CPKMS: A Knowledge Management Repository For Community Pediatrics

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Abstract

There has been rapid advancement from data to information-to knowledge in the scope of medicine. Although knowledge management conceptual frameworks and models in medicine have been proposed, there is, however, the need for a knowledge management system to cater for the rural healthcare sector. The purpose of this paper is to capitalize medical knowledge in community pediatrics and make it available to medical users (nurses, community doctors and rural health workers) by identifying, capturing, representing and storing such medical knowledge for reuse and distribution. The study begins with brief theoretical background and then it presents a conceptual framework adapted for the implementation of a prototype.

Keywords: Knowledge Management System; Community Pediatrics; Rural Healthcare;
        Medicine; Medical Knowledge.

1.0   Introduction

The notion of knowledge has been interpreted by various researchers in their fields from different perspectives. Reviews of past literatures reflect the various views based on a researchers' field and philosophical view. A detailed description about the various concepts of knowledge is discussed extensively in this section. The viewpoints of knowledge in the medical domain most importantly in community pediatrics are also addressed.

1.1   Knowledge- definitions So Far

Knowledge as defined by Davenport and Prusak (1998) states that "*it is a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information*". Nonaka (1994) stated that knowledge is a justified belief that increases an individual's ability to take effective action. Bender and Fish (2000) explained that "*knowledge originates in the head of an individual (the mental state of having ideas, facts, concepts, data and techniques, as recorded in an individual's memory) and builds on information that is transformed and enriched by personal experience, beliefs and values with decision and action-relevant meaning*". Oladejo et al (2009)'s view states that an individual gets knowledge as facts retrieved from observation, learning, experience and understanding of a reality in a particular situation or context for a particular period of time.

1.2   Knowledge Management

Skyme (2011) defined Knowledge management as "*the explicit and systematic management of vital knowledge- and its associated processes of creation, organization, diffusion, use and exploitation- in pursuit of business objectives*". Jarrar *et al.* (2010)'s view of Knowledge management is that it is the process of continually managing knowledge of all kinds to meet existing and emerging needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities. It is a systematic process of underpinning, observation, instrumentation, and optimization of the firm's knowledge economies. Its overall purpose is to maximize the enterprise's knowledge related effectiveness and returns from its knowledge assets and to renew them constantly. It is the generation, representation, storage, transfer, transformation, application, embedding, and protecting of organizational knowledge (Adapted from Hedlund, 1994). Knowledge management according to Newman and Conrad (1999) is a discipline that helps improve the performance of individuals and organizations by maintaining and leveraging the present and future value of knowledge assets. It encompasses both human and automated activities and their associated artifacts.

1.3   Knowledge Management in the Medical Context

Medical knowledge is created through collection of local experience around specific clinical cases and health services/ programs, generation of new understandings of relationships between specific factors,

processes, and outcomes from primary research and policy development (Mosawi, 2011). Montani (2002) discussed the nature of medical knowledge. He opined that the introduction of Hospital Information System into clinical practice has led to the memorization of a huge quantity of data being extracted from day by day activity, and reporting the unarticulated experience of individual workers. Hsia *et. al* (2006) proposed a conceptual framework that integrated the nursing process, KM activities, and enabling information technology (IT) for designing such a nursing KMS. Orzano *et.al* (2008) pointed out that knowledge management should be seen as a framework for positioning primary care practice to meet the challenges of a rapidly changing health care system in the 21st century. A medical ontology was built by Dieng *et.al* (2006) for knowledge management for a health care network. This enables a cooperative diagnosis by members of the health care network who are doctors, nurses, and social workers. Almeida *et.al* (2010) in their work developed a knowledge management system for supporting creation, capture, storage and dissemination of information about epilepsy and epileptic seizures. Abidi *et al* (2009) developed a web-based knowledge sharing medium for fostering a community of pediatric pain practitioners that engage in collaborative learning and problem solving. The design and use of a web portal featuring a discussion forum to facilitate experiential knowledge sharing based on their knowledge sharing model (LINKS) was presented.

