International Journal of Engineering and Information Systems (IJEAIS)
ISSN: 2000-000X
Vol. 1 Issue 4, June – 2017, Pages: 71-88

Knowledge Based System for Long-term Abdominal Pain (Stomach Pain) Diagnosis and Treatment

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***Abstract*: *Background**: the abdomen is called (the belly, tummy, stomach, or midriff) establishes the part of the body between the thorax (chest) and pelvis, in humans. The abdomen contains most of the tube like organs of the digestive tract, as well as several solid organs. Hollow abdominal organs comprise the stomach, the small intestine, and the colon with its attached appendix. Organs such as the liver, its attached gallbladder, and the pancreas function in close association with the digestive tract and communicate with it via ducts. **Objectives**: the main goal of this expert system is to get the appropriate diagnosis of abdomen disease and the correct treatment. **Methods**: in this paper the design of the proposed expert system which was produced to help internist physicians in diagnosing many of the abdomen diseases such as: hiatal hernia, gastritis, ulcer or heartburn; the proposed expert system presents an overview about abdomen diseases are given, the cause of diseases are outlined and the treatment of disease whenever possible is given out. Clips expert system language was used for designing and implementing the proposed expert system. **Results**: the proposed abdomen diseases diagnosis expert system was evaluated by medical students and they were satisfied with its performance. **Conclusions**: the proposed expert system is very useful for internist physician, patients with abdomen problem and newly graduated physician.*

Keywords: Expert system, abdominal diseases, SL5 Object, Nosological expert system**.**

1. INTRODUCTION

The abdomen is the region of the body - of a vertebrate - between the thorax and the pelvis. It contains: small intestine, large intestine, liver and pancreas. See the photo below:

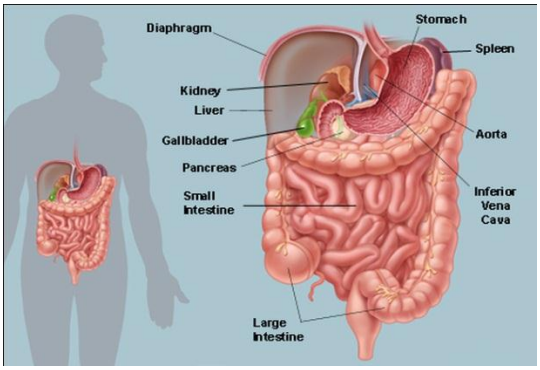

Figure 1: The human abdomen

Abdominal diseases can have many reasons .But it is easy to diagnose them if you know where and when the pain is, and how does it behave (i.e. is it local or does it radiate?).

The main diseases we dealt with in this paper are [3]:

1- **HIATAL HERNIA :**it is a type of hernia in which the upper part of the stomach protrudes into the chest cavity through the esophageal hiatus in the thoracic diaphragm due to a tear or weakness in the diaphragm .The most common cause is obesity

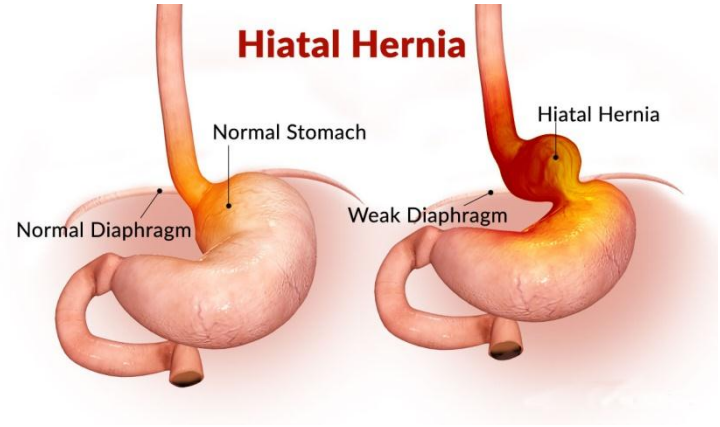

Figure 2: Hiatal Hernia

It can be diagnosed if the following symptoms are found:

- heartburn: chest pain or burning,
- nausea, vomiting or retching (dry heaves)
- burping.
- Waterbrash , the rapid appearance of a large amount of saliva in the mouth that is stimulated by the refluxing acid.

2- **ULCER or HEARTBURN**: it a burning sensation in the central chest or upper central abdomen.

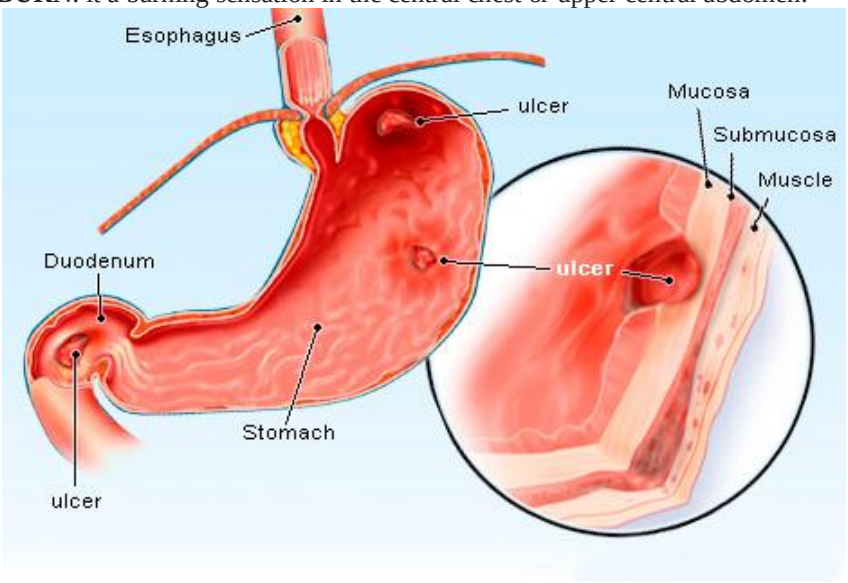

Figure 3: ULCER

The pain often rises in the chest and may radiate to the neck, throat, or angle of the jaw.

