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Expert System for Polymyalgia Rheumatic

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***Abstract**: Polymyalgia Rheumatica (PMR) presents with a broad spectrum of clinical manifestations and almost exclusively occurs in the population aged over 50 years. After rheumatoid arthritis, PMR is the second most common autoimmune rheumatic disorder. Visual loss is the most feared complication in temporal arteritis, and extracranial arteries. No specific laboratory parameter exists for diagnosis of PMR.*
Imaging techniques such as ultrasonography, MRI or F-fluorodeoxyglucose PET may be helpful in the diagnosis and evaluation of the extent of vascular involvement in these diseases. This paper presets an expert system for classification criteria for PMR, recent advances of diagnostic and therapeutic procedures. This expert System was written using SL5 Object Expert System Language.

Keywords: PMR, temporal arteritis, SL5 Object Expert System Language

1. INTRODUCTION

PMR is characterized by pain and stiffness in the proximal regions of the extremities and neck, and elevated markers of inflammation [2]. GCA may present with a broad spectrum of clinical manifestations that are either attributable to a systemic inflammatory response, including fever, weight loss or anemia, or to local complications of vascular injury, such as headache, visual symptoms or limb claudicating.

Polymyalgia rheumatica is a typical disease of the elderly and are among the most common indications for prolonged corticosteroid therapy in this population. While treatment-associated complications are the most significant factors contributing to long-term morbidity of PMR patients.

Expert System is a computer application of Artificial Intelligence (AI), which contains a knowledge base and an inference engine, the main components and details are represented in figure[23-30].

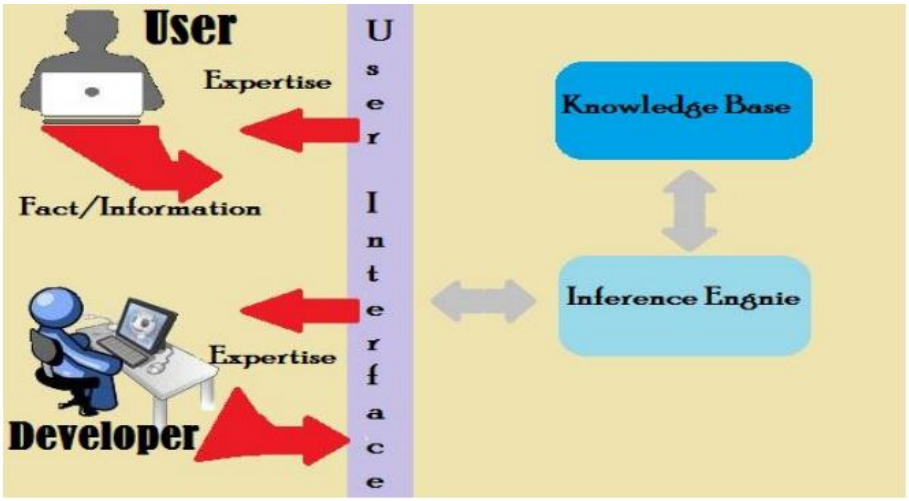

Figure 1: The figure presents the Main Components of an Expert System, Designed by the authors.

The proposed Expert System for polymyalgia rheumatica Diseases Diagnosis was implemented using SL5 Object language which stands for Simpler Level 5 Object [21]. 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 [22]. 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.

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2. KNOWLEDGE REPRESENTATION

Symptoms of polymyalgia rheumatic usually begin quickly and are worse in the morning. Most people who develop polymyalgia rheumatica are older than 65. It rarely affects people under 50 [1].

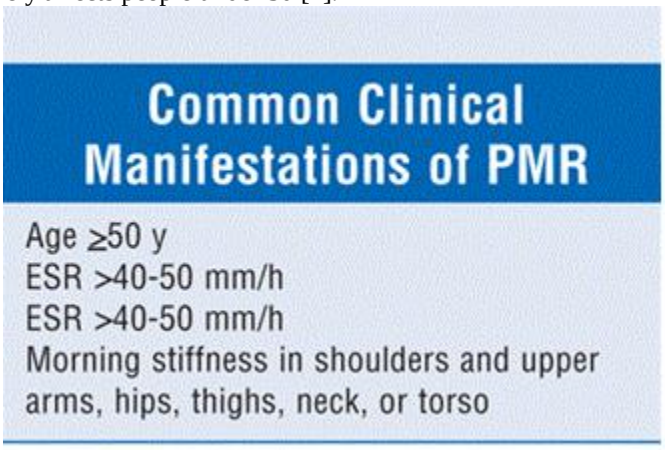

Figure 2: present common clinical manifestations of PMR

You may receive symptom relief by taking anti-inflammatory drugs called corticosteroids. But relapses are common, and you'll need to visit your doctor regularly to watch for serious side effects of these drugs [7].