The above literature review points out the fact that knowledge management is no doubt, indispensible and it is therefore relevant in all aspects of medicine.

1.4 Community Pediatrics

Community pediatrics as defined by AAP (1999) states thus:
"Community pediatrics is all of the following:

- A perspective that enlarges the pediatrician's focus from one child to all children in the community.

- A recognition that family, educational, social, cultural, spiritual, economic, environmental, and political forces act favorably or unfavorably, but always significantly, on the health and functioning of children.

- A synthesis of clinical practice and public health principles directed toward providing health care to a given child and promoting the health of all children within the context of the family, school and the community.

- A commitment to use a community's resources in collaboration with other professionals, agencies, and parents to achieve optimal accessibility, appropriateness, and quality of services for all children, and to advocate especially for those who lack access to care because of social or economic conditions or their special health care needs.

- An integral part of the professional role and duty of the pediatrician".

Community pediatrics focuses on the provision of primary health care to children from day old babies to adolescence.

2.0 Medical knowledge Representation and Exploitation in Community pediatrics

The aim of this paper is to capitalize medical knowledge in community pediatrics and make it available to medical users (nurses, community doctors and rural health workers) by identifying, capturing, representing and storing such medical knowledge for reuse and distribution. The approach adopted is to apply knowledge management tools to community pediatrics since existing medical knowledge management systems either excluded or included community pediatrics in them as discussed above in the literature review of knowledge management in medicine.

