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A Knowledge Based System for Neck Pain Diagnosis

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Abstract

Modern life and scientific achievements contributed to the worsening of neck pain problems in great shape. Especially in people who work in offices and students in schools or universities. There are many neck diseases that people encounter in their lives. Therefore, the main objectives of this paper are to help people who suffer from neck pain by diagnosing their conditions through our knowledge based system. Further more, this system which we are presenting will give patient the correct diagnosis of the disease and the treatment required. In this paper the strategy of the Knowledge Based System for diagnosing many of the existed neck diseases: (Abnormalities in the bone or joints, Trauma, Poor posture, Degenerative diseases, Tumors, Muscle strain) is presented, an overview about the neck diseases are outlined, the cause of diseases are sketched and the treatment of disease at any time possible is given. SL5 Object expert system language for the suggested knowledge based system is used.

Keywords: Expert Systems, Knowledge Based System, SL5 Object, Neck Diseases

Introduction

Neck supports the weight of the head and is highly flexible, allowing the head to turn and flex. Neck is the part of the body between the head and the shoulder also it connects the head with the body. The neck is very important for human. Neck pain, based on *Orthopedic doctors* mainly caused by: Stress the neck area and the bottom of the head and shoulders higher, as a result of sitting for long periods in the wrong way, when studying, writing, or using a computer[1,2]. Human neck consists of three triangles (as seen in Figure 1).

These triangles are divided into anterior, posterior and clavicle for describing neck. Many Orthopedic doctors listed the major causes of neck disease[1,2]:



Fig 1: The structure of neck - designed by Suheir H. ALmursheidi

- Stressing the neck area and the bottom of the head and shoulders more than usual, as a result of sitting for long periods in the wrong way.
- Using bad pillow when you are sleeping, contributes to the emergence of neck pain. In addition, the use of a cell phone and land phone for long periods, with the neck shoulder hand bend, which adds an unusual strain on the neck.
- Resulting from chronic muscle inflammation or as a result of the presence of roughness in the vertebrae, which are located in the neck area or for a herniated disc in the cervical spine. In these cases, the pain may extend to the shoulder, arm and forearm.

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Knowledge Based Systems

A Knowledge Based System is a computer application of Artificial Intelligence (AI) which emulates the performance of a human expert in a specific field. Knowledge Based System consists of a user Interface, knowledge base and an inference engine; see Figure 2 for details[3,5,7]

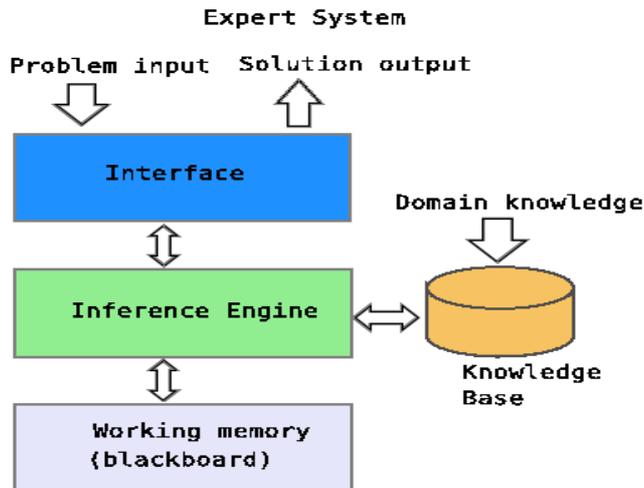


Fig 2: Main Components of an Knowledge Based System

The proposed Knowledge Based System for neck diseases diagnosis was designed and implemented using SL5 Object a rule-based language for specifying expert systems[8].

Background/ Literature Review

Knowledge Based System (KBS) is a software that follows the decision-making skill of a human expert. KBS is aimed to solve complicated problems by thinking about the knowledge which is represented mainly as if-Conditions-then rules rather than through conventional programming languages [3,4,6].

There are many Knowledge Based System designed to diagnose some diseases like: Eye, Endocrine, skin [10-17]. However there is no special knowledge based system specializes in neck disease offered free. In this paper we designed and developed a new knowledge based system related to neck disease to help people diagnosing the disease related to neck pain they face.