Polymyalgia rheumatica is related to another inflammatory disorder called giant cell arteritis, which can cause headaches, vision difficulties, jaw pain and scalp tenderness. It's possible to have both of these conditions together.

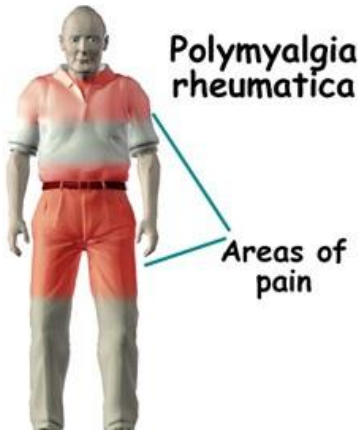

Figure 3: The figure presents the PMR area of pain

Symptoms:

The signs and symptoms of polymyalgia rheumatica usually occur on both sides of the body and may include [3]:

- Aches or pain in your shoulders (often the first symptom)
- Aches or pain in your neck, upper arms, buttocks, hips or thighs
- Stiffness in affected areas, particularly in the morning or after being inactive for a long time
- Limited range of motion in affected areas
- Pain or stiffness in your wrists, elbows or knees (less common)

You may also have more general signs and symptoms, including:

- Mild fever
- Fatigue

- A general feeling of not being well (malaise)
- Loss of appetite
- Unintended weight loss
- Depression

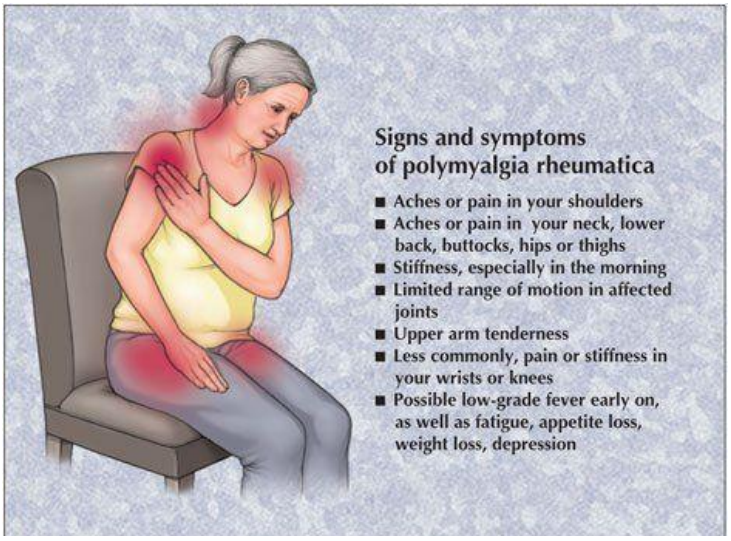

Figure 4: the figure present signs and symptoms of PMR

Causes:

The exact cause of polymyalgia rheumatica is unknown. Two factors appear to be involved in the development of this condition [18- 19]:

- Genetics. Certain genes and gene variations may increase your susceptibility.
- An environmental exposure. New cases of polymyalgia rheumatica tend to come in cycles and may develop seasonally. This suggests that an environmental trigger, such as a virus, might play a role. But no specific virus has been shown to cause polymyalgia rheumatica.

Giant cell arteritis

Polymyalgia rheumatica and another disease known as giant cell arteritis share many similarities. Giant cell arteritis results in inflammation in the lining of arteries, most often the arteries located in the temples. Giant cell arteritis can cause headaches, jaw pain, vision problems and scalp tenderness. If left untreated, it can lead to stroke or blindness.

Polymyalgia rheumatica and giant cell arteritis may actually be the same disease but with different manifestations. The overlap between the two diseases is significant:

- About 20 percent of people with polymyalgia rheumatica also have signs and symptoms of giant cell arteritis.
- About half of the people with giant cell arteritis may also have polymyalgia rheumatica.

