

Knowledge-based Evaluation of Nursing Care Practice

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Abstract

Providing people with a complete and responsive healthcare solution requires a multi-tiered health service delivery system. One aspect in the healthcare hierarchy is the need for care provided by nurses. Nursing care and observation provide the basis for nurses to communicate their practice with others in the healthcare system. It is necessary to capture and manage knowledge of nursing care to improve the quality nursing practice. This paper proposes a novel knowledge-based decision support system for nurses to capture and manage nursing practice, and further, to monitor nursing care quality, as well as to test aspects of an electronic health record for recording and reporting nursing practice. As part of ongoing collaborative research of the nursing school and the department of computer science, a prototype toolset was developed to capture and manage nursing practice in order to improve the quality of care. A case study is presented to demonstrate the toolset used by nurses in a local hospital environment.

Keywords: knowledge management, nursing language processing, information integration, information visualization, AHP.

1. Introduction

The U.S. government aims that most health records in the United States will be electronic within the next few years. Most electronic health records reflect a medical model; reports of distinctive nursing practice are missing from the available software products. Nurses employ the expansive and complex repertoire of knowledge and skills of nursing science, and also use knowledge from other bodies of knowledge for nursing purposes, including fields such as medicine, psychology, sociology and philosophy. In spite of the critical value of nursing practice to improve well-being of patients, the contributions of nursing practice in health care often remains unnoticed.

There exists no means to electronically capture the array of nursing practice used by nurses in caring for patients. Nursing informatics is a field that integrates nursing science, computer science and information science to manage and communicate data, information, knowledge and wisdom in nursing practice [2]. The system helps to reduce the paper work, helps in nursing education, and demonstrates the contribution of nursing practice to patient health outcomes.

The next section discusses some of the fundamental issues related to nursing practice and nursing theory models. Section 3 gives an overview of a nursing practice model and discusses use of the proposed software system as a way to capture nursing knowledge. Section 4 illustrates an example of how this system is used in nursing practice in a local hospital. Finally, Section 5 summarizes the paper and outlines possible avenues for future research.

2. Related Work

Nursing theory is used to guide, explain and report experience, observations, relationships and project outcomes [3]. Swan [4] describes it as “nursing theory is an inductively and/or deductively derived collage of coherent, creative and focused nursing phenomena that frame, give meaning to, and help explain specific and selective aspects of nursing research and practice.” There are three different types of nursing theories: Grand theory, middle range theory and nursing practice theory. Grand theory includes theories by Leininger [5], Newman [6], Rogers [7], and Parse [8]. Examples of middle range theory are Cristina Sieloff’s theory of group power within Organizations [9], Katherine Kolcaba’s theory of comfort [10]. Nursing practice theories have the narrowest scope and thus are used within specific range of the nursing situations.

2.1 Nursing Caring Model

Our work is based on the Community Nursing Practice Model of Parker and Barry [1] that helps to define complexities of nursing practice and to address and explore the hidden nursing values essential to nursing practice. We have applied computational process to nursing practice data captured during encounters between patient and nurse so as to capture and structure the nursing knowledge of caring.

Essential Values	Instrumental Values
Caring	Access
Wholeness	Essentiality
Respect	Empowerment
Connection	Community Involvement

Figure 1: Community Nursing Practice Model Values

2.2 Nursing Data Collection Process

In order to quantify the qualitative data of nursing practice, a multilevel hierarchical decision making model namely Analytical Hierarchical Process (AHP) is used to help the decision making process that involves structuring multiple choice criteria into a hierarchy, assessing the relative importance of these criteria, comparing alternatives for each criterion, and determining an overall ranking of the alternatives [13].

Some work has been done on applications of Analytical Hierarchical Process in the fields of healthcare and medical informatics. Michihiko, etc [11] applied AHP to evaluate physiological factors of family caretakers of patients with dilemma where the application concluded that the patients and those families who valued quality of life preferred to stay at home while for those patients whose family thought caring would be burdensome preferred hospitalization. This application helped to analyze and decide the caring policy for older people. Elliot, etc [12] conducted survey and showed the importance of AHP for engineers and clinicians to analyze and decide alternative purchase of technology as well as help medical staff to make decisions. They showed how AHP is applied in actual

hospital focused microeconomic HTA Health Technology Assessment which includes complexities in medical technology to evaluate and select the best neonatal ventilator.

