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Expert System for the Preeclampsia Prevention Program

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Abstract:- In this paper we present the prototype of the Expert System for the Preeclampsia Prevention Program (ESPPP), a ruled-based medical expert system that supports diagnostic and therapeutic decisions in the realm of hypertensive disorders of pregnancy (HDP) and that could be used for training physicians and for guiding them to accurately perform all the activities of a public health program ("Preeclampsia Prevention Program"). ESPPP applies pragmatic criteria for diagnosing, classifying and suggesting the appropriate treatment of the HDP and their complications. This system guides the user for collecting patient information easily, and based on those items that leads to the possible diagnose and treatment for that patient. ESPPP has been developed for the Preeclampsia Prevention Program to be used by all physician that assist pregnant women in Mérida, Venezuela. ESPPP will be carefully evaluated and, if proven effective and accurate, it will be presented to practitioners a new tool for delivering high-quality, standard and individually adapted health care.
Key Words:- Expert Systems, Artificial Intelligence, Medical Diagnosis, Hypertensive Disorders of Pregnancy, Preeclampsia.

1 Introduction

An Expert system (ES) is a computer software that uses the knowledge captured in its program to solve difficult problems, that normally require human expertise [1]. They concentrate information given by a human expert to replace him/her when not available or when his/her knowledge is needed in several places simultaneously [1-3]. Well-designed ES imitates the reasoning process experts use to solve specific problems, and can be used by non-experts to improve their problem-solving capabilities and by experts as a knowledgeable assistant [1]. In medicine, ES contain information about the diagnostic and therapeutic strategies to apply on the patient, and can help training physicians to choose the best strategy with the accuracy of a specialist.

ESPPP is a rule-based ES in medicine, which supports the diagnosis and the therapeutic decision making in the field of hypertensive disorders of the pregnancy (HDP), their risk factors and complications. ESPPP can be useful for training general practitioners and to guarantee the suitable and accurate execution of the activities of the public health Preeclampsia Prevention Program (PPP). ESPPP applies pragmatic criteria, based on published evidences, expertise and the requirements of the PPP, to classify, to diagnose and to suggest the treatment of HDP and their complications. This system can guide the user to comprehensively assess the patient, to easily collect patient's information, and based on those data it can suggest the possible diagnosis and appropriate treatment for that patient. The diagnostic and therapeutic strategies are highly standardized and individualized, which would guarantee qualified medical service and low costs. Its data base registers, collects, stores, and process all the necessary information for the epidemiological surveillance system for the PPP. This information could also be used for researches concerning the effectiveness of the therapeutic strategies, among other epidemiological parameters.

The article is organized as follows: section 2, brief review about ES and their applications in medicine; section 3, the justification for developing the system with a brief scope of the magnitude of the impact of the HDP as well as the public health program "Preeclampsia Prevention Program", in section 4 it

is described the ESPPP, and section 5 contains some conclusions.

2 Expert Systems

Knowledge based systems are one of the artificial intelligence areas, which compile information about a subject and, if that information is given by a human expert, it is called Expert System [4-6]. The process of knowledge acquisition and its suitable structuring is known as Knowledge Engineering.

The capabilities that ES have related to compiling information that human experts have concerning a particular field and since they could be able to replace this experts in case of absence, brought them to great interest for the industries where highly qualified personnel can leave at any time [8, 10].

Since the early 80's, ES have been widely used in medicine and radiology and they are numerous and constantly increasing. ES in medicine are knowledge data bases founded on patient data, literature search and experts opinions. With these systems it is, for instance, possible to test or to take clinical decisions. These systems are, among other uses, employed for quality assurance and documentation, as a teaching instrument, as well as a knowledge base. The possibility of their use in the application of diagnostic and staging or screening protocols seems particularly attractive. ES should guarantee specialists expertise to be available to non specialist such as general doctors [1]. They are appropriate for being used in telemedicine systems and could be of great value in the optimization tasks to be executed in public health programs, such as: to identify risk factors, to screen accurately the population, to classify and to comprehensively assess patients, to standardize, to individualize conducts, to compile epidemiological information in its data base, among others.