Risk factors for polymyalgia rheumatica include:

- Age. Polymyalgia rheumatica affects older adults almost exclusively. The average age at onset of the disease is 73.
- Sex. Women are about two times more likely to develop the disorder.
- Race and geographic region. Polymyalgia rheumatica is most common among whites in northern European populations.

Complications

Symptoms of polymyalgia rheumatica can greatly affect your ability to perform everyday activities. The pain and stiffness may contribute to difficulties with tasks such as the following:

- Getting out of bed, standing up from a chair or getting out of a car
- Bathing or combing your hair
- Getting dressed or putting on a coat

These difficulties can affect your health, social interactions, physical activity, sleep and general well-being [2-3] .

In addition, people with polymyalgia rheumatica seem to be more likely to develop peripheral arterial disease EX giant cell arteritis [4].

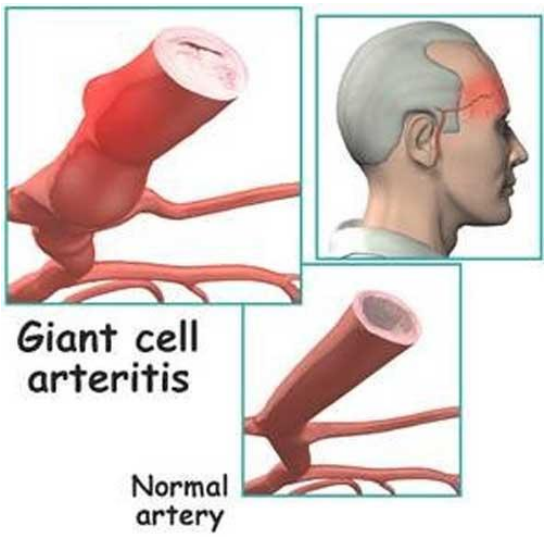

Figure 5: figure shows the difference between GCA & normal artery

Tests and exams

Your answers to questions, a general physical exam and the results of tests can help your doctor determine the cause of your pain and stiffness. This diagnostic process also helps your doctor rule out other disorders that have similar symptoms to polymyalgia rheumatica.

Your doctor may reassess your diagnosis as your treatment progresses. Studies show that 2 to 30 percent of people initially given a diagnosis of polymyalgia rheumatica were later reclassified as having rheumatoid arthritis.

Exam

Your doctor will conduct an exam to get an idea of your overall health, identify possible causes or rule out certain diseases. He or she may gently move your head and limbs to assess whether your symptoms affect your range of motion.

Blood tests

A nurse or assistant will draw a sample of your blood. This sample will be used for several laboratory tests that your doctor will order. Typically, your doctor will check the complete blood counts (CBC) and two indicators of inflammation — sed rate (erythrocyte sedimentation rate) and C-reactive protein.

Imaging tests

Increasingly, ultrasound is being used to distinguish polymyalgia rheumatica from other conditions that cause similar symptoms. Magnetic resonance imaging (MRI) can also identify other causes of shoulder pain, such degenerative joint changes.

Monitoring for giant cell arteritis

Your doctor will monitor you for signs and symptoms that may indicate the onset of giant cell arteritis. Talk to your doctor immediately if you experience any of the following:

- New, unusual or persistent headaches
- Jaw pain or tenderness
- Blurred or double vision or visual loss
- Scalp tenderness

If your doctor suspects you may have giant cell arteritis, he or she will likely order a biopsy of the artery in one of your temples. This procedure, performed during local anesthesia, removes a tiny sample of the artery, which is then examined in a laboratory for signs of inflammation [12].

Treatments and drugs

Treatment usually involves medications to help ease your symptoms. Relapses are common.

Corticosteroids

Polymyalgia rheumatica is usually treated with a low dose of an oral corticosteroid, such as prednisone. A daily dose at the beginning of treatment is usually 12 to 25 milligrams a day [5].

You'll likely start to feel relief from pain and stiffness within the first two or three days. If you aren't responding to treatment, your doctor may refer you to a rheumatologist.

After the first two to four weeks of treatment, your doctor may begin to gradually decrease your dosage depending on your symptoms and the results of blood tests. The goal is to keep you on as low a dose as possible without triggering a relapse in your symptoms.

Most people with polymyalgia rheumatica need to continue the corticosteroid treatment for at least a year. You'll need frequent follow-up visits with your doctor to monitor how the treatment is working and whether you're having any side effects.