3- **GALLSTONES or CHOLECYSTITIS: CHOLECYSTITIS** is inflammation of the gallbladder. Symptoms include right upper abdominal pain, nausea, vomiting, and occasionally fever.

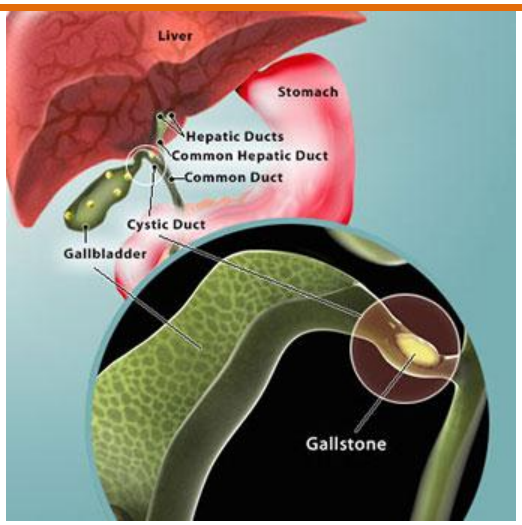

Figure 4: CHOLECYSTITIS

A gallstone is a stone formed within the gallbladder out of bile components

4- **SPASTIC COLON**: Irritable bowel syndrome (IBS) is a group of symptoms—including abdominal pain and changes in the pattern of bowel movements without any evidence of underlying damage.

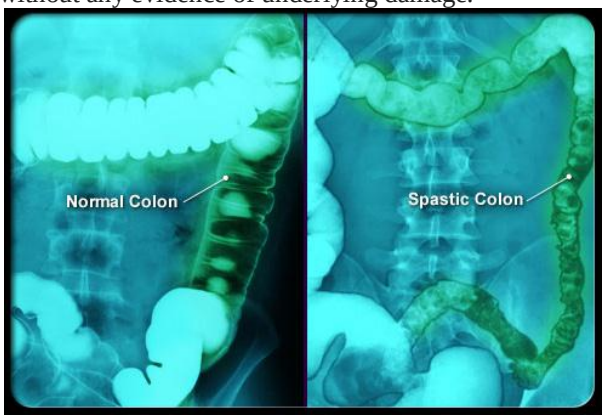

Figure 5: SPASTIC COLON

5- **Ulcerative colitis (U**C) is a long-term condition that results in inflammation and ulcers of the colon and rectum.

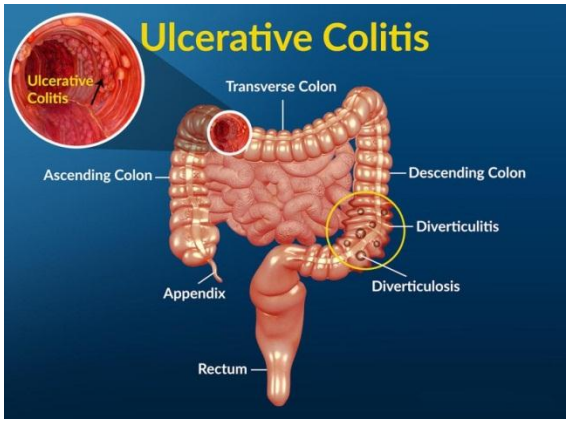

Figure 6: Ulcerative colitis

6- Cancer

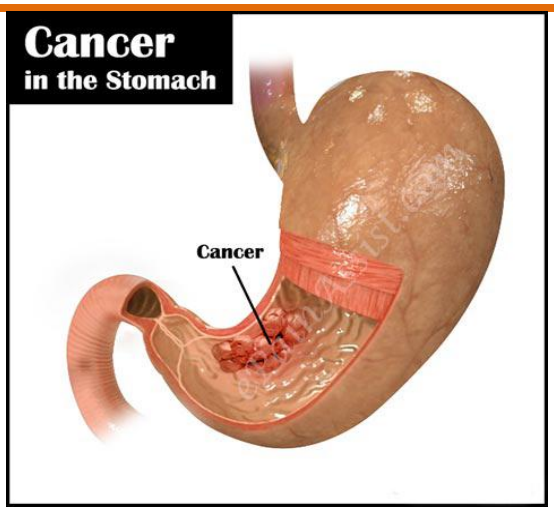

Figure 7: Cancer

7- **Viral Hepatitis**: it is liver inflammation due to a viral infection.

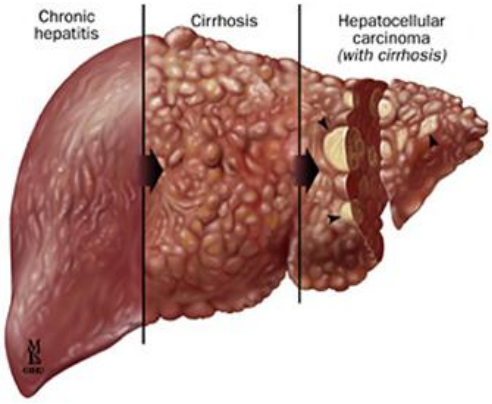

Figure 8: Viral Hepatitis

8- **Mononucleosis**: is an infection commonly caused by the Epstein–Barr virus (EBV). Most people are infected by the virus as children, when the disease produces little or no symptoms. In young adults, the disease often results in fever, sore throat, enlarged lymph nodes in the neck, and tiredness. Most people get better in two to four weeks; however, feeling tired may last for months. The liver or spleen may also become swollen. In less than one percent of cases splenic rupture may occur.