3. The Nursing Practice Software System

We have applied AHP to the Essential Values of the Parker and Barry Community Nursing Practice Model. The tool developed facilitates the nurse to assign nursing attributes to action taken by the nurse while caring for patient. The Software provides nurse an interface where one can assign numeric values to nursing attributes in order of their relevant importance in caring for the patient. .

3.1 Nursing Care Software System Architecture

The overall research goal is to monitor the intensity of nursing attributes during entire time span of the patient care process as well as allows nurses to map up the action taken by them to the nursing essential values.

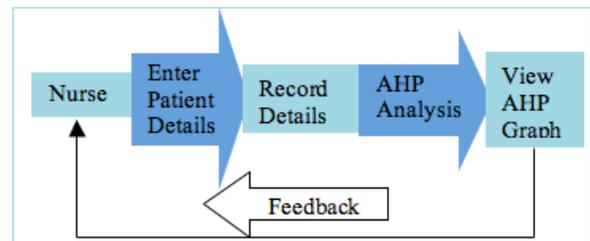


Figure 2: Workflow of Nursing Care System Implementation

Figure shows the workflow of the nursing care system to analyze decision made by a nurse. It captures the nursing practice knowledge, quantifies data, applies AHP process and calculates the weight of each essential value, and then generates graph showing intensities of these values with respect to each patient visit. The graph can be saved and exported and stored in Microsoft Word, Excel formats, and provides a graphical and user interactive way to analyze decision making process of a nurse and hence provides a feedback. The overall system architecture is shown in Figure 1.

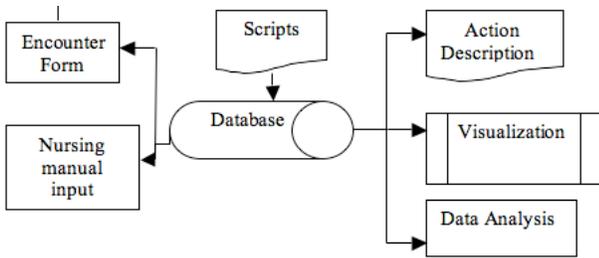


Figure 1: System Architecture Diagram

3.2 Nursing Data Collection and Processing

The system we developed provides the form where nurses can assign numeric values to nursing attributes, namely caring, respect, wholeness and connection, and write in brief about her actions taken to interact with the patient. Finally the software system applies AHP and calculates the relative importance of these attributes with respect to each other which would show the current and previous state of the patient’s physiological condition.

The process applied by the data collection and analyses are explained in this section. $N \times N$ matrix is used with the values A_{ij} . The data is processed in the nursing care application as follows:

Step1: we calculate geometric average for each row and get the values of A, B, C and D as shown below

$$A = \sqrt[n]{A_{11} \times A_{12} \times A_{13} \times A_{1n}}, B = \sqrt[n]{A_{21} \times A_{22} \times A_{23} \times A_{2n}}$$

$$C = \sqrt[n]{A_{31} \times A_{32} \times A_{33} \times A_{3n}}, D = \sqrt[n]{A_{n1} \times A_{n2} \times A_{n3} \times A_{nn}}$$

Step2: we get value of W by summation of all the average values. Next we divide the values of A, B, C and D by the value of W to get the priority vector as follow. The summation of priority vector w_j would be near to 1.

$$W = A + B + C + D, \sum_{i=1}^n W = 1.$$

4. Case Study

Over a period of one week at the university health clinic of Florida Atlantic University we provided nurses with the software. These values assigned by the nurse were saved in the database and they determine the relative importance of those nursing attributes at the time of encounter with a single patient. We also allowed nurses to describe the steps taken by her corresponding to each attribute.