People who taper off the medication too quickly are more likely to have a relapse. Thirty to 60 percent of people with polymyalgia rheumatica will have at least one relapse when tapering off the corticosteroids. Relapses (flares) are treated by increasing your drug dosage for a while then tapering again.

Diagnosing PMR: the spectrum of classical vs atypical PMR.

	History, examination, investigations	Trial of gluco-corticoids: dose	Response to treatment
A safe diagnosis of PMR in primary care can be made in presence of ALL THREE of these	Classical clinical features	15 mg prednisolone	'Magic', 'miracle', within 3 days
Consider other diagnoses if ANY of these are present (but can be 'atypical PMR')	Atypical features	Need for >15 mg prednisolone to relieve symptoms	Incomplete or delayed response

Figure 6: The figure present diagnosing PMR, comprehension between classical & typical PMR

Monitoring side effects

Long-term use of corticosteroids can result in a number of serious side effects. Your doctor will monitor you closely for problems. He or she may adjust your dosage and prescribe treatments to manage these reactions to corticosteroid treatment. Possible side effects include:

- Weight gain
- Osteoporosis — the loss of bone density and weakening of bones
- High blood pressure (hypertension)
- Diabetes
- Cataracts — a clouding of the lenses of your eyes

Calcium and vitamin D supplements

Your doctor will likely prescribe daily doses of calcium and vitamin D supplements to help prevent bone loss induced by corticosteroid treatment. The American Academy of Rheumatology recommends the following daily doses for anyone taking corticosteroids:

- 1,200 to 1,500 milligrams (mg) of calcium supplements
- 800 to 1,000 international units (IU) of vitamin D supplements

Pneumonia vaccine

Your doctor may suggest you get a pneumonia vaccine if you are taking 20 milligrams or more of prednisone a day.

Methotrexate (Trexall)

Joint guidelines from the American Academy of Rheumatology and the European League Against Rheumatism suggest using Methotrexate with corticosteroids in some patients. This is an immune-suppressing medication that is taken by mouth. It may be useful early in the course of treatment or later, if you relapse or don't respond to corticosteroids.

Physical therapy

You may benefit from physical therapy if you've had a long stretch of limited activity owing to polymyalgia rheumatica. Talk with your doctor about whether physical therapy is a good option for you if you're trying to regain strength, coordination and the ability to perform everyday tasks.

Over-the-counter no steroidal anti-inflammatory drugs, such as ibuprofen (Advil, Motrin, others) or naproxen (Aleve), are not usually recommended for easing the signs and symptoms of polymyalgia rheumatica.

Healthy lifestyle choices can help you manage the side effects that may result from corticosteroid treatment:

- Eat a healthy diet. Eat a diet of fruits, vegetables, whole grains, and low-fat meat and dairy products. Limit the salt (sodium) in your diet to prevent fluid buildup and high blood pressure.
- Exercise regularly. Talk to your doctor about exercise that is appropriate for you to maintain a healthy weight and to strengthen bones and muscles.
- Use assistive devices. Use luggage and grocery carts, reaching aids, shower grab bars and other assistive devices to help make daily tasks easier. Take steps to minimize the risk of falls, such as wearing low-heeled shoes. Talk to your doctor about whether the use of a cane or other walking aid is appropriate for you to prevent falls or other injury.

3. LITERATURE REVIEW

Many expert systems have been designed [23-52] to help facilitating diagnosing and managing a lot of diseases and medical problems which considered as a part of applying Artificial Intelligence and computer science in order to help doctors, hospitals and health care facilities decision making to enable them to offer their health services in the correct way. The current Expert System is designed for diagnosing Polymyalgia Rheumatic problems and recommends the proper treatment.

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4. MATERIALS AND METHODS

The proposed expert system performs the diagnosis of Polymyalgia Rheumatic problems by asking questions that requires Yes/No answers. The proposed expert system will ask the user to choose the correct answer in each screen. At the end of the diagnosis session, the proposed expert system provides the proper diagnosis of the problem and gives a recommendation for the treatment to the users. Figure 2 shows the first screen of the expert system session. Figure 2 shows a question from the dialogue between the user and the expert system, and Figure 3 shows how the expert system displays the diagnosis of the problem and the recommendation for treating the patient.