2.1 Adaptable Knowledge Management Framework for Community Pediatrics (AKMFCP)

Olaolorun & Oladejo (2012) proposed a conceptual framework for knowledge management in community pediatrics. The knowledge management framework is called "Adaptable Knowledge Management Framework for Community Pediatrics" (AKMFCP). AKMFCP consists of the essential components of knowledge management and its application to community pediatrics.
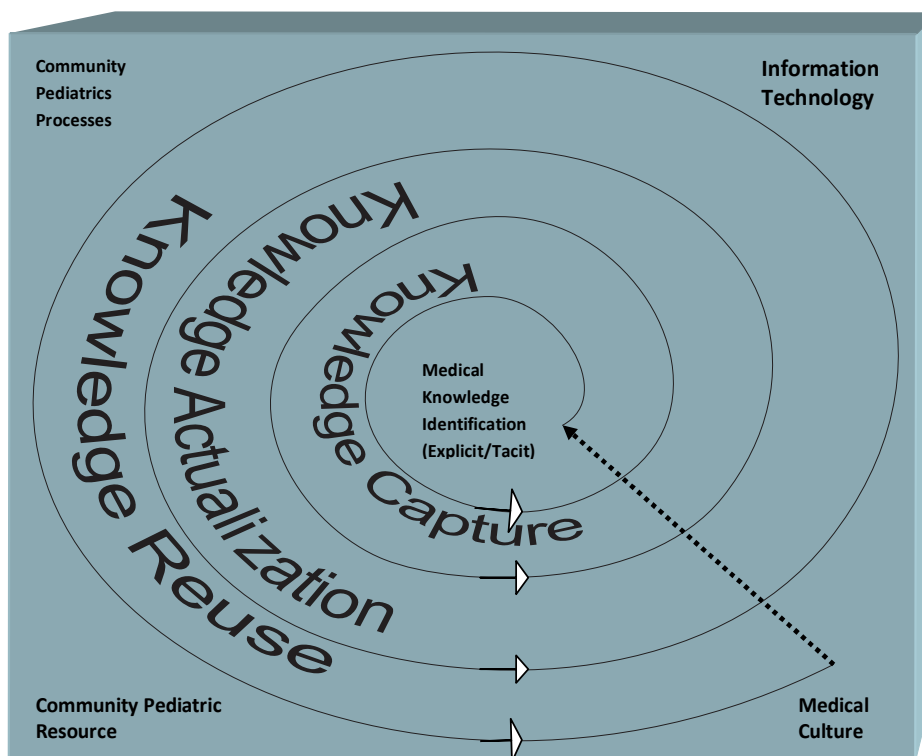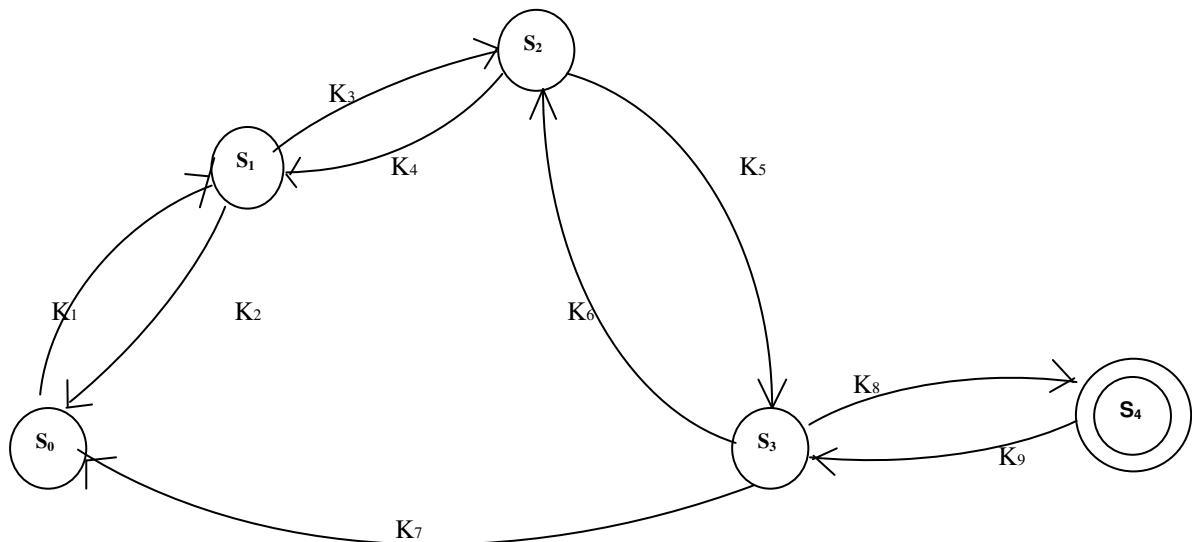
Fig 1: An Adaptable Knowledge Management Framework for Community Pediatrics (Olaolorun & Oladejo, 2012)

Fig 1 above consists of the following components which are:

- **Knowledge Management Processes.** Knowledge management processes are the methods used to capture and share knowledge. These processes include; medical knowledge identification, knowledge capture, knowledge actualization and knowledge reuse.

- **Community Pediatrics Processes.** These are the processes or series of activities performed in most pediatric section of rural health care centers. They include examination of child patient, diagnoses, treatment and health education.

- **Community Pediatric Resources**. These are resources needed for the smooth running of the knowledge management system. They include human resources, operational resources, medical and physical resources.

- **Information Technology**. Information technology offers a potentially useful environment within which to build a multimedia repository for rich, explicit knowledge. Input is captured by forms for assigning various labels, categories, and indices to each unit of knowledge through computer systems and applications.

2.2 Knowledge Representation using Finite Automata

Finite Automata is used for knowledge representation as suggested in (Borisa, 2010). The figure below shows the finite automata for the framework discussed in the above section.

Fig 2: The Finite Automaton for Adaptable Knowledge Management Framework for Community Paediatrics (AKMCP)

The above Finite Automaton (FA) in figure 2 is a five tuple (Q, $\sum$, δ, So, F) describing the transition of medical knowledge from one state to another.

