

Development and Evaluation of an Expert System for the Diagnosis of Child Autism

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Abstract. This paper presents the development of an expert system for the diagnosis of child autism and discusses potential benefits of its implementation in a clinical environment. The development of the expert system was based on a diagnostic algorithm supported by a developmental scale (PEDS) and a diagnostic tool of autism (CARS). Twelve nurses who work in pediatric hospital were asked to use the expert system for a session of 30 minutes and were asked to assess its usefulness, usability and diagnostic value. The majority of nurses agree that it is a useful and promising diagnostic tool for the clinical practice and for the identification of potential child autism cases.

Keywords: Expert systems, artificial intelligence, autism, diagnosis.

Introduction

An Expert System is a computer program that performs at the level of a human expert in a complex but narrow field [1]. Expert systems code and handle knowledge of a human-expert in a specific domain. The main role of these systems is to solve human problems and give advice [2]. Artificial Intelligence (AI) covers a wide area of sciences. The technology of expert systems is an important part of practical methods of AI.

Autism is a modern mental illness plaguing families globally. The existence, therefore, of a diagnostic expert system is based entirely on diagnostic criteria, standards and strict semantics. It is a compelling tool for the healthcare professional in the 21st century. The expert system provides to any practitioner a quick, clear and effective way to improve the diagnostic results[3]. During the last few years, expert systems have been extensively used in various medical environments to support the diagnosis in a way that reflects and mimics human logic.

1. Methods

The expert system for the diagnosis of child autism was based on diagnostic algorithms of autism [4], [5] suggested by scientific publications. The first level of diagnostic process focuses on the recognition of developmental delays. This part includes the routine developmental surveillance of a child that should be performed at all visits to a pediatrician. At this stage, the system deals with the classification of the developmental stage and the mental age of child, is supported by “PEDS: PESPONSE FORM”.

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“PEDS” is a valid screening tool that evaluates the linguistic development and the social skills of a child [12]. Parents are asked to answer ten questions on the PEDS Response Form about their perspectives on their child for each area of development including health issues such as sleeping, eating, vision, and hearing. “PEDS” assigns probabilities of delay and disabilities to various types of concerns, whereas it can be used both by parents and clinicians. As a follow up, the system outputs suggestions for further laboratory investigation and screening for autism based on the provided replies. The second tool that has been selected for the expert system is “CARS” (Childhood Autism Rating Scale) [6]. This is a screening diagnosis instrument that focuses on children with autism. “CARS” is an interview scale that contains 15 different sections about a child’s behavior. It is intended to be used as a structured interview and observation instrument to assess the severity of autism [5]. “CARS” is widely recognized as a reliable instrument for the diagnosis of autism. Both scales are implemented within a single software environment. Users are expected to reply to the first set of questions and, based on the provided answers, the second set may follow up.

The expert system was developed with the use of a symbolic programming language, namely Prolog, which is based on predicate logic [7]. In this system, the methodology of solving problems is characterized by an architecture based on knowledge base and on a backbone inference engine.

The system was evaluated by 12 nurses who worked in pediatric hospitals. All nurses have previously attended a master’s course in Health Informatics. The diagnostic tool was evaluated with the use of a semi-structured interview for the perceived belief of nurses regarding its (i) usefulness (overall clinical value, importance in diagnosis process) (ii) usability (ease of system use, learning curve, application in everyday practice) and (iii) diagnostic value (perceived sensitivity and specificity, coverage of all aspects of autism).

2. Results

The group of 12 nursing practitioners, who were selected to pilot test the expert system, were asked to use the application in three sample autistic cases after a 30 minute presentation of the system features. Discussion in the form of a semi structured interview followed up, pinpointing to their perception regarding the system usability, usefulness and diagnostic value. This pilot evaluation indicated that the system could potentially support the diagnosis of autism. There was also a common consensus that the tool is based on evidence based diagnostic algorithms widely accepted by the health care community. Finally, most nurses expressed the opinion that the expert system is a potentially necessary diagnostic instrument that assists on clinical practice and could be implemented within health information systems.

The expert system for the diagnosis of autism takes into account on the one hand, the clinical signs, symptoms and on the other hand the developmental characteristics of a child. Moreover, it provides a timely and effective way of diagnosis and inference, with well defined queries and structured output. The system has an easy enough learning curve. It can be used by any healthcare professional, regardless his prior experience in using e-health applications. More extensive use by a larger group of practitioners is expected to provide further quantitative evaluation measures.

3. Discussion

The study describes the development of an expert diagnostic system for the assessment of child autism. The system was based on well-known diagnostic algorithms and was implemented with the use of a powerful platform. The application has been pilot tested by 12 health care professionals working in pediatric departments and was assessed positively, as a reliable and useful diagnostic tool, also demonstrating the feasibility of the proposed expert system. This pilot study provides evidence for the necessity to implement expert systems for the diagnosis of child autism in clinical practice. Proper training sessions of all clinicians that will potentially use the system, about the features is very important for the successful implementation. Specific functions of the proposed system can potentially be used by clinicians as a routine follow-up test to all children who visit the hospital.

Many research studies demonstrate the advantages of expert systems: they are rapid, easy to operate, noninvasive, and not expensive [8]. It is possible that the current pilot study could stimulate health informaticians to further develop such an expert system to provide a professional application, based on machine learning algorithms [9]. The research of expert systems has focused on complex human problems of various fields such as health [10]. To conclude, it is evident that expert systems document human scientific knowledge and help improve clinical practice and therapy [11]. It is therefore understood that the promotion of expert systems in health is imperative for improving health care services of a child who suffers.

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