Materials and Methods

The suggested KBS is capable of diagnosing seven neck diseases of different stages of the human life starting by asking the patient many questions based on their pain symptoms. This KBS gives the patient clear idea about the disease and the diagnosis of his/her pain. At the end, the proposed KBS provides recombination of how to treat the disease. Figure 3 shows a question type of True or False related with the disease and Figure 4 shows the diagnosis and recommendation about the disease.

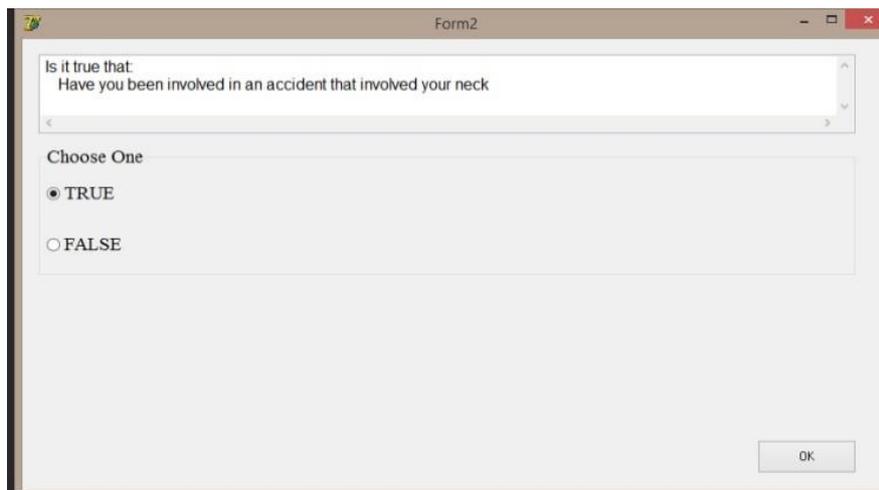


Fig 3: Shows a True/False question asked by the KBS

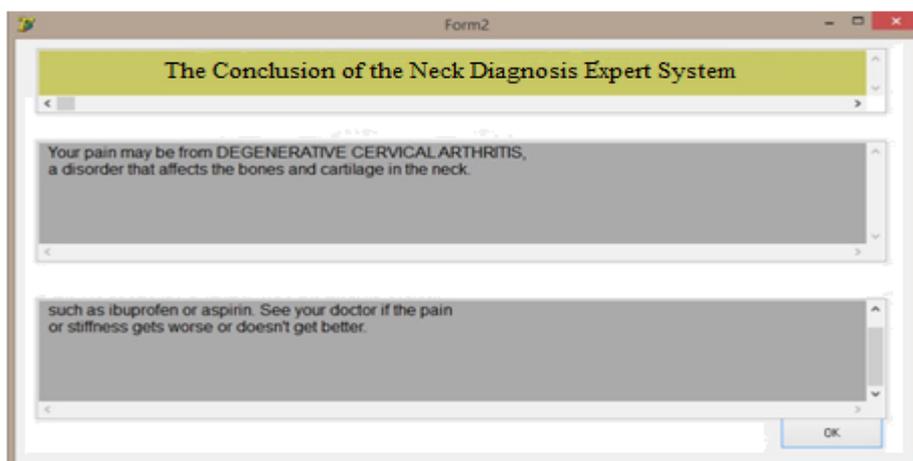


Fig 4: Shows when the system provide the diagnosis and recommendation

Knowledge Representation

The central sources of the data for this KBS are Podiatric physician and specializes websites for neck diseases[1,2]. The solicited knowledge has been transformed into SL5 Object Expert System Language. Knowledge base syntax takes the form of Facts, Rules and Objects. Currently the KBS covers nine neck diseases: Cervical Degenerative Disc Disease, Cervical Disc Herniation, Cervical Radiculopathy, Cervical Strain & Sprain, Facet Syndrome, Muscle Spasms, Osteoarthritis, Pinched Nerve and Subluxation.