    I.   **Q is the set of states** in the automaton represented by circles in the above diagram.

        $Q = \{S_0, S_1, S_2, S_3, S_4\}$ where

        S_0= Medical data and information

        S_1= Medical knowledge in documents, medical databases, textbooks, tacit knowledge from medical practitioners

        S_2= Useful and necessary medical knowledge (tacit and explicit) extracted from documents, medical databases, textbooks, diagnoses, surgeries, treatments prescribed, observation and interviews

        S_3= Corporate memory (CM), Knowledge Management System (KMS)

        S_4= Extracted knowledge used and reused from the Corporate memory (CM), Knowledge Management System (KMS) developed.

    II. Σ **is the alphabet of characters** that can legally occur in the input stream. Typically, Σ is the union of the edge labels in the diagram.

    III. δ**: Q $\times$ Σ $\rightarrow$ Q is the transition function** for the automaton. It encodes the state changes induced by an input character for each state; δ is represented in the diagram by the labeled edges that connect states.

        $\{(<S_0, k_1> \longrightarrow S_1), (<S_1, k_2> \longrightarrow S_0), (<S_1, k_3> \longrightarrow S_2), (<S_2, k_4> \longrightarrow S_1), (<S_2, k_5> \longrightarrow S_3),$
        $(<S_3, k_6> \longrightarrow S_2), (<S_3, k_7> \longrightarrow S_0), (<S_4, k_9> \longrightarrow S_3), (<S_3, k_8> \longrightarrow S_4)\}$

        $\{K_j\}$: j = 1,2 …n where K_j represents medical concepts
        K_1 = Knowledge Identification

        K_2= Insufficient data/information available (backward transition)

K_3= Knowledge Capture

K_4= Inadequate or insufficient extracted medical knowledge (backward transition)

K_5= Knowledge Actualization, capitalization

K_6= Improper knowledge representation (backward transition)

K_7= Knowledge Retrieval and Reuse

K_8= Medical knowledge Updates

K_9= Corporate memory or Knowledge Management system not useful, outdated or irrelevant hence the (backward transition)

IV. **The state $S_0 \in Q$ is the starting state** or initial state of the automaton.

V. **$F \subseteq Q$ is the set of states** that are considered final or accepting states. In the above diagram, there is only one final state S_4 as it is drawn with a double circle.

3. Experimentation of AKMFCP and knowledge Representation with a Prototype

We build "Community Pediatrics Knowledge Management System (CPKMS)" for community pediatrics as a prototype of the framework proposed. We make use of the user-based search technique for exploration of the repository for identical cases of medical knowledge resources.