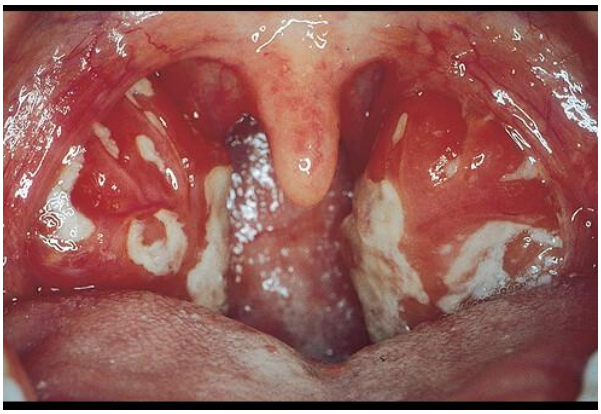

Figure 9: Mononucleosis

9- **CELIAC DISEASE**: Celiac disease is a digestive disorder that damages the small intestine. People with celiac disease cannot eat gluten, a protein found in wheat, barley, and rye. The disease can cause long-term digestive problems and keep you from getting nutrients you need.

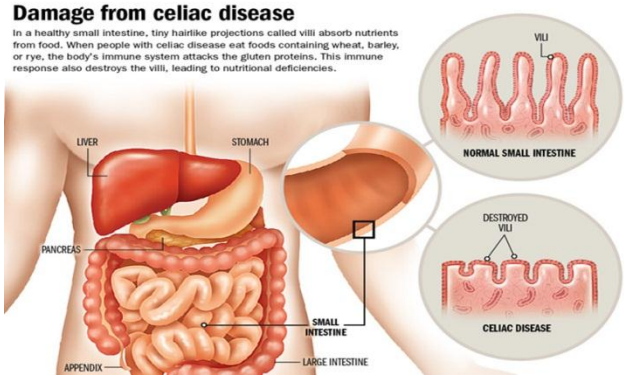

Figure 10: CELIAC DISEASE

10- PANCREATIC INSUFFICIENCY

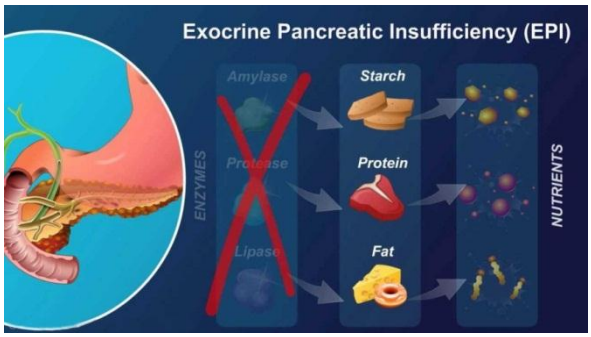

Figure 11: Pancreatic Insufficiency

11- **DIVERTICULITIS**: is a digestive disease in which pouches within the large bowel wall become inflamed.

Figure 12: Diverticulitis

12- GIARDIASIS: Giardiasis, popularly known as beaver fever, is a parasitic disease caused by Giardia lamblia. About 10% of those infected have no symptoms. When symptoms occur they may include diarrhea, abdominal pain, and weight loss. Vomiting, blood in the stool, and fever are less common. Symptoms usually begin 1 to 3 weeks after exposure and without treatment may last up to six weeks.

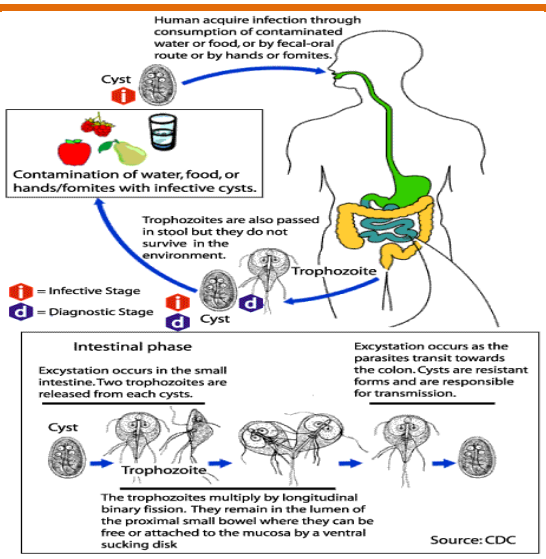

Figure 13: GIARDIASIS

13- HEMORRHOID:

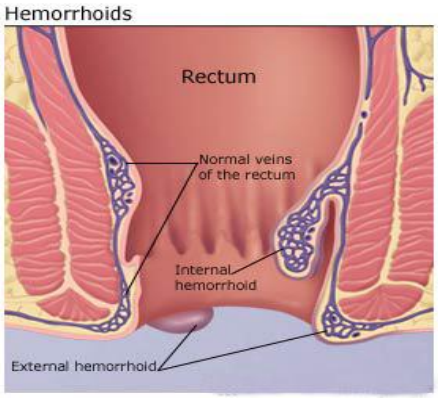

Figure 14:HEMORRHOID

14- CONSTIPATION

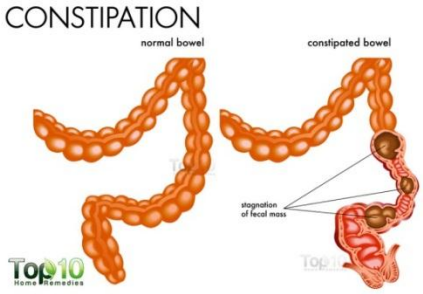

Figure 15: CONSTIPATION

2. LITERATURE REVIEW

Medical expert systems have met a pretty interest within the academic milieu. During the literature review of the subject we have come across many case studies that are worth to mention.