Cervical Degenerative Disc Disease

Degenerative Joint Disease, Degenerative Disc Disease, Osteoarthritis and spondylosis means the same fad. They refer to wearing and tearing of all joints. Over time, gravity, pressure of the damage, and broad use of the joints, as the parts in a the vehicle, lead to the possibility of wearing. In fact, it is not a disease or arthritis, but it is normal changes that occur in our spine of joints and disks. Risk factors can promote the velocity of degeneration in joint. Figure 5 shows Cervical Degenerative Disc Disease.

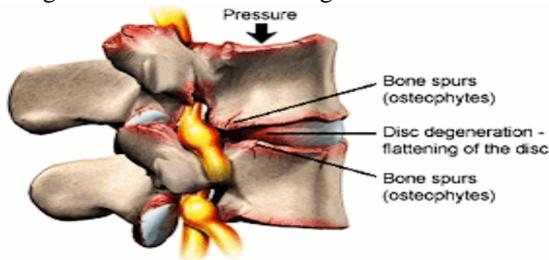


Fig 5: Cervical Degenerative Disc Disease

Cervical Disc Herniation

Herniated disc refers to any of the problems of the rubber pad (disk) between the individual bones that are piled up the spinal column (vertebrae). Disk with a soft center that has been wrapped in a hard shell, is like a donut. Sometimes, push through a more crack a part of the soft "jelly" to external hard when the herniated disc or disc herniation occurs. Intervertebral disc herniation, can infuriate the nearby nerves, causing numbness and weakness in arms and legs. On the other hand, lots of people do not show the symptoms of a herniated disc. Figure 6 shows Cervical Disc Herniation.



Fig 6: Cervical Disc Herniation

Cervical Radiculopathy

All or part of the intervertebral disc of the spine herniated disc (glide) is generated when it is forced through a fragile portion of the disk. This can put pressure on nearby nerves. Flexible clamp relaxes neck muscles. It can restrict the

movement of the neck. This can reduce the collision of the nerve roots in the movement as shown in Figure 7.

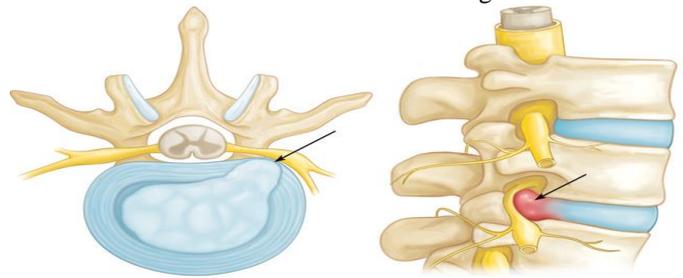


Fig 7: Cervical Radiculopathy

Cervical Strain and Sprain

The most common neck injury in athletes, is probably sprains and acute strains of contusion of the neck muscles and soft tissue. whiplash leads to injury of the muscle that occurs when muscle is stretched or filled to capacity. Neck muscles tension Sterno is the trapezius muscle that may contain the scalene and levator scapula. Whiplash from a fall may occur as a result of trauma, or, more often, a collision of the vehicle. These injuries occur as a result of the collision from all directions, in many cases, there is a possibility that occurs when a person's car is hit from behind. Sudden acceleration, push the individual in front of the body, his head back quickly to the front of the eyelashes (acceleration and deceleration). This movement may damage bone, the facet joints, muscles, blood vessels, ligaments, nerves, esophagus, and a lot of organization and neck structure including a variety of the intervertebral disc. Almost all of the cervical spine injury leads to some degree of muscle damage. Serious damage to neck muscles stabilizes the movement of the spine(see Figure 8 for detail).

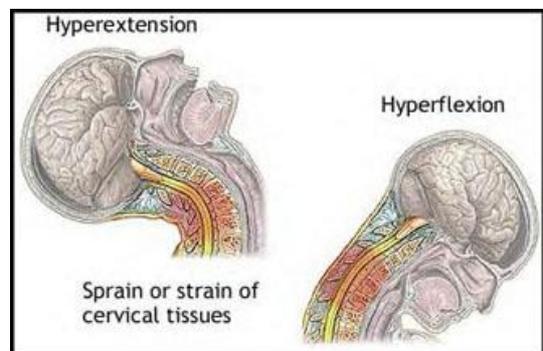


Fig 8: Cervical Strain and Sprain

Facet Syndrome

Facet syndrome causes back pain. Facet syndrome is a symptoms where the joint behind the spine deteriorate and leads to pain. Facet joints can be found in all levels on both sides of the lumbar spine. They provide about 20 percent of stability for the twist at the waist. Each facet joints provide particularly the necessary support for rotation, are located at each level of the spine. Facet joints also, prevents vertebrae from slipping to the bottom of it. Small facet joint capsule, provide high lubricant nutritious for each joint (as shown in Figure 9).