3.1 Description of CPKMS

CPKMS is a medical knowledge repository for community pediatrics. The essence of CPKMS is to allow ease of diagnoses and treatments for pediatric patents by the rural health workers. Ailments peculiar to a particular age range of children are classified and grouped together. Each age category has peculiar diseases, diagnosis and prescribed treatments. The diagram in figure 3 below shows a sequence diagram describing the basic flow of operations in the developed system.
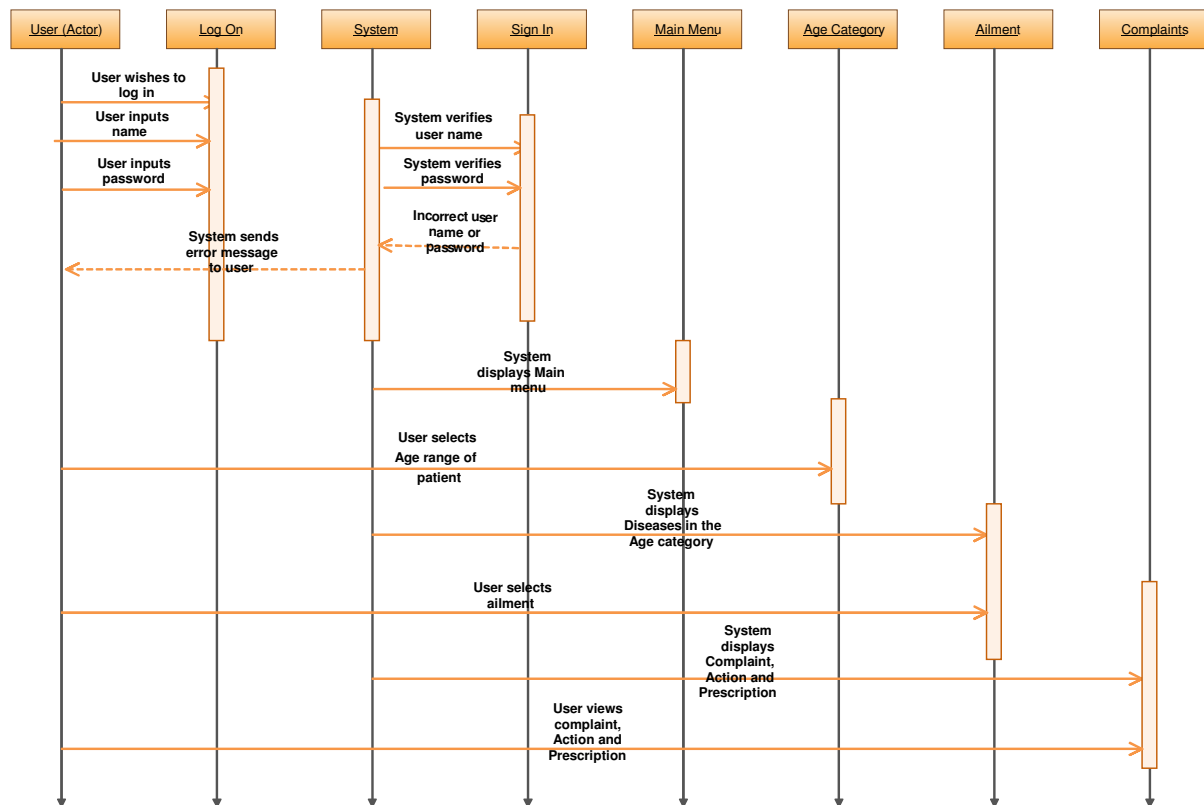
Fig 3: A Sequence Diagram Showing the Activities Performed Between the System and the User

3.2   Experimentation

The framework and finite automata described in section 3 are implemented using a prototype to simulate the acquisition and representation of medical knowledge. The prototype also presents the exploitation of medical knowledge for reuse.