4.1 Nursing Care Data Collection

AHP was applied to the data collected from nurses and calculated the relative importance of those nursing

practice values for a patient with fracture in his right ankle. The data for five visits was captured: On the first day level of pain for the patient was 9 on scale of nursing care that gradually fell to 7, 5, 3 and 1. For patient Y Nurse A considered connection to be the most important factor and caring to be least important. The intensity of caring as compared to respect, connection and wholeness were 1 and that of respect was twice than Caring and that of wholeness was thrice than caring and 3/2 times respect and that of connection was 4 times than caring and twice than respect and 4/3 times wholeness. Wholeness gradually became less important. As the level of pain fell to 5, 3 and 1, level of caring and respect shoot up to 4, and that of wholeness and connection came down to the minimum eventually. We conclude that in the beginning as the patient was suffering a lot it was very difficult for nurse to connect to the patient, as the pain level decreased and the patient’s health condition improved nurse didn’t have any problem in communicating but the level of caring and respect increased.

4.2 Nursing Care Data Processing

We could conclude that Nurse X gave maximum importance to connection and its value came out to be 0.83, whereas values of caring, respect and wholeness were calculated as 0.05, 0.21 and 0.47 respectively. For the second nurse the values of caring, respect, wholeness and connection were calculated a to be 0.29,0.07,0.29 and 0.66 respectively, finally these values changed to 1.00,1.00,0.06,0.06.This data helps to explore the physiological state of the patient at the time of interaction of patient and nurse generate a dynamic graph that represents the result in graphical format as shown in the following Figure 4.

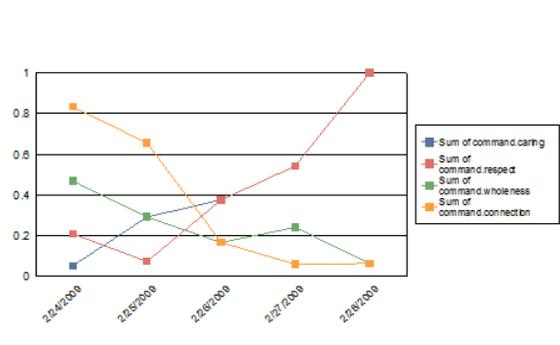


Figure 4: Nursing Value Intensities with Respect to Time

Each nursing physiological attribute is shown by distinct color line in the graph. The colors used to represent different nursing values as follows: Blue line represents caring, red line represents respect, and green line represents wholeness and connection is represented by yellow line. We can observe from the graph that, the values of caring and respect on 2/24/2009 were 0.05 and 0.21 respectively which increased drastically to 0.83 on 2/28/09 for the same patient which means that the patient needed more nursing care and respect at the end of his health care treatment. Similarly we can clearly observe that the values of wholeness and connection were 0.47 and 0.83 respectively thus connection and wholeness were the most important attribute for the patient as evaluated by the nurse on 2/24/2009 whereas on 2/28/2009 the values for wholeness and connection were calculated to be 0.06 and 0.06 respectively. The above observation depicts that as the patient had acute pain it was difficult for nurse to communicate with him on the first interaction due to which a nurse had to calm him down, feel his pain and had to concentrate on how to communicate with him. Moreover, nurse had to analyze the condition of the patient following holistic approach but after a day as the patient went through a treatment and he was relieved from the initial pain it was easy to communicate with him for a nurse but he needed more caring and respect as he was bed ridden and could hardly help himself to carry out basic activities like take a medicine, hence the value of caring and respect went up as discussed earlier.

5. Summary and Future Work

Effectively capturing and managing nursing practice and nurse's knowledge are the essential steps towards the goal to meet the future mandate that all health encounters be recorded electronically, and to bring healthcare closer to the person and the family in the home and community settings. This paper proposed a framework that captures and manages nursing care practice based on nursing care model. The framework quantifies the qualitative nursing caring data and provides an effective way to monitoring the nursing practice values and quality. A prototype software system was developed to demonstrate the approach, and it was used in a local hospital setting. As we could see from the results there was a significant change in physiology of a patient as analyzed by several different nurses on different dates for the same patient. This information is stored in the database and provides a reference as well as feedback to the nurse who may face similar situation in

the future. This knowledge-based architecture would help a new nurse to analyze the condition of patient so as to assist her to improve patients' health following a holistic approach and the nursing values can serve as analyzing factors for nurses in the healthcare industry. This system structures nursing language statements. As a part of the future work, we will make the graph user interactive and include more nursing attributes to make the system more scalable.

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