1- **A Ruled Based System for Ear Problem Diagnosis and Treatment [**17**].** This Ruled Based System for Ear Problem Diagnosis was implemented using, SL5 Object language. In this ruled based system ear problems were divided into three main categories:

a- External ear problems
b- Middle ear problems
c- Inflammation of the inner ear

2- **Lower Back Pain Expert System Diagnosis and Treatment[13]**
This paper proposes an expert system that can be used to successfully diagnose low back pain intensity. This system enquires the symptoms then finally it can decide the illness causing these symptoms and suggests the appropriate cure.

3- **A Proposed Expert System For Foot Diseases Diagnosis [23]**
The proposed expert system performs diagnosis for eighteen foot diseases of all stages of the human life starting with newborn to the elderly by asking yes or no questions. The proposed 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.

4- **Fuzzy MLP based expert system for medical diagnosis[36]**
A fuzzy MLP model, developed by the author, is used as a connectionist expert system for diagnosing hepatobiliary disorders. It can handle uncertainty and/or impreciseness in the input as well as the output. The input to the network is modelled in terms of linguistic pi-sets whose centres and radii along each feature axis are determined from the distribution of the training data. In case of partial inputs, the model is capable of querying the user for the more important feature information, when required. Justification for an inferred decision may be produced in rule form.

5- **A Knowledge Based System for Neck Pain Diagnosis[16]**
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. The proposed Knowledge Based System for neck diseases diagnosis was designed and implemented using SL5 Object a rule-based language for specifying expert systems

6- **An expert system for shoulder problems using CLIPS[22]**
The proposed expert system for Shoulder problems diagnosis was designed and implemented using CLIPS which was developed at NASA's Johnson Space Center in 1996.

7- **A Review: Expert System for Diagnosis of Myocardial Infarction[37]**
In this paper, the author present s the review of past work that has been carried out by various researchers based on development of expert systems for the diagnosis of cardiac disease.

8- **Expert system urination problems diagnosis[24]**
In this paper the design of the proposed Expert System which was created to help Urination Problems in diagnosing some of the Urination diseases (Pyelonephritis, Kidney Stone, Bladder infection, Prostatitis, Urethritis, Gonorrhea, Interstitial cystitis, Stress incontinence, Trauma in kidney or bladder) are presented, an overview about the Urination diseases are displayed, the cause of diseases are outlined and the treatment of disease whenever is possible is given. SL5 Object language was used for designing the proposed expert system.

9- **A Proposed Rule Based System for Breasts Cancer Diagnosis[18]**
The proposed Rule Based System was produced to help people to Prevent and early detection breast cancer; because it is known that this disease does not have medication or cure yet. SL5 Object language was used in the designing of the proposed ruled based system.

10- **Development of a Medical Expert System as an Expert Knowledge Sharing Tool on Diagnosis and Treatment of Hypertension in Pregnancy [38]**
This paper outlines the development a Medical Expert System for the diagnosis and treatment Hypertension in Pregnancy to be used in the Reproductive Health Division, at Moi Teaching and Referral Hospital in Eldoret, Kenya.

11- **An Expert System for Endocrine Diagnosis and treatments using JESS [30]**
The proposed Rule Based System was produced to help diagnose endocrine glands diseases .The authors used JESS(Java Expert System Shell) to develop it.

12- **A Proposed Expert System for Skin Diseases Diagnosis [10]**
The proposed Expert System for Skin Diseases Diagnosis was implemented using, CLIPS(C Language Integrated Production System)

13- **Male Infertility Expert System Diagnoses and Treatment[14]**

In this paper the researchers present an expert system for male infertility diagnosis which will 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.. This expert system for male infertility diagnosis used a very high level 5th generation language called: SL5 Object language for its design and implementation.

14- Design and Development of Diabetes Intelligent Tutoring System[34]

This paper describes the design of a desktop based intelligent tutoring system for teaching diabetes to the student to overcome the difficulties they face. Intelligent Tutoring Systems purposed to provide immediate and customized instruction or feedback to learners.

The intelligent tutoring system for diabetes was designed and developed using ITSB (An Intelligent Tutoring System Authoring Tool by DR. S. Abu Naser)[35].

15- AN EXPERT SYSTEM FOR DIAGNOSING EYE DISEASES USING CLIPS[9]

This work presents the design of an expert system that aims to provide the patient with background for suitable diagnosis of some of the eye diseases. CLIPS language is used as a tool for designing the expert system.

16- Expert Systems Research: Modeling the Medical Decision Making Process[39]

The VM (Ventilator Manager)program has suggested that knowledge engineering techniques, such as those developed for MYCIN, can be adapted to dynamic clinical settings such as monitoring patients in the intensive care unit.

The Ventilator Manager project was supported by NIH Grant GM-24669, awarded to the Institute of Medical Science at Pacific Medical Center (San Francisco). Computing resources were provided by the SUMEX-AIM facility at Stanford University under NIH Grant RR-00785. Dr. Shortliffe is recipient of research career development award LM-00048 from the National Library of Medicine.

17- An Expert System for Mouth Problems in Infants and Children[21]

The proposed expert system will ask the user to answer the questions about the symptoms of the patient and end up with the diagnosis. Then this expert system shows the user some information about the disease and some advices telling him/her how to deal with the baby.

SL5 Object expert system language was used to design and implement this expert system.

18- Knowledge Management in ESMDA: Expert System for Medical Diagnostic Assistance[29]

This research involved designing a prototype expert system that helps patients in diagnosing their diseases and offering them the proper advice; furthermore, the knowledge management used in the expert system is discussed. One of the main objectives of this research was to find a proper language for representing patient's medical history and current situation into a knowledge base for the expert systems to be able to carry out the consultation effectively. Production rules were used to capture the knowledge. The expert system was developed using CLIPS(C Language Integrated Production System) with Java Interface.