3.1.2   Medical knowledge acquisition and representation of CPKMS

The acquisition and representation of medical knowledge is simulated. Figure 4 shows the access page. The users of the system are primarily medical professionals. Access to the contents of the system is granted based on permission level stored in the database. Figure 5 describes the categorization of diseases based on the age range of children. This is because some ailments are peculiar to a particular age group.
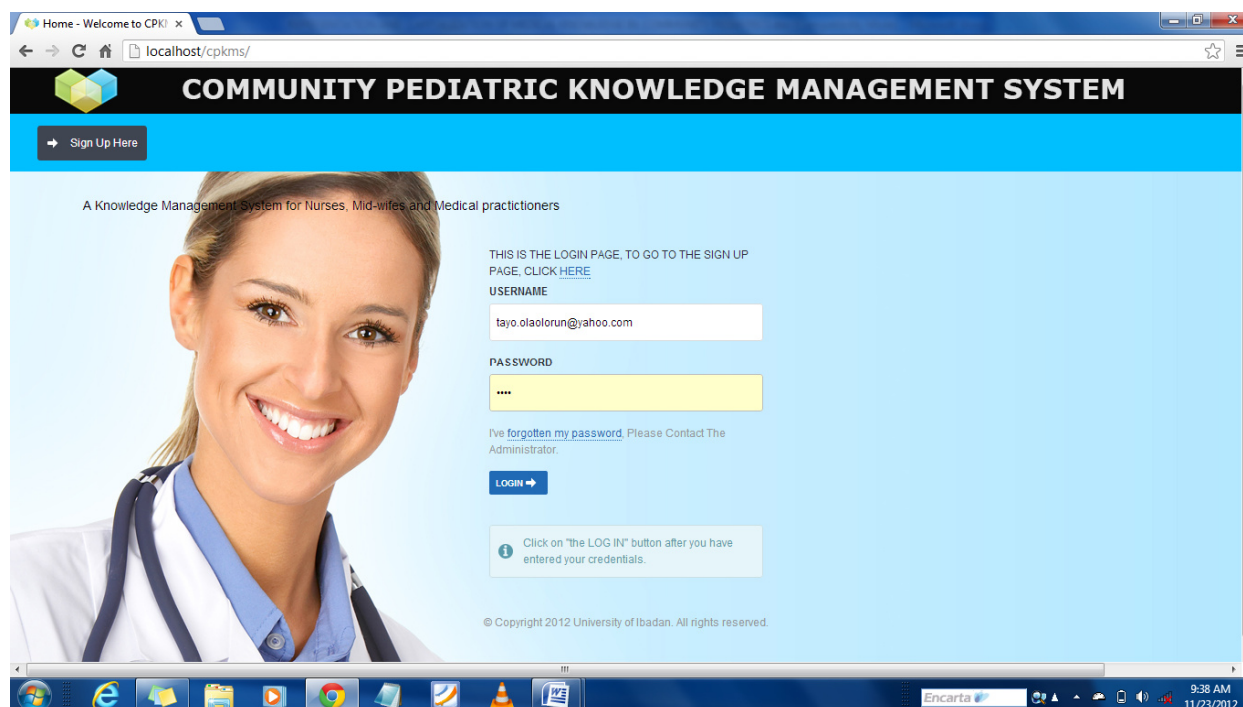
Fig 4: Access Verification for CPKMS
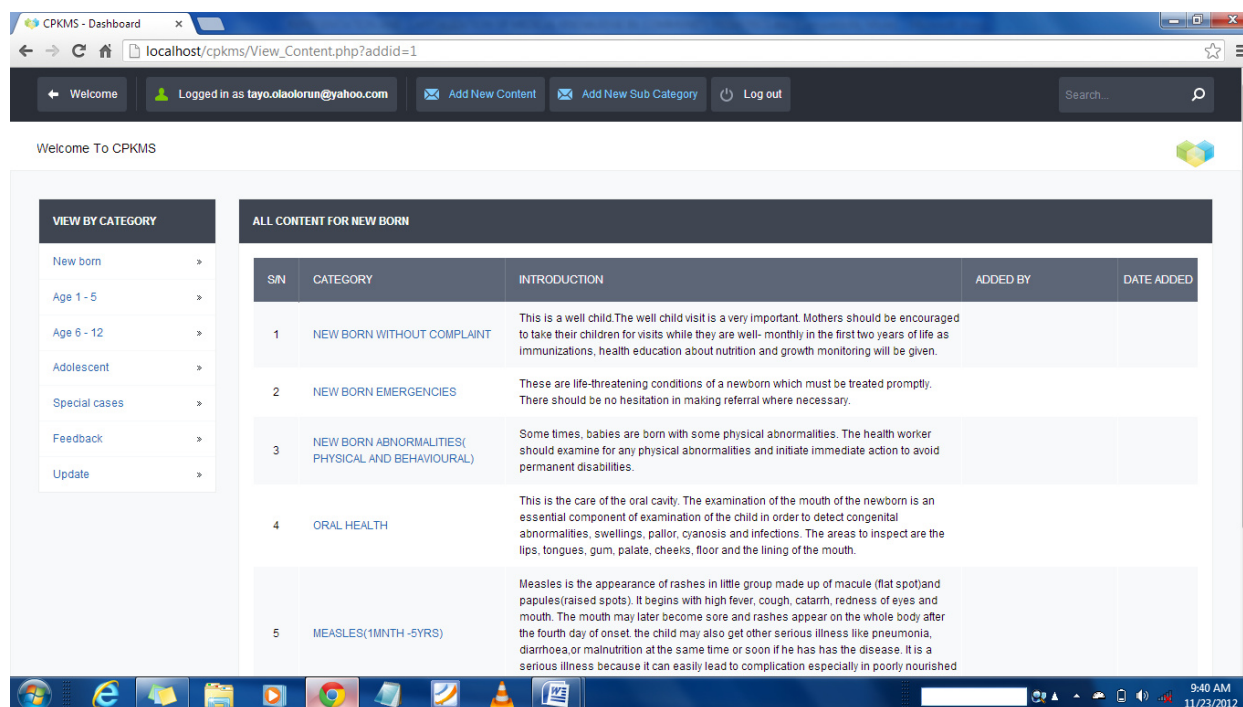
Fig 5: Selection by Age Category and Description of Diseases Peculiar to New Born Infants