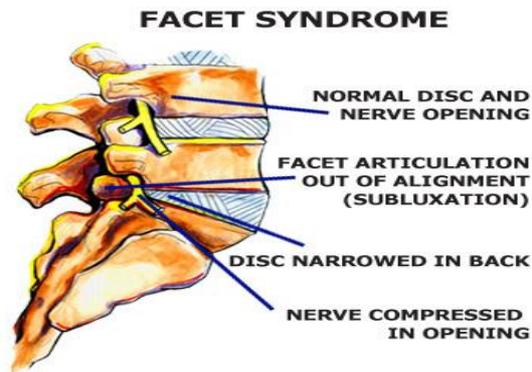


Fig 9: Facet Syndrome

Muscle Spasms

Medical spasms sudden contraction, is a hollow organ or similar sudden contraction orifice of involuntary muscles such as the heart. It is often, but mainly refers to the muscle spasms that are accompanied by a sudden bang of pain, usually it is harmless, and then stopped after a few minutes. Involuntary muscle contractions of other causes can be more serious, depending on a variety of factors. Spasm of the muscle is the result of the occurrence inflammation if the muscle is torn or overstretching. This is the tension of the muscles that are not similar to serious injury in the beginning, but can cause severe back pain. Figure 10 outline the Muscle Spasms.



Fig 10: Muscle Spasms

Osteoarthritis

Osteoarthritis, is a normal consequence of aging. In addition, it is caused by wear in a joint. Cartilage is firmly elastic tissue to cushion the bones of the joints and bones are well fit to the other. If the cartilage has worn destruction, bone rub together. This causes pain, swelling

and stiffness. Osteophytes or additional bone, can be formed around the joint. Weak ligaments and muscles around the joints, will be stiffer. In many cases, the cause of osteoarthritis is unknown. This is mainly related to aging. See Figure 11 for Osteoarthritis neck.

Osteoarthritis Neck

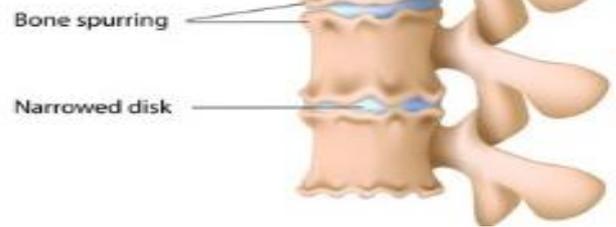


Fig 11: Osteoarthritis neck

Pinched Nerve

When extra force is applied to the nerve by surrounding tissues, like: nerve impingement, bone, cartilage, muscles and tendons. This force extinguish the nerve function, leading to pain, numbness, weakness and tingling. Figure 12 shows pinched nerve.

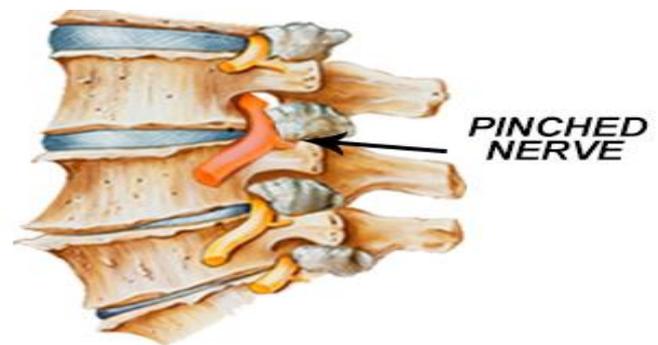
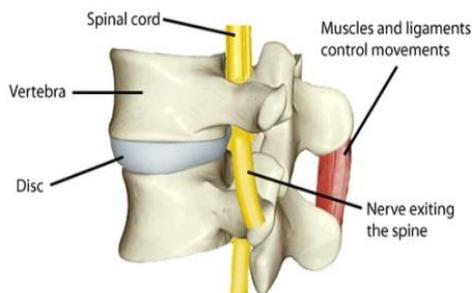