19- Medical Expert Systems for Diagnosis of Various Diseases[40]

This review paper presents a comprehensive study of medical expert systems for diagnosis of various diseases. It provides a brief overview of medical diagnostic expert systems and presents an analysis of already existing studies.

20- Medical Expert System- A Comprehensive Review[41]

This study summarizes some of the rule based; fuzzy expert system and artificial neural network based medical diagnostic systems.(very similar to the last paper mentioned above).

21- EVALUATION OF MEDICAL EXPERT SYSTEMS:A Case Study in Performance Assessment[42]

A number of methods for critically evaluating the performance of medical expert systems in practice are surveyed. To illustrate the concepts involved, clinical evaluation of the performance of a computer-based decision aid for patients having transient ischemic attacks is discussed in some detail. Two factors are identified as crucial in the rapid development and testing of this system: the availability of a domain-independent expert system generator, and the existance of a database of relevant patient records.

22- mMES: A Mobile Medical Expert System for Health Institutions in Ghana[43]

This paper introduces and proposes a Mobile Medical Expert System (mMES) using mobile devices and computing technology so that Medical Doctors in Ghana can speed up diagnosis, confirm their own diagnosis, provide advice on found diagnosis and provide advice on certain diseases when diagnosed on a patient.

23- Medical Expert Systems-Knowledge Tools for Physicians[44]
In this paper the author discusses mainly the expert system ONCOCIN. ONCOCIN is an advanced expert system for clinical oncology that has been under development at Stanford University School of Medicine since 1979. It is designed for use after a diagnosis has been reached, focusing instead on assisting with the management of patients with cancer who are receiving chemotherapy.

24- Knowledge Acquisition by Encoding Expert Rules Versus Computer Induction From Examples: A Case Study Involving Soybeans Pathology[45]
The researchers in this study found that the inducted decision rules are better than the rules derived by representing the knowledge of experts.

3. EXPERT SYSTEMS

It is an Artificial intelligence based system that converts the knowledge of an expert in a specific subject into a software code. This code can be merged with other such codes (based on the knowledge of other experts) and used for answering questions (queries) submitted through a computer. Expert systems typically consist of three parts (as seen in Figure 16)[1,2,4-8,11-12,15,19-20,25,27-28,31-34]:

- a knowledge base which contains the information acquired by interviewing experts, and logic rules that govern how that information is applied;
- an Inference engine that interprets the submitted problem against the rules and logic of information stored in the knowledge base; and an
- Interface that allows the user to express the problem in a human language such as English.

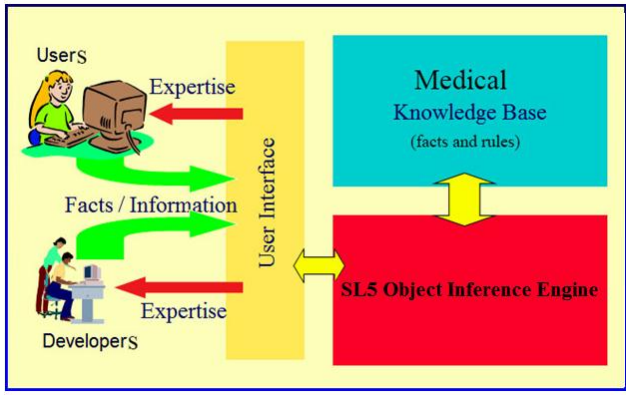

Figure 16: Expert System Architecture

4. KNOWLEDGE REPRESENTATION

We could build an expert system: ”Smart Abdominal Diagnoses ”(S A D for short) that can diagnose 14 different abdominal diseases using only 15 questions and give appropriate recommendations.

We used expertise that is stored in a specialized website namely ‘www. familydoctor.org’.

S A D can deduce the diagnosis using some questions which the user must answer with ‘yes’ or ‘no’ thereafter it can give him or her the diagnosis with a recommendation.

We have used the SL5 Object expert system language [26] to represent the knowledge of SAD.

5. MATERIALS AND METHODS

a) **Data collection**: the main expertise knowledge used in this system is taken from the specialized website https://familydoctor.org Familydoctor.org is operated by the American Academy of Family Physicians (AAFP), a national medical organization representing more than 124,900 family doctors, family medicine residents, and medical students. The AAFP was founded in 1947 to promote and maintain high quality standards for family doctors. Family doctors take care of the physical, mental, and emotional health of the whole family, from newborns to older adults.

The AAFP follows the Council of Medical Specialty Societies (CMSS) Code for Interaction with Companies. This voluntary code is designed to ensure that societies' interactions with companies are independent and transparent, and advance medical care for the benefit of patients and populations. Information about the AAFP's sources of non-dues revenue is included in an annual report to the AAFP's Congress of Delegates.(more information can be found in "about" section).

