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Clinical Decision Support System for Diagnosis of Pneumonia in Children

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Abstract: This paper describes a proposed fuzzy based expert system for diagnosing Pneumonia, which is a number one killer diseases in the world but little attention is paid to it in the past. Given symptoms associated with this disease, the pediatrician can ascertain the level of severity of the disease. Our proposed system is very effective and efficient than all other existing diagnosis systems.

Keywords: Pneumonia, fuzzy expert system, clinical decision support system, fuzzy logic.

1. Introduction

Pneumonia continues to be a number one killer of children in the world. THE United Nation Children's Fund (UNIFEF) recently estimated that pneumonia causes 18% of all child mortality an estimated of 1.3 million child deaths in 2011 alone [1]. Pneumonia kills more children than any other illness – more than AIDS, malaria and measles combined. Yet, little attention is paid to this disease [2]. Majority of pneumonia cases are preventable and treatable [3] and more than 99% of pneumonia death occur in developing countries [4].

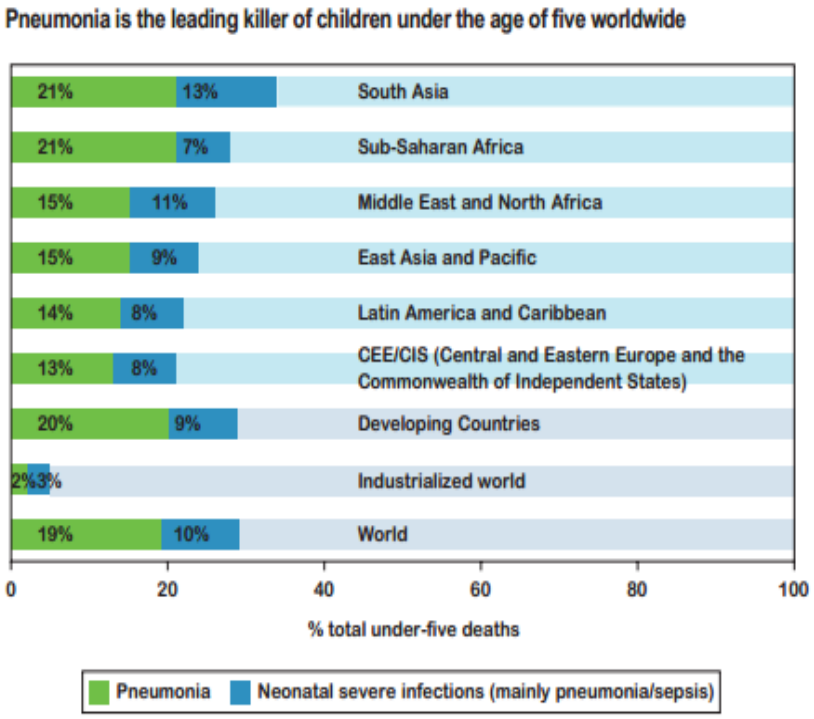

Fig 1: This bar chart shows that pneumonia is the *leading killer of children under five worldwide.* "Pneumonia: The forgotten killer of children, "The United Nations Children's Fund (UNICEF) World Health Organization (WHO). 2006.

The World Health Organization (WHO) and UNICEF released the Global Action Plan for Prevention and Control of Pneumonia (GAPP) in 2009, setting out a 90% coverage target by 2015 for three interventions: vaccination, breastfeeding, access to care and antibiotic treatment [3]. GAPP main goal is to focus on ways to prevent pneumonia infection, protect children from condition that increase risk of pneumonia and treatment of infection. Progress report revealed improvement in some areas along with some challenges. Nigeria, India, and the Democratic Republic of Congo continue to suffer from low vaccination coverage and high child mortality [5].

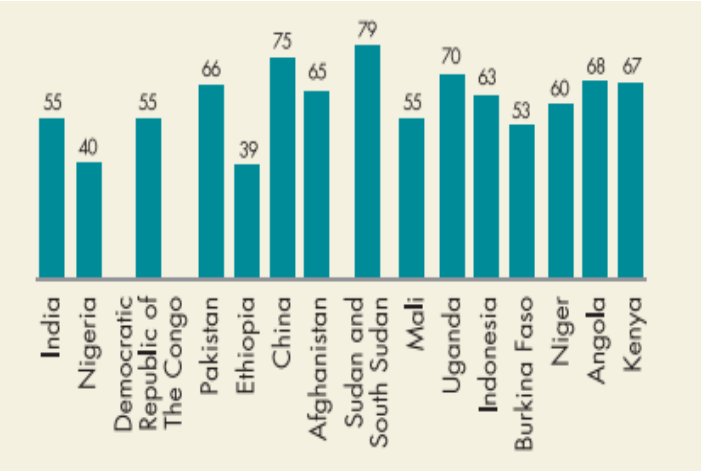

Fig 2: *GAPP intervention score 2012 calculation*

Clinical decision support systems (CDSS) are computer systems designed to impact clinician decision making about individual patients at the point in time that these decisions are made. A fuzzy expert system is a collection of fuzzy rules and membership functions that are used to reason about data. Fuzzy logic which is one of the soft computing techniques can render precise what is imprecise inherent in medical diagnosis [6]. Some applications of fuzzy concept in medical diagnosis are discussed in [7, 8, 9, 10]. Fuzzy logic was developed by Lotfi Zadeh in 1965. Fuzzy systems can be used for estimating, decision-making, and mechanical control systems.