Fig 12: Show Pinched Nerve

Subluxation

One or more of the bones of the spine (vertebrae) is moved out of the its position, when you created pressure on, or irritated the spinal nerves. Spinal cord nerves come out from among the bones of the spine. This force on the nerves cause nerves malfunction and interferes with the signals passing through the nerves. Figure 13 shows the normal and the Subluxation.

Normal



Subluxation

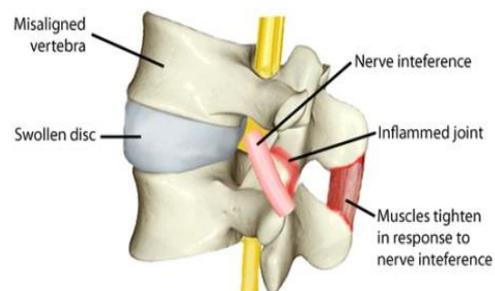


Fig 13: Show Subluxation

Decision tree for the KBS Neck Pain Diagnosis

Decision tree, each internal node is a tree that contained the question with a finite number of answers[9]. For example, True/False question has the answers true or false and can be used as yes or no question or as multiple choice question. Figure 14 diagnoses neck pain problems using AT trees, based on the response from the user, it then includes

questions that appears through the appropriate node for of children decision tree which shows the problem with this node. In this way, according to the response of the end user, we move from the root of the tree to the leaves. When it reaches a leaf node, the conclusion will be provided for the end user.