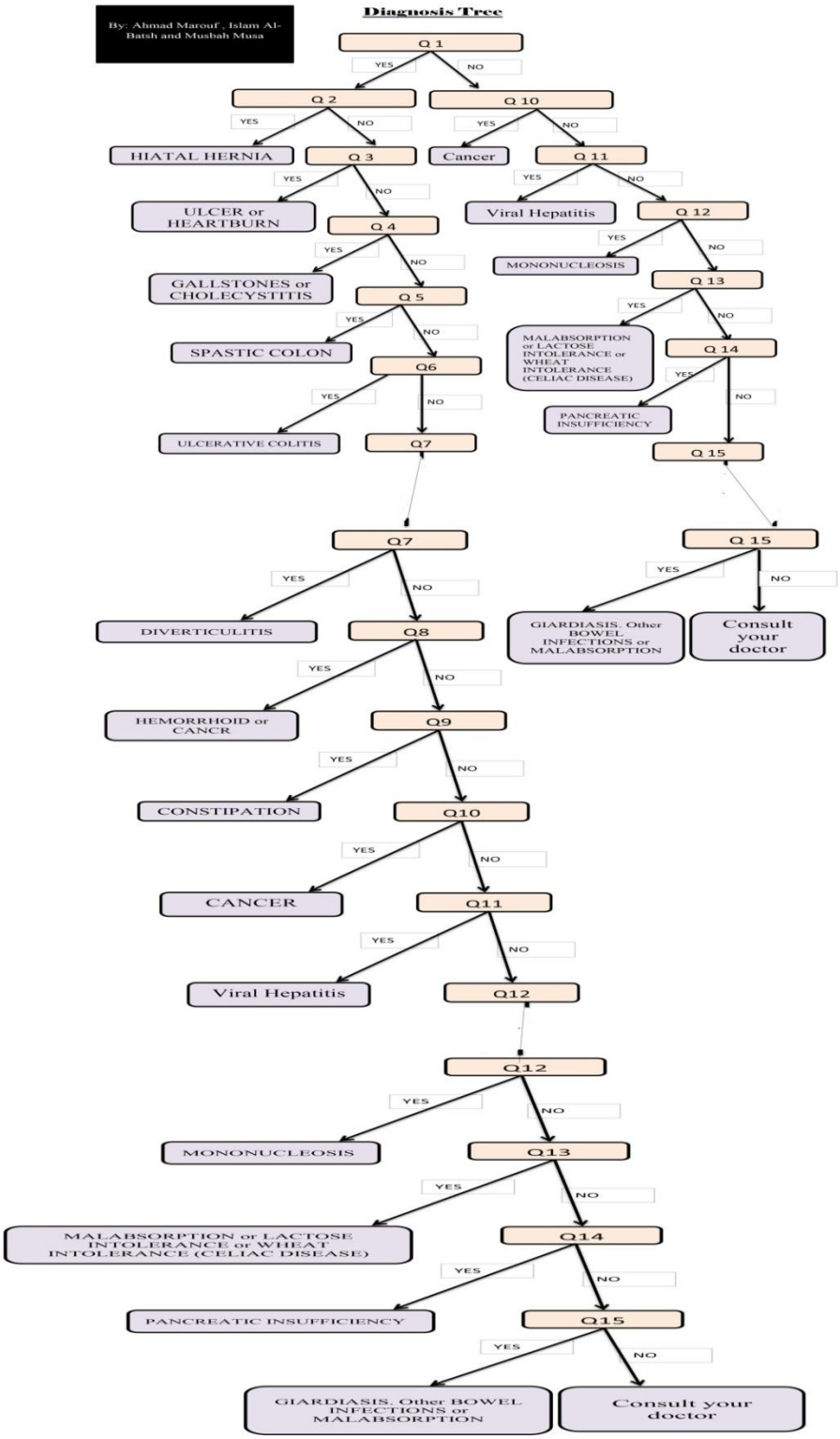

Figure 16: Decision tree of the diagnosis

b) We executed our work following the teamwork spirit

c) The knowledge has been depicted as a decision-tree to smooth the coding process , it is depicted in the next page:

d) The programming language used to accomplish the project was SL5 Object language which stands for Simpler Level 5 Object [26]. It is a forward chinning reasoning expert system that can make inferences about facts of the world using rules, objects and take appropriate actions as a result. The SL5 Object engine is implemented in Delphi Embarcadero RAD Studio XE6. SL5 Object executes any Expert System looks like frames. It's easy for the knowledge engineer to build the Expert System and for the end users when they use the system .Figure 18 shows abdominal expert system welcome Form. Figure 19 shows a sample dialogue between the expert system and the user .Figure 20 shows how the users get the diagnosis and recommendation.