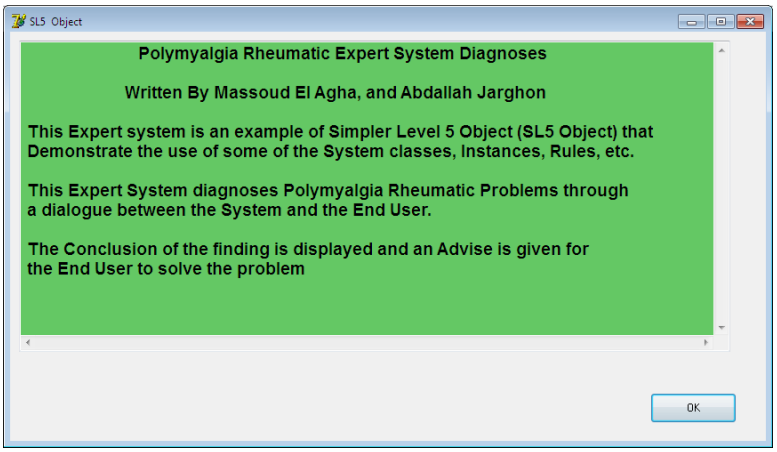

Figure 7: The figure shows the starting screen of the expert system.

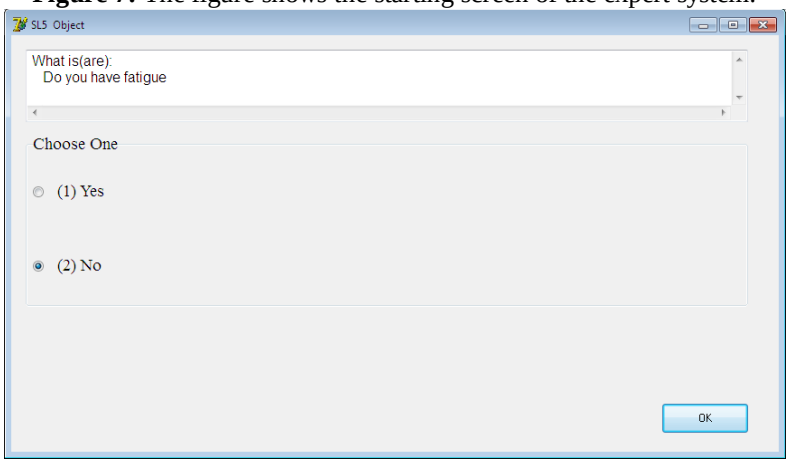

Figure 8: The figure shows when the system asks the user.

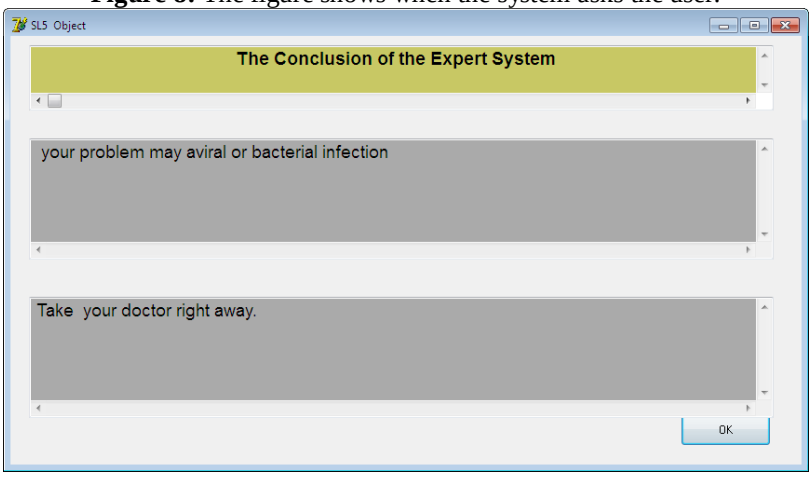

Figure 9: The figure shows diagnosis and recommendation of the expert system.

5. CONCLUSION

Polymyalgia rheumatica is a common disease in the elderly. New classification criteria for PMR have recently been presented and will facilitate future studies on treatment and outcome of this disease.

In this research we have tried our best to help people to diagnose themselves with the aid of specialized expert system for Polymyalgia rheumatic. This expert system is easy to use and has a user friendly interface.