3 Justification for developing an Expert system

Preeclampsia, a HDP, is a serious public health problem, according to the World Health Organization (WHO). It is the first cause of maternal and perinatal morbimortality in the world, particularly in the underdeveloped countries. It has large incidence (up to 13% of the total pregnant women) and is much greater in the pregnant women of high risk (nulliparity, previous preeclampsia, obesity, hypertension, diabetes, hypertension, among Africans and descendents, familiar history of hypertension or preeclampsia, twin pregnancy, systemic erythematous lupus, among others). It is the pathology that generates the highest costs in the obstetrical field, generates high costs due to Caesarean sections, hospitalization costs, complications, disability, death, absenteeism, among others [11]. It is possible to prevent, the cost of the preventive treatment could be low, its availability could be global and it could practically eliminate the development of complications. Antenatal care itself is not enough to prevent preeclampsia, the treatment could almost completely reverse the disease and prevent complications, as long as the diagnosis and the indication of the appropriate treatment are instituted as soon as needed.

Due to the importance that this disease has on the morbimortality during the pregnancy, and particularly in Mérida, Venezuela; 13 years ago, it was created and implemented the "Preeclampsia Prevention Program" (PPP) [11] with the aim of reduce the incidence of preeclampsia and its morbimortality. The first version of an expert system for the diagnosis and treatment of preeclampsia was done on 1998, but had some inconveniences concerning rules actualization and/or edition, so we now developed ESPPP.

4 Expert System for the Preeclampsia Prevention Program

ESPPP was developed using Visual Basic 6.0 programming language; including the design of all the interfaces that take place in the system, the users interface (medical doctor) and data bases. These data bases are stored on Visual Fox Pro 6.0. ESPPP consists on two main modules: The Knowledge Base Editor, fed with the expert information and, the Diagnostic/Therapeutical Application, which guides the doctor on the assessment of the patient. A specialized and standardized comprehensive clinical examination, which conform clinical history and the execution of the inferences engine, allows the diagnosis emission and pertinent suggestions,

associated with the information processed by the PPP. The Diagnostic/Therapeutical Application send to the facts base all the important information of the assessment and the results of the medical consultation.

The human-machine interface works under Windows®. Menus allow access to forms, which contain: text type controls, single selection, multiple selection, lists, images and buttons that direct the procedures according to the user's requirements; most of them contented within the information classifier cards and system operations (Figure 1). The user's ID number is used for log in the system and the patient's ID give access to the patient's record.

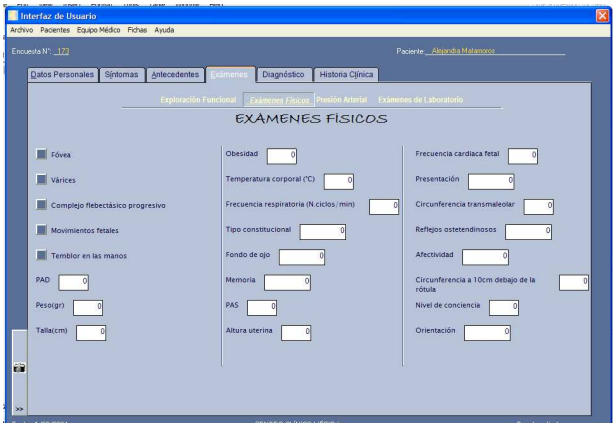

Figure 1. Patient information form

The Knowledge Base Editor offers the user the possibility of creating new diagnostic-therapeutical rules under a graphical, friendly easy-to-use framework (Figure 2); being these the representative statements of the system's expertise and are conformed by logic expressions that validate, in a relational or a binary way, each one of the studied items (variables) associated to the diagnoses that form the knowledge base. The items classification - relational or binary- is made by the expert according to the kind of answer that is required, and the classification is preserved according to the evaluation mode within the rules and logical expressions. The complexity level of the rules with respect to the amount of individual logical expressions and the possibility of association among them for generating nested expressions without relevant restriction is one of capabilities that offer this module. In this sense, the editor was designed to be able to identify the type of item that conforms the rule, the expressions grouping ways, the use of logic and relational operators and the handling of predefined comparison patterns with manual insertion (numerical or text type) or calculation by means of predefined formulas, making this way a step by step rule syntax supervision to avoid the insertion of invalid sentences.

