerance to cold. Thy symptoms for hyperthyroidism are Irritability/nervousness, Muscle weakness/tremors, Infrequent, scant menstrual periods, Weight loss, Sleep disturbances, Enlarged thyroid gland, Vision problems or eye irritation, Heat sensitivity.

When thyroid disease is detected early, treatment can control the disorder even before the onset of symptoms. Thyroid diseases are life-long conditions. With careful management, people with thyroid disease can lead normal and healthy lives.

Fluoride in water and hypothyroidism, According to researchers at the University of Kent, the fluoridation of water above a certain level is associated with 30 percent higher than expected rates of hyperthyroidism and hypothyroidism, which may lead to weight gain and depression. The study was published online in the Journal of Epidemiology and Community Health. [1]

An expert system is a computer system that emulates, or acts in all respects, with the decision-making capabilities of a human expert. It has main components: Knowledge base, it's obtainable from books, magazines, knowledgeable persons, etc. Inference engine, it draws conclusions from the knowledge base. [2]

In the below figure 2 display the main components.

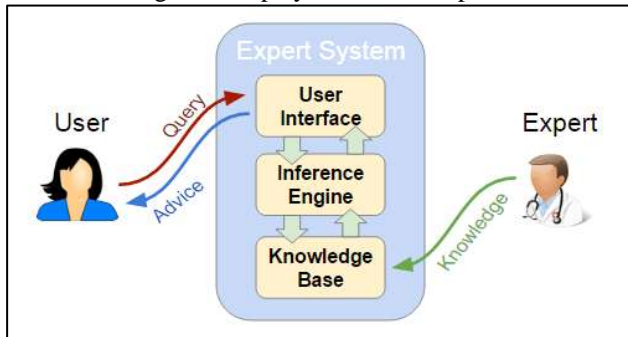


Figure 2: main components of expert system

The Expert system for Thyroid Diseases Diagnosis was implemented using SL5 Object language. SL5 object stands for Simpler Level 5 Object, forward-chaining, starting from the facts, a solution is developed. It influenced by OPS5 and L5 object, also it implemented in Delphi Embarcadero RAD studio XE6 for efficiency and portability, developed by Prof. Dr. Samy S. Abu Naser for Education Purposes, it runs on PC. SL5 Object provides mechanisms for expert systems to production rule interpreter.

## 2. MATERIALS AND METHODS

The expert system accomplishes diagnosis for two type of thyroid diseases of all stages of the human life starting with newborn to the elderly by asking yes or no questions. The expert system will ask the user to choose the correct answer in each screen. At the end of the dialogue session, the proposed expert system provides the diagnosis and recommendation of the disease to the user. Figure 3 shows a sample dialogue between expert system and user describe the type of thyroid. Figure 4 shows the symptoms for type selected. Figure 4 shows the conclusion of the thyroid expert system include the diagnosis and recommendation.

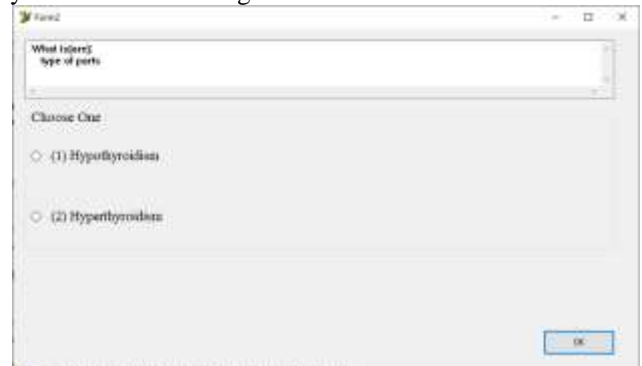


Figure 3: screen of type thyroid disease



Figure 4: screen hypothyroidism symptom

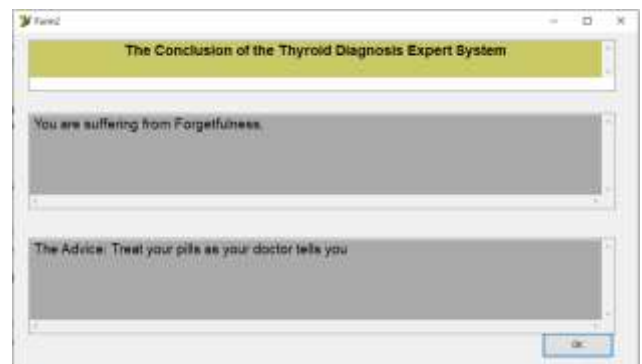


Figure 5: screen of the conclusion and advice

### 3. LITERATURE REVIEW

A lot of intelligent systems are found that were designed and implemented for helping doctors and patient in diagnosing human diseases such as:

- An expert system for nausea and vomiting problems in infants and children [65] 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 [58] 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 [48] can be used to positively diagnose low back pain concentration.
- A Proposed Expert System for Foot Diseases Diagnosis [61] 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 [57] 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 [68] can help in diagnosing shoulder problems.
- Expert system urination problems diagnosis [69] 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 [60] 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 [74] 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 [50] 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 [66] 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 [16] 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 [17] 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 [15] 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 [13] 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 [71] quickly diagnose patient's condition and propose a suitable solution for the problem.
- Knowledge Based System for Ankle Diseases Diagnosis [74] 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 [45] for diagnosing infants and children patients with twelve various shortness of breath in infants and children diseases.
- Polymyalgia Rheumatic Expert System [12] 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 [61] to assist doctors, parents, and care

giver in diagnosing chest pain in infants and children.

- Rickets Expert System Diagnoses and Treatment [50] assist doctors to discover everything connected to the problems of rickets.
- Expert System for Hair Loss Diagnosis and Treatment [71] for diagnosing eleven diverse hair loss diseases of the human stages from childhood to adults by asking questions with a Yes or No answer.
- An Expert System for Depression Diagnosis [18] 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 [56] 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 [41] diagnoses the patient's condition and provides the appropriate solution.
- Knowledge Based System for Long-term Abdominal Pain (Stomach Pain) Diagnosis and Treatment [67] 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 [47] 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 [43] swiftly diagnoses patient's condition and proposes a appropriate answer for the problem.
- An expert system for feeding problems in infants and children [46] to diagnose feeding problems in infants and children.
- Detecting Health Problems Related to Addiction of Video Game Playing Using an Expert System [49] 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 [55] 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 [62] diagnoses genital problems in infants which is one of the most common problems that need quick intervention in the newly born stage.

There is no specialized expert system for the diagnosis of thyroid available free and use SL5 Object language. This expert system is easy to use by doctors and patients.

#### 4. KNOWLEDGE REPRESENTATION

The main sources of the knowledge for this expert system are thyroid physician and specializes websites for thyroid diseases. The captured knowledge has been converted into SL5 Object Knowledge base. Currently the expert system has two types conditions cause, each types contain several symptoms:

**First type is hypothyroidism**, also called underactive thyroid or low thyroid, is a disorder of the endocrine system in which the thyroid gland does not produce enough thyroid hormone. It have number of symptoms such as, fatigue, frequent, heavy menstrual periods, forgetfulness, weight gain, dry, coarse skin and hair, hoarse voice, intolerance to cold [7].

The inactive thyroid gland requires long-term ways of regulating, so it is normal to be concerned about the effects of persistent fatigue. Characterized by extreme fatigue, lack of energy, physical fatigue, fatigue can be seriously harmful to well-being [8].



Figure 6: Fatigue is very common symptom of hypothyroidism

Heavy periods can occur due to several things, often as a result of hormonal imbalance. Hormones - estrogen and progesterone - control of menstruation. During menopause, women have fluctuating levels of these hormones. These often cause periods to become heavy periods [9].



Figure 7: heavy period's symptoms

### How is Hypothyroidism treated?

Hypothyroidism deficiency is treated with drugs that give your body the thyroid hormone it needs to function normally. The most common medications are man-made forms of thyroid hormone. You will probably need to take thyroid hormone pills for the rest of your life. When you eat grains as your doctor tells you, the grains are very safe.

**Second Type is Hyperthyroidism**, causes your thyroid to make thyroid hormone more than your body needs. This speeds up many body functions, such as metabolism and heart rate. The most common cause of hyperthyroidism is the Graves' disease. Graves' disease is a problem in the immune system.



Figure 8: Hyperthyroidism disease

**How is hyperthyroidism treated?** Your doctor's choice of treatment depends on your symptoms and your hyperthyroidism. Treatments include:

- Medication.
  - Antithyroid drugs prevent the thyroid gland from making the new thyroid hormone. These drugs do not cause permanent damage to thyroid gland.
  - Beta blockers prevent the effects of thyroid hormone on your body. These medications can be helpful in slowing down the heart rate and treating other symptoms until one of the other forms of treatment is activated. Beta blockers do not reduce the amount of thyroid hormones that are produced.