6. EXPERT SYSTEM SOURCE CODE

```
! Polymyalgia Rheumatica
ATTRIBUTE Do you have fatigue ?  COMPOUND
Yes, No

ATTRIBUTE Do you have malaise ?  COMPOUND
Yes, No

ATTRIBUTE Did you feel any fever ?  COMPOUND
Yes, No

ATTRIBUTE Did you have a sudden weight loss ?  COMPOUND
Yes, No

ATTRIBUTE Did you have loss of appetite ?  COMPOUND
Yes, No

ATTRIBUTE Did your red blood cell account low ?  COMPOUND
Yes, No

ATTRIBUTE Did your ESR result high ?  COMPOUND
Yes, No

ATTRIBUTE Did you have positive CRP & RF ?  COMPOUND
Yes, No

ATTRIBUTE Did you feel a limited range of motion ?  COMPOUND
Yes, No

ATTRIBUTE start SIMPLE

 INSTANCE the domain ISA domain
 WITH start := TRUE

INSTANCE the application ISA application
 WITH title display := introduction
 WITH conclusion display :=  Conc
 WITH numeric precision := 8
 WITH simple query text := "Is it true that:
  WITH numeric query text := "What is(are):
  WITH string query text := "What is(are):
  WITH time query text := "What is(are):
  WITH interval query text := "What is(are):
  WITH compound query text := "
  WITH multicompound query text := "What is(are):

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 "=:
Polymyalgia Rheumatic Expert System Diagnoses  Written By Massoud El Agha, and Abdallah Jarghon
This Expert system is an example of Simpler Level 5 Object (SL5 Object) that Demonstrate the use of some of the System classes, Instances, Rules, etc.
This Expert System diagnoses Polymyalgia Rheumatic Problems through a dialogue 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 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 R0
```

IF start
THEN ASK Do you have fatigue ?

RULE R1
IF Do you have fatigue ? IS Yes
THEN ASK Do you have malaise ?

RULE R1a
IF Do you have fatigue ? IS No
THEN ASK Did you feel any fever ?

RULE R2
IF Do you have malaise ? IS Yes
THEN ASK Did you feel any fever ?

RULE R2a
IF Do you have malaise ? IS No
THEN text OF problem textbox := "you are healthy but you may have general weakness"
AND text OF advise textbox := "Take your doctor right away."

RULE R3
IF Did you feel any fever ? IS Yes
THEN text OF problem textbox := " your problem may aviral or bacterial infection"
AND text OF advise textbox := "Take your doctor right away."

RULE R3a
IF Did you feel any fever ? IS No
THEN ASK Did you have a sudden weight loss ?

RULE R4
IF Did you have a sudden weight loss ? IS Yes
THEN ASK Did you have loss of appetite ?

RULE R4a
IF Did you have a sudden weight loss ? IS No
THEN text OF problem textbox := " your problem may be a gastric infection"
AND text OF advise textbox := "Take your doctor right away."

RULE R5
IF Did you have loss of appetite ? IS Yes
THEN ASK Did your red blood cell account low ?

RULE R5a
IF Did you have loss of appetite ? IS No
THEN ASK Did your ESR result high ?

RULE R6
IF Did your red blood cell account low ? IS Yes
THEN ASK Did your ESR result high ?

RULE R6a
IF Did your red blood cell account low ? IS No
THEN text OF problem textbox := " you must do some more test"
AND text OF advise textbox := "Take your doctor right away."

RULE R7

IF Did your ESR result high ? IS Yes
THEN ASK Did you feel a limited range of motion ?
RULE R7a
IF Did your ESR result high ? IS No THEN ASK Did you have positive CRP & RF ?
RULE R8
IF Did you have positive CRP & RF ? IS Yes
THEN text OF problem textbox := " you may have an arthritis"
AND text OF advise textbox := "Take your doctor right away."
RULE R8a
IF Did you have positive CRP & RF ? IS No
THEN ASK Did you feel a limited range of motion ?
RULE R9
IF Did you feel a limited range of motion ? IS Yes
THEN text OF problem textbox := " May be your problem is a polymalysia rheumatica See your doctor , avoid efforts & aggressive physical motion , do ESR and RCs frequently...."
AND text OF advise textbox := "Take your doctor right away."
RULE R9a
IF Did you feel a limited range of motion ? IS No
THEN text OF problem textbox := " Your problem may be an anemia"
AND text OF advise textbox := "Take your doctor right away."
END

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