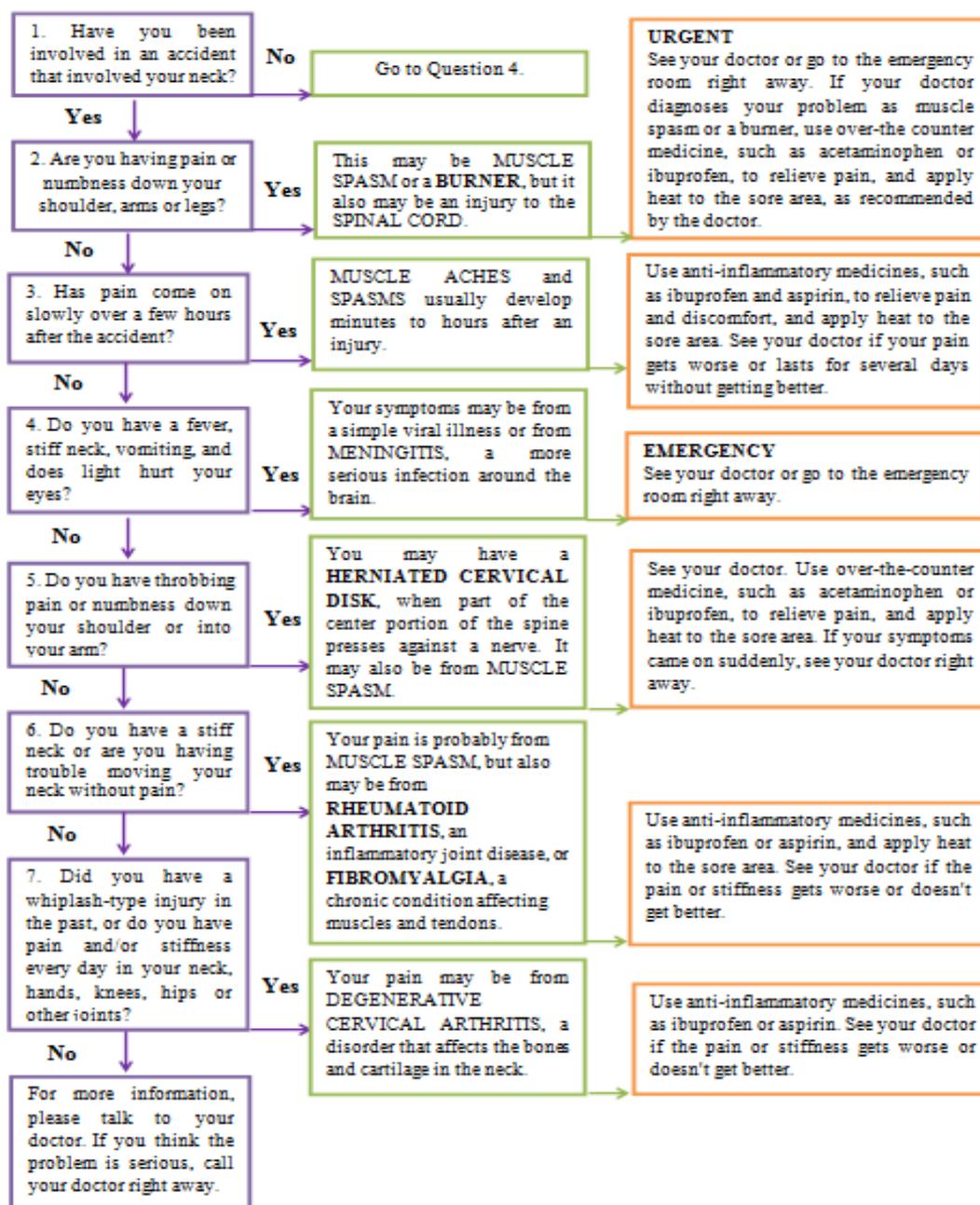


Fig 14: Decision tree for the Knowledge Based System of Neck and Pain Diagnosis

System Evaluation

In this step a preliminary test was carried out by patients suffering from neck pain problems. My co-author father (Mr. Hassan ALmursheidi) who is suffering from a Radiculopathy Disease and Cervical Disc has tested this knowledge based system and her was satisfied with it. Other patient with neck problems tested this system and they also were satisfied and very comfortable with it.

Conclusion

In this paper, a new knowledge based system was developed and presented for helping patients in diagnosing

their neck pain diseases. The system currently cover the following neck diseases: Abnormalities in the bone or joints, Trauma, Poor posture, Degenerative diseases, Tumors and Muscle strain. Patients can get the diagnosis faster than the traditional way so they can save their time and effort. The system was developed using SL5 Object expert system language with a simple user interface to use so patients can use this system easily without any complication.

Future Work

This system it considered to be easy and useful, more neck

diseases are planned to be added to the expert system for future work and add more enhancement to the system based on the patients' needs.

Expert System Source Code

! A Knowledge Based System for Neck Pain Diagnosis

! Written by Suheir H. ALmursheidi

ATTRIBUTE Have you been involved in an accident that involved your neck SIMPLE INIT TRUE

ATTRIBUTE Are you having pain or numbness down your shoulder arms or legs SIMPLE INIT TRUE

ATTRIBUTE Has pain come on slowly over a few hours after the accident SIMPLE INIT TRUE

ATTRIBUTE aaa SIMPLE INIT TRUE

ATTRIBUTE Do you have a fever stiff neck vomiting and does light hurt your eyes SIMPLE INIT TRUE

ATTRIBUTE Do you have throbbing pain or numbness down your shoulder or into your arm SIMPLE

ATTRIBUTE Do you have a stiff neck or are you having trouble moving your neck without pain SIMPLE

ATTRIBUTE Did you have a whiplash type injury in the past or do u have pain or stiffness in u neck hands SIMPLE

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 :="

A Knowledge Based System for Neck and Pain Diagnosis

- Written By Suheir H. ALmursheidi -

This Expert system is an developed using Simpler Level 5 Object (SL5 Object) that

Uses some of the System classes, Instances, Rules, etc.

This Expert System diagnoses Neck Pain through a dialogue between the System and the End User.

The Conclusion of the finding is displayed and a recommend is given for the End User To diagnoses the Diseases."