- Radioactive Iodine. This treatment kills thyroid cells that make thyroid hormones. Often, this causes permanent thyroid.
- Surgery. Thyroid surgery removes most or all of the thyroid gland. This may cause permanent hypothyroidism [10].

## 5. LIMITATIONS

Currently the proposed expert system is specialized in the two types of thyroid diseases hypothyroid and hyperthyroid, each type have some of symptoms. Hypothyroidism have this symptoms: Fatigue, Frequent, heavy menstrual periods, Forgetfulness, Weight gain, Dry, coarse skin and hair, Hoarse voice and Intolerance to cold. Hyperthyroidism have this symptoms: Irritability/nervousness, Muscle weakness/tremors, Infrequent, scant menstrual periods, Weight loss, Sleep disturbances, Enlarged thyroid, gland, Vision problems or eye irritation, Heat sensitivity.

## 6. SYSTEM EVALUATION

As an introductory evolution, a group of doctors and medical specialists tested this proposed Expert System and they were satisfied with its performance, efficiency, user interface and ease of use.

## 7. CONCLUSION

In this paper, a proposed expert system was presented for helping doctors and medical specialists in diagnosing patients with different possible thyroid diseases. They can get the diagnosis faster and more accurate than the traditional diagnosis. This expert system does not need intensive training to be used; it is easy to use and has user friendly interface. It was developed by using SL5 Object Expert System language.

## 8. FUTURE WORK

This expert system is considered to be a base of future ones; more thyroid diseases are planned to be added and to make it more accessible to users from anywhere at any time.

## 9. EXPERT SYSTEM SOURCE CODE

```
! This is a demo
! Written bu Fatima Maher Salman
!
ATTRIBUTE type of parts COMPOUND
    Hypothyroidism, Hyperthyroidism
```

```
ATTRIBUTE Hypothyroidism Symptom COMPOUND
    Fatigue,
    Frequent and heavy menstrual periods,
    Forgetfulness,
    Weight gain,
    Dry and coarse skin and hair,
    Hoarse voice,
    Intolerance to cold
```

ATTRIBUTE Hyperthyroidism Symptom COMPOUND

Irritability or nervousness,  
Muscle weakness or tremors,  
Infrequent and scant menstrual periods,  
Weight loss,  
Sleep disturbances,  
Enlarged thyroid gland,  
Vision problems or eye irritation,  
Heat sensitivity

ATTRIBUTE start SIMPLE

INSTANCE the domain ISA domain  
WITH start := TRUE

INSTANCE the application ISA application  
WITH title display := introduction  
WITH conclusion display := Conc

INSTANCE introduction ISA display  
WITH wait := TRUE  
WITH delay changes := FALSE  
WITH items [ 1 ] := textbox 1

INSTANCE textbox 1 ISA textbox  
WITH location := 10,10,800,350  
WITH pen color := 0,0,0  
WITH fill color := 100,200,100  
WITH justify IS left  
WITH font := "Arial"  
WITH font style IS bold  
WITH font size := 14  
WITH text := "

Thyroid Diagnosis Expert System

Written By Fatima M. Salman

This Expert System diagnoses Thyroid Problems through a dialog between the System and the End User.

The Conclusion of the finding is displayed and an Advise is given for the End User to solve the problem."

INSTANCE Conc ISA display  
WITH wait := TRUE  
WITH delay changes := FALSE  
WITH items [1] := title textbox  
WITH items [2] := problem textbox

WITH items [3] := advise textbox

INSTANCE title textbox ISA textbox  
WITH location := 20,10,800,70  
WITH pen color := 0,0,0  
WITH fill color := 200,200,100  
WITH justify IS center  
WITH font := "Arial"  
WITH font style IS bold  
WITH font size := 14  
WITH text := " The Conclusion of the Thyroid Diagnosis Expert System"

INSTANCE problem textbox ISA textbox  
WITH location := 20,110,800,130  
WITH pen color := 0,0,0  
WITH fill color := 170,170,170  
WITH justify IS left  
WITH font := "Arial"  
WITH font size := 14  
WITH text := " --====--"

INSTANCE advise textbox ISA textbox  
WITH location := 20,280,800,130  
WITH pen color := 0,0,0  
WITH fill color := 170,170,170  
WITH justify IS left  
WITH font := "Arial"  
WITH font size := 14  
WITH text := " --====--"