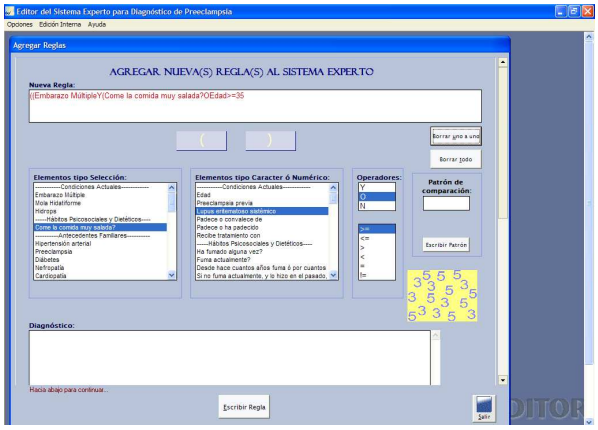

Figure 2. Expert System rule editor

For safety reasons, the editor can only be accessed by authorized people and is protected by passwords, which guarantees that the knowledge base will maintain stored only that information provided by experts who count with the appropriate permission for it.

The Diagnostic/Therapeutical Application is presented on frameworks in which items of the assessment, diagnosis and patients' record review are classified by groups. Since it is based on expertise, the ESPPP is able to deactivate items that are not pertinent to approach during the assessment so it make the consultation free of risk for committing inadmissible errors while spending less time. The system registers only those data that the expert considers that are important to conserve for his possible use in later consultations.

The two applications that conform the system, offer the user a Help Menu containing all the information regarding to their use, by means of the tasks classification and procedures that they allow to make.

The capabilities of this system are:

1. It guides the user appropriately to follow the requirements and activities of the PPP, and collect the epidemiological data needed for assessment.
2. It supports the diagnosis of one or more diseases (HDP, their risk factors and their complications) and suggests the appropriate management.
3. It diagnoses the absolute absence of anyone of these diseases.
4. It finds some symptoms or signs attributable to any exogenous cause (differential diagnosis).
5. It notifies the doctor that the patient does not fulfill the minimum criteria for some of the diseases and in this case it suggests a later revaluation with more data (IE: lab).
6. It compiles, stores, and process information on the data base to be used in the epidemiological surveillance system and research projects.

Some important characteristics of ESPPP, include the accomplishment of individualized questions for each patient and the data selection that is going to be acquired, both based on answers to previous questions. The recommendations are highly specific for the person.

5 Conclusions

A user friendly ES has been developed and is a potential tool for the computer aid diagnosis for HDP and for helping in the suitable execution of the public health program PPP. The feasibility that the system has concerning that the stored expertise can be edited and considering that it supports guided assessment to reach medical conclusions emitted by experience programmed under an easy-to-use environment, make ESPPP a computational tool of potential application in the telemedicine area and could be used in the telemedicine network in Mérida, Venezuela. It has been designed to facilitate the autolearning and to avoid the execution of errors in guidelines, requirements and activities of PPP. ESPPP combines the facilities of a traditional expert system for the clinical diagnosis with several modules designed for educative intentions and a useful data base for registering all the necessary information for executing and for evaluating the epidemiological surveillance system. The ESPPP is actually being evaluated and, if it proves to be effective and precise, this new tool will be presented to doctors in order to offer high quality medical, standardized and individualized services.

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