2. Literature Review

Quite a number of expert systems have been designed for the diagnosis and treatment of some diseases. Some of which are;
In 2002, Isabel database was launched in UK for paediatrics [11]. The Isabel Database is a CDSS featuring a clinical checklist and topic-specific knowledge components. The system consists of two parts, Isabel Diagnosis Checklist System (IDCS) and the knowledge component. Isabel uses proprietary natural language processing software to search its database of medical textbooks and journals. The database comprises of more than 11,000 diagnoses and 4,000 drugs.
X.Y. Djam et all [12] designed a Decision Support System for Tuberculosis Diagnosis. It was designed as a fuzzy expert system for diagnosis of tuberculosis which was developed for providing decision support platform to tuberculosis researchers, physicians, and other healthcare practitioners in tropical medicine. In this research, a proposed fuzzy expert system for the diagnosing pneumonia in children is developed. The objective of the system is to provide a decision support platform to researchers in the field of paediatrics, physicians and other healthcare practitioners.

3. Algorithm

The proposed expert system assist paediatrician in the diagnosis of the diseases the patient might have, in a fuzzy way. Based on the patient complaints, the signs and symptoms are input into the system, according to the selection the fuzzy expert system diagnosis diseases based on its knowledge. The algorithm for the proposed system is adapted from [13];
Step 1: Input signs and symptoms of patient complaint into the system. Where s = number of signs and symptoms.
Step 2: Search the knowledge-base for the disease p whether it matches the signs and symptoms identified.
Step 3: Get the associated degree of intensity (weighing factor) di = 1, 2, and 3. Where 1 = Mild, 2 = Moderate, 3 = Severe.
Step 4: Apply fuzzy rules.
Step 5: Map fuzzy inputs into their respective weighing factors to determine their degree of membership.
Step 6: Determine the rule base evaluating (non-minimum values).
Step 7: Determine the firing strength of the rules R.
Step 8: Calculate the degree of truth R, of each rules by evaluating the nonzero minimum value.
Step 9: Compute the intensity of the disease.
Step 10: Output fuzzy diagnosis.

4. Research Methodology

A fuzzy expert system will be developed for the management/diagnosis of Pneumonia. The proposed system uses fuzzy logic approach. The system will be designed as a rule based expert system. A rule based expert system is one whose knowledge base contains the domain knowledge coded in the form of rules.
The main components of system are:

- Knowledge base.
- Fuzzification.

- Fuzzy Inference.
- Defuzzification.

4.1 KNOWLEDGE BASE

This is the component of the expert system that contains the system's knowledge. It contains concise representation of domain expert in Pneumonia. Sample fuzzy rule base for pneumonia diagnosis is shown below:

Table 1: Sample fuzzy rule

IF								THEN	
Rule no	**Fever**	**Chills**	**Cough**	**Chest pain**	**Loss of appetite**	**Fatigue**	**Haemoptysis**	**Fast breath**	**Conclusion**
1	Mild	Mild	Mild	Mild	Mild	Severe	Mild	Mild	Mild
2	Moderate	Mild	Mild	Mild	Severe	Moderate	Moderate	Moderate	Moderate
3	Severe	Severe	Moderate	Severe	Severe	Severe	Severe	Moderate	Severe

4.2 FUZZIFICATION

Fuzzification is a process that determines the degree of membership to the fuzzy set based on fuzzy membership function. The first step is to

- Create a fuzzy set of the parameters. The parameters will be described with three linguistic variables (mild, moderate and severe).
- The degree of membership for a fuzzy system is of the range [0 1]. A range of the fuzzy value using the linguistic variables will be determined by the expert e.g. mild $0.1 \leq x \leq 0.3$.
- The fuzzy rule will be developed with the assistance of the domain expert.

4.3 FUZZY INFERENCE

The inference engine controls how the rules are applied towards facts. This is the part of rule-based expert system that makes inferences. It decides which rules are satisfied by facts and controls overall execution. Also, it matches the facts against the rules to see what rules are applicable. The system will make use of forward chaining reasoning; it would make use of the facts given by the patient to diagnose the problem.

Fuzzy inference is the process of mapping from a given input to an output using the theory of fuzzy sets [14]. Rules are used in the knowledge-base by the fuzzy inference engine to derive conclusion based on the rules.

4.4 DEFUZZIFICATION

This involves changing fuzzy output back into numerical values for system action. The output from the inference engine is translated into crisp output which is more precise than the fuzzy output.

5. Conclusion

Fuzzy logic technology provides a simple way to arrive at a definite conclusion from vague, ambiguous and imprecise data. Our proposed knowledge based diagnosis system can be used to find a permanent solution to the effective and efficient treatment of this disease. The system facilitates the pediatrician to determine his/her patient's probable diseases very quickly with the aid of a knowledge base expert system. As the knowledge based designed provide the feedback which can be greatly relied on.

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