RULE R1  
IF type of parts IS Hypothyroidism  
THEN ASK Hypothyroidism Symptom

RULE R2  
IF type of parts IS Hyperthyroidism  
THEN ASK Hyperthyroidism Symptom

RULE R0  
IF start  
THEN ASK type of parts

RULE R4  
IF type of parts IS Hypothyroidism  
AND Hypothyroidism Symptom IS Fatigue THEN  
text OF problem textbox := " You are suffering from Fatigue. "  
AND text OF advise textbox := "The Advice: Treat your pills as your doctor tells you"

RULE R5  
IF type of parts IS Hypothyroidism  
AND Hypothyroidism Symptom IS Frequent and heavy menstrual periods THEN

text OF problem textbox := "You are suffering from Frequent and heavy menstrual periods."  
AND text OF advise textbox := "The Advice: Treat your pills as your doctor tells you "

**RULE R6**

IF type of parts IS Hypothyroidism  
AND Hypothyroidism Symptom IS Forgetfulness  
THEN text OF problem textbox := "You are suffering from Forgetfulness."  
AND text OF advise textbox := "The Advice: Treat your pills as your doctor tells you "

**RULE R7**

IF type of parts IS Hypothyroidism  
AND Hypothyroidism Symptom IS Weight gain  
THEN text OF problem textbox := "You are suffering from Weight gain."  
AND text OF advise textbox := "The Advice: Treat your pills as your doctor tells you "

**RULE R8**

IF type of parts IS Hypothyroidism  
AND Hypothyroidism Symptom IS Dry and coarse skin and hair  
THEN text OF problem textbox := "You are suffering from Dry and coarse skin and hair."  
AND text OF advise textbox := "The Advice: Treat your pills as your doctor tells you "

**RULE R9**

IF type of parts IS Hypothyroidism  
AND Hypothyroidism Symptom IS Hoarse voice  
THEN text OF problem textbox := "You are suffering from Hoarse voice."  
AND text OF advise textbox := "The Advice: Treat your pills as your doctor tells you "

**RULE R10**

IF type of parts IS Hypothyroidism  
AND Hypothyroidism Symptom IS Intolerance to cold  
THEN text OF problem textbox := "You are suffering from Intolerance to cold."  
AND text OF advise textbox := "The Advice: Treat your pills as your doctor tells you "

**RULE R11**

IF type of parts IS Hyperthyroidism  
AND Hyperthyroidism Symptom IS Irritability or nervousness  
THEN text OF problem textbox := "You are suffering from Irritability or nervousness."  
AND text OF advise textbox := "The Advice: choice correct treatment will depend on your symptoms"

**RULE R12**

IF type of parts IS Hyperthyroidism  
AND Hyperthyroidism Symptom IS Muscle weakness or tremors  
THEN text OF problem textbox := "You are suffering from Muscle weakness or tremors."  
AND text OF advise textbox := "The Advice: choice correct treatment will depend on your symptoms"

**RULE R13**

IF type of parts IS Hyperthyroidism  
AND Hyperthyroidism Symptom IS Infrequent and scant menstrual periods  
THEN text OF problem textbox := "You are suffering from Infrequent and scant menstrual periods."  
AND text OF advise textbox := "The Advice: choice correct treatment will depend on your symptoms"

**RULE R14**

IF type of parts IS Hyperthyroidism  
AND Hyperthyroidism Symptom IS Weight loss  
THEN text OF problem textbox := "You are suffering from Weight loss."  
AND text OF advise textbox := "The Advice: choice correct treatment will depend on your symptoms"

**RULE R15**

IF type of parts IS Hyperthyroidism  
AND Hyperthyroidism Symptom IS Sleep disturbances  
THEN text OF problem textbox := "You are suffering from Sleep disturbances."  
AND text OF advise textbox := "The Advice: choice correct treatment will depend on your symptoms"

**RULE R16**

IF type of parts IS Hyperthyroidism  
AND Hyperthyroidism Symptom IS Enlarged thyroid gland  
THEN text OF problem textbox := "You are suffering from Enlarged thyroid gland."  
AND text OF advise textbox := "The Advice: choice correct treatment will depend on your symptoms"

**RULE R17**

IF type of parts IS Hyperthyroidism  
AND Hyperthyroidism Symptom IS Vision problems or eye irritation  
THEN text OF problem textbox := "You are suffering from Vision problems or eye irritation."  
AND text OF advise textbox := "The Advice: choice correct treatment will depend on your symptoms"

**RULE R18**

IF type of parts IS Hyperthyroidism  
AND Hyperthyroidism Symptom IS Heat sensitivity  
THEN text OF problem textbox := "You are suffering from Heat sensitivity."

AND text OF advise textbox := "The Advice: choice correct treatment will depend on your symptoms"  
END

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