3.1.3   Medical knowledge Reuse and Update

Users can extract, add, update and reuse the medical knowledge stored - as this is one of the major objectives of knowledge representation and exploitation. The search technique used is The Standard Boolean Model for

knowledge extraction and retrieval by Keyword-matching. The search is based on the keyword- matching of the medical user's query statements. Figure 6 presents a sample user's query and response. Figure 7 shows a view for knowledge update. Knowledge update is carefully carried out as it will have to be accepted by members of the medical community at large for review before an upload can be carried out.
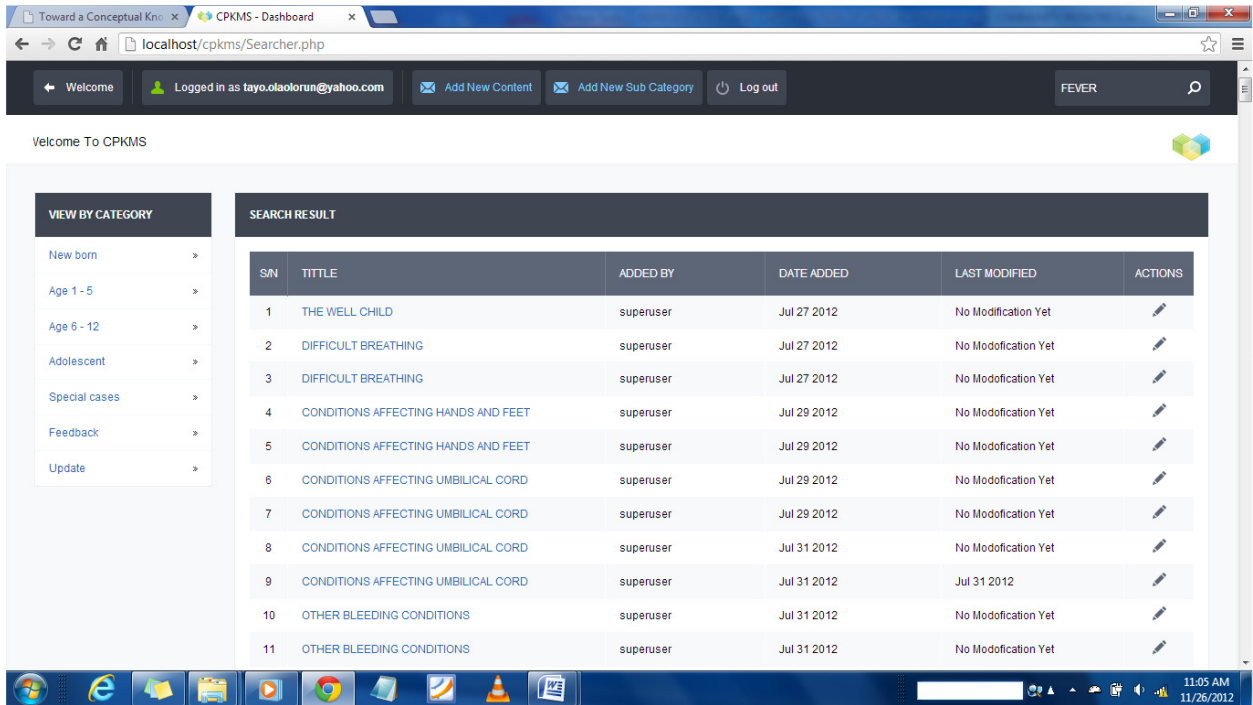
Fig. 6: User's Query and Response Based on Keyword Match
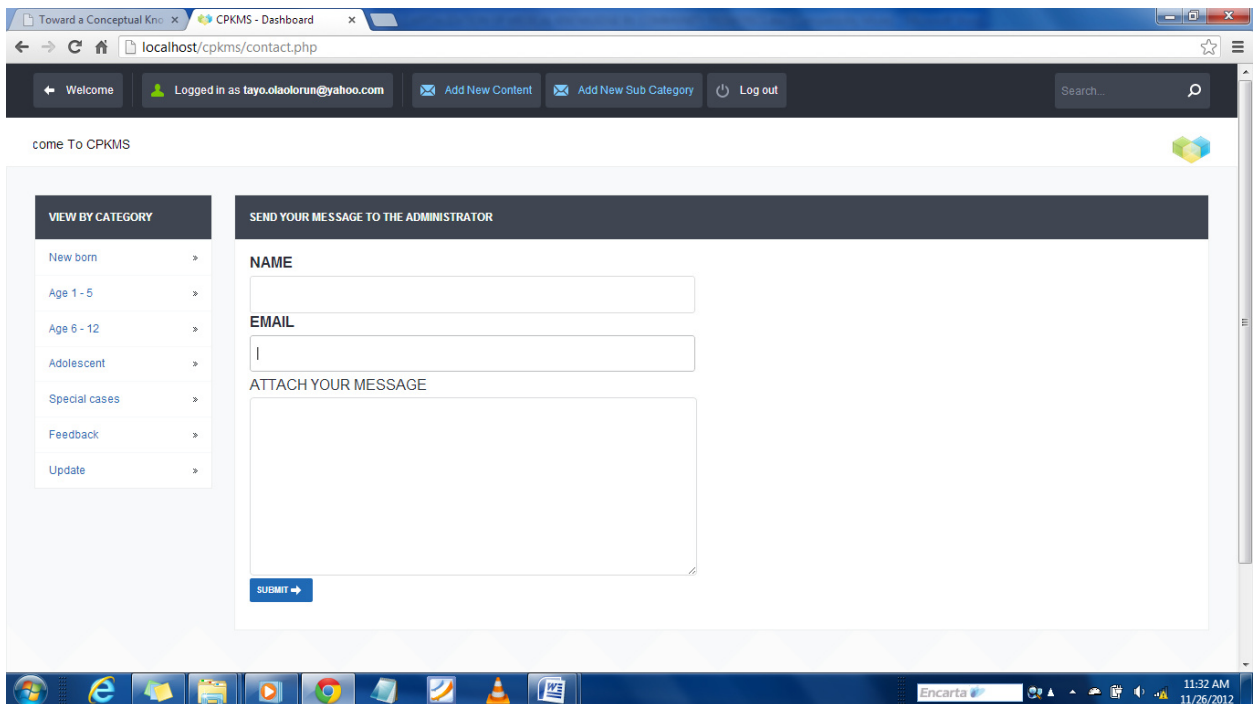
Fig.7: A view for Medical Knowledge Update

4.0   Conclusion

CPKMS is undergoing testing exercise as at the time of writing this work to ensure its reliability and efficiency since it has to do with the diagnoses and prescription of treatment to children patients.

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