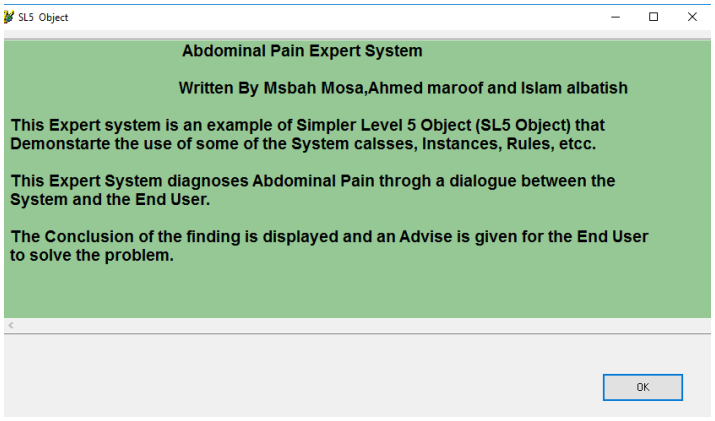

Figure 17: Abdominal expert system

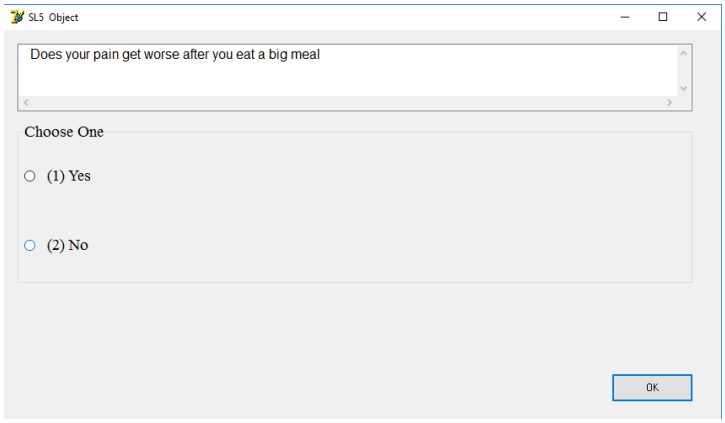

Figure 19: Sample dialogue between the expert system and the user

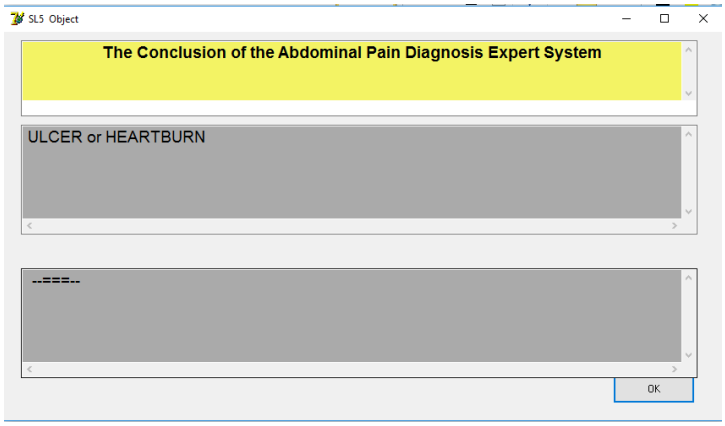

Figure 20: How the users get the diagnosis and recommendation**.**

6. LIMITATIONS

The current proposed expert system is specialized in the diagnosis only the following 14 Abdominal diseases: HIATAL HERNIA, ULCER or HEARTBURN, GALLSTONES or CHOLECYSTITIS, SPASTIC COLON, Ulcerative colitis, Cancer, Viral Hepatitis ,Mononucleosis, CELIAC DISEASE, PANCREATIC INSUFFICIENCY, DIVERTICULITIS, GIARDIASIS, HEMORRHOID, CONSTIPATION.

7. SYSTEM EVALUATION

As a preliminary evolution, Dr. Ayman Abed Al Hady and other Medical students tested this proposed Expert System and they were satisfied with its performance, efficiency, user interface and ease of use.

8. CONCLUSION

The paper presents a proposed expert system to help in diagnosing abdominal diseases, where patients can get a diagnosis and a recommendation for the treatment fast and accurate diagnoses. This rule based system does not require extensive training to be ready for use, where it is easy and simple to be used and it has been developed using SL5 Object programming language.

9. FUTURE WORK

This rule based system has been developed to diagnose chronicle diseases. It can be modified (or developed) to diagnose short-term diseases.