INSTANCE Conc ISA display

WITH wait := TRUE

WITH delay changes := FALSE

WITH items [1] := title textbox

WITH items [2] := diagnosis textbox

WITH items [3] := recommend 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 Neck Diagnosis Expert System"

INSTANCE diagnosis 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 := 12

WITH text :=" -----"

INSTANCE recommend 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 := 12

WITH text :=" -----"

RULE R0

IF start

THEN ASK Have you been involved in an accident that involved your neck

RULE R1

IF Have you been involved in an accident that involved your neck = TRUE

THEN ASK Are you having pain or numbness down your shoulder arms or legs

ELSE ASK Do you have a fever stiff neck vomiting and does light hurt your eyes

RULE R2

IF Are you having pain or numbness down your shoulder arms or legs = TRUE

THEN text OF diagnosis textbox := " This may be MUSCLE SPASM or a BURNER,

but it also may be an injury to the SPINAL CORD. "

AND text OF recommend textbox := " URGENT See your doctor or go to the emergency room right away.

If your doctor diagnoses your problem as muscle spasm or a burner, use over-the counter medicine, such as acetaminophen or ibuprofen, to relieve pain, and apply heat to the sore area, as recommended by the doctor. "

ELSE ASK Has pain come on slowly over a few hours after the accident

RULE R3

IF Has pain come on slowly over a few hours after the accident = TRUE

THEN text OF diagnosis textbox:= " MUSCLE ACHES and SPASMS usually develop minutes to hours after an injury. "

AND text OF recommend textbox:= " Use anti-inflammatory medicines, such as ibuprofen and aspirin, to relieve pain and discomfort, and apply heat to the sore area.

See your doctor if your pain gets worse or lasts "
 ELSE ASK Do you have a fever stiff neck vomiting and
 does light hurt your eyes

RULE R4

IF Do you have a fever stiff neck vomiting and does light
 hurt your eyes = TRUE
 THEN text OF diagnosis textbox := " Your symptoms may
 be from a simple viral illness
 or from MENINGITIS, a more serious infection around the
 brain. "
 AND text OF recommend textbox := " EMERGENCY See
 your doctor or go to the emergency room right away. "
 ELSE ASK Do you have throbbing pain or numbness down
 your shoulder or into your arm

RULE R5

IF Do you have throbbing pain or numbness down your
 shoulder or into your arm = TRUE
 THEN text OF diagnosis textbox := " You may have a
 HERNIATED CERVICAL DISK, when part of the center
 portion of the spine presses against a nerve. It may also be
 from MUSCLE SPASM. "
 AND text OF recommend textbox := " See your doctor.
 Use over-the-counter medicine,
 such as acetaminophen or ibuprofen, to relieve pain, and
 apply heat to the sore area. If your symptoms came on
 suddenly, see your doctor right away."
 ELSE ASK Do you have a stiff neck or are you having
 trouble moving your neck without pain

RULE R6

IF Do you have a stiff neck or are you having trouble
 moving your neck without pain = TRUE
 THEN text OF diagnosis textbox := " Your pain is probably
 from MUSCLE SPASM,
 but also may be from RHEUMATOID ARTHRITIS, an
 inflammatory joint disease, or FIBROMYALGIA,
 a chronic condition affecting muscles and tendons. "
 AND text OF recommend textbox := " Use anti-
 inflammatory medicines, such as ibuprofen or aspirin,
 and apply heat to the sore area. See your doctor if the pain
 or stiffness gets worse or doesn't get better."
 ELSE ASK Did you have a whiplash type injury in the past
 or do u have pain or stiffness in u neck hands

RULE R7

IF Did you have a whiplash type injury in the past or do u
 have pain or stiffness in u neck hands = TRUE
 THEN text OF diagnosis textbox := "Your pain may be
 from DEGENERATIVE CERVICAL ARTHRITIS, a
 disorder that affects the bones and cartilage in the neck. "
 AND text OF recommend textbox := "Use anti-
 inflammatory medicines, such as ibuprofen or aspirin. See
 your doctor if the pain or stiffness gets worse or doesn't get
 better. "
 ELSE text OF diagnosis textbox := " For more information,
 please talk to your doctor. If you think the problem is
 serious, call your doctor right away."
 AND text OF recommend textbox := " "
 END

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