10. EXPERT SYSTEM SOURCE CODE

```
! WRITTEN BY MSBAH MOSA, ISLAM AL BATISH, AHMED MAROOF
!
ATTRIBUTE Does your pain get worse after you eat a big meal? COMPOUND Yes, No
ATTRIBUTE Do you feel pressure in your upper abdomen that gets worse when you bend over or lie down at night?
COMPOUND
Yes, No
ATTRIBUTE Is the pain relieved by antacids? COMPOUND Yes, No
ATTRIBUTE Does the pain start in your upper middle or upper right abdomen and is it brought on by greasy or fatty foods?
COMPOUND Yes, No
ATTRIBUTE Does your pain get worse when you're under stress or do you alternate between loose and hard bowel movements?
COMPOUND Yes, No
ATTRIBUTE Do you have soft or diarrhea like bowel movements many times throughout the day and mucus or blood in your
stools? COMPOUND Yes, No
ATTRIBUTE Do you have recurrent bouts of pain in the lower left side of your abdomen along with fever? COMPOUND
Yes, No
ATTRIBUTE Do you have bright red blood in or on your bowel movements? COMPOUND Yes, No
ATTRIBUTE Has it been a few days or longer since you last had a bowel movement and do you have to strain when you have a
bowel movement? COMPOUND Yes, No
 ATTRIBUTE Has your appetite decreased and have you lost 10 to 15 pounds over the past few months without trying?
COMPOUND Yes, No
 ATTRIBUTE Do your skin or eyes have a yellow color or is your urine dark? COMPOUND Yes, No
 ATTRIBUTE Have you had fever sore throat or extreme tiredness? COMPOUND Yes, No
 ATTRIBUTE Do you have abdominal bloating and discomfort made worse by milk or wheat products? COMPOUND Yes, No
 ATTRIBUTE Are your bowel movements yellow and greasy and do they float in the toilet? COMPOUND Yes, No
 ATTRIBUTE Do you have excess gas that is very foul smelling and occasional loose bowel movements? 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:
*
is
"*
  WITH numeric query text := "What is(are:(
*
of
"*
  WITH string query text := "What is(are:(
*
of
"*
  WITH time query text := "What is(are:(
*
of
"*
  WITH interval query text := "What is(are:(
*
of
"*
  WITH compound query text" =:
*
of
"*
  WITH multicompound query text := "What is(are:(
*
of
"*
INSTANCE introduction ISA display
  WITH wait := TRUE
  WITH delay changes := FALSE
  WITH items [1 ] := textbox 1

INSTANCE textbox 1 ISA textbox
  WITH location := 10,10,1000,350
  WITH pen color := 0,0,0
  WITH fill color := 150,200,150
  WITH justify IS left
  WITH font := "Arial"
  WITH font style IS bold
  WITH font size := 14
  WITH text "=:
                              Abdominal Pain Expert System

                             Written By Msbah Mosa,Ahmed maroof and Islam albatish

          This Expert system is a Simpler Level 5 Object (SL5 Object) that
          Demonstarte the use of some of the System calsses, Instances, Rules, etcc.

          This Expert System diagnoses Abdominal Pain 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 := 20,10,800,90
  WITH pen color := 0,0,0
  WITH fill color := 243,243,100
  WITH justify IS center
  WITH font := "Arial"
  WITH font style IS bold
  WITH font size := 14
  WITH text := "The Conclusion of the Abdominal Pain 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 R0
IF start
THEN ASK Does your pain get worse after you eat a big meal ?

RULE R1
IF Does your pain get worse after you eat a big meal? IS Yes
THEN ASK Do you feel pressure in your upper abdomen that gets worse when you bend over or lie down at night?

RULE R1a
IF Does your pain get worse after you eat a big meal? IS No
THEN ASK Has your appetite decreased and have you lost 10 to 15 pounds over the past few months without trying?

RULE R2
IF Do you feel pressure in your upper abdomen that gets worse when you bend over or lie down at night? IS Yes
THEN text OF problem textbox  := "HIATAL HERNIA"

RULE R2a
IF Do you feel pressure in your upper abdomen that gets worse when you bend over or lie down at night? IS No
THEN ASK Is the pain relieved by antacids?

RULE R3
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IF Is the pain relieved by antacids? IS Yes
THEN text OF problem textbox := "ULCER or HEARTBURN"

RULE R3a
IF Is the pain relieved by antacids? IS No
THEN ASK Does the pain start in your upper middle or upper right abdomen and is it brought on by greasy or fatty foods?

RULE R4
IF Does the pain start in your upper middle or upper right abdomen and is it brought on by greasy or fatty foods? IS Yes
THEN text OF problem textbox := "GALLSTONES or CHOLECYSTITIS"

RULE R4a
IF Does the pain start in your upper middle or upper right abdomen and is it brought on by greasy or fatty foods? IS No
THEN ASK Does your pain get worse when you're under stress or do you alternate between loose and hard bowel movements?

RULE R5
IF Does your pain get worse when you're under stress or do you alternate between loose and hard bowel movements? IS Yes
THEN text OF problem textbox := "SPASTIC COLON"

RULE R5a
IF Does your pain get worse when you're under stress or do you alternate between loose and hard bowel movements? IS No
THEN ASK Do you have soft or diarrhea like bowel movements many times throughout the day and mucus or blood in your stools?

RULE R6
IF Do you have soft or diarrhea like bowel movements many times throughout the day and mucus or blood in your stools? IS Yes
THEN text OF problem textbox := "ULCERATIVE COLITIS"

RULE R6a
IF Do you have soft or diarrhea like bowel movements many times throughout the day and mucus or blood in your stools? IS No
THEN ASK Do you have recurrent bouts of pain in the lower left side of your abdomen along with fever?

RULE R7
IF Do you have recurrent bouts of pain in the lower left side of your abdomen along with fever? IS Yes
THEN text OF problem textbox := "DIVERTICULITIS"

RULE R7a
IF Do you have recurrent bouts of pain in the lower left side of your abdomen along with fever? IS No
THEN ASK Do you have bright red blood in or on your bowel movements?

RULE R8
IF Do you have bright red blood in or on your bowel movements? IS Yes
THEN text OF problem textbox := "HEMORRHOID or CANCR"

RULE R8a
IF Do you have bright red blood in or on your bowel movements? IS No
THEN ASK Has it been a few days or longer since you last had a bowel movement and do you have to strain when you have a bowel movement?

RULE R9
IF Has it been a few days or longer since you last had a bowel movement and do you have to strain when you have a bowel movement? IS Yes
THEN text OF problem textbox := "CONSTIPATION"

RULE R9a

IF Has it been a few days or longer since you last had a bowel movement and do you have to strain when you have a bowel movement? IS No
THEN ASK Has your appetite decreased and have you lost 10 to 15 pounds over the past few months without trying?

RULE R10
IF Has your appetite decreased and have you lost 10 to 15 pounds over the past few months without trying? IS Yes
THEN text OF problem textbox := "CANCER"

RULE R10a
IF Has your appetite decreased and have you lost 10 to 15 pounds over the past few months without trying? IS No
THEN ASK Do your skin or eyes have a yellow color or is your urine dark?

RULE R11
IF Do your skin or eyes have a yellow color or is your urine dark? IS Yes
THEN text OF problem textbox := "Viral Hepatitis"

RULE R11a
IF Do your skin or eyes have a yellow color or is your urine dark? IS No
THEN ASK Have you had fever sore throat or extreme tiredness?

RULE R12
IF Have you had fever sore throat or extreme tiredness? IS Yes
THEN text OF problem textbox := "MONONUCLEOSIS"

RULE R12a
IF Have you had fever sore throat or extreme tiredness? IS No
THEN ASK Do you have abdominal bloating and discomfort made worse by milk or wheat products?

RULE R13
IF Do you have abdominal bloating and discomfort made worse by milk or wheat products? IS Yes
THEN text OF problem textbox := "MALABSORPTION or LACTOSE INTOLERANCE or WHEAT INTOLERANCE (CELIAC DISEASE"(

RULE R13a
IF Do you have abdominal bloating and discomfort made worse by milk or wheat products? IS No
THEN ASK Are your bowel movements yellow and greasy and do they float in the toilet?

RULE R14
IF Are your bowel movements yellow and greasy and do they float in the toilet? IS Yes
THEN text OF problem textbox := "PANCREATIC INSUFFICIENCY"

RULE R14a
IF Are your bowel movements yellow and greasy and do they float in the toilet? IS No
THEN ASK Do you have excess gas that is very foul smelling and occasional loose bowel movements?

RULE R15
IF Do you have excess gas that is very foul smelling and occasional loose bowel movements? IS Yes
THEN text OF problem textbox := "GIARDIASIS. Other BOWEL INFECTIONS or MALABSORPTION"

RULE R15a
IF Do you have excess gas that is very foul smelling and occasional loose bowel movements? IS No
THEN text OF problem textbox := "Consult your doctor"
AND text OF advise textbox := "For more information, please talk to your doctor. If you think the problem is serious, call your doctor right away" . .

END

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