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# Patient Safety in Critical Care Unit: Development of a Nursing Quality Indicator System

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# Abstract

# Methods

This is a methodological study and technological production that aims to describe the development of a computerized system of nursing care quality indicators for the Intensive Care Unit. The study population consisted of a systems analyst and fifteen critical care nurses. For the development of the system we adopted some of the best practices of the Unified Process methodology using the Unified Modeling Language and the programming language Java Enterprise Edition 7. The system consists of an access menu with the following functions: Home (presents general information), New Record (records the indicator), Record (record search), Census (add information and indicators of the patient), Report (generates report of the indicators) and Annex (accesses the Braden Scale). This information system allows for measurement of the quality of nursing care and to evaluate patient safety in intensive care unit by monitoring quality indicators in nursing.

# Keywords:

Nursing Informatics; Quality Indicators; Intensive Care Unit.

# Introduction

Applications of information technology in nursing aim for knowledge systematization to quantify management and nursing care [1]. In the area of patient safety, a Health Information System can be developed in order to reduce the occurrence of adverse events by improving the quality of care practice using quality indicators, which are screening tools for the purpose of identifying potential areas concerning clinical care quality. Quality indicators also reflect the quality of care in hospitals and should bring to light what is usually invisible in nursing, rather than what is visible only when absent [2,3]. Therefore, it is essential to control indicators to improve clinical care and to achieve the desired results. Among the various health care scenarios, the Intensive Care Unit (ICU) stands out as an environment where the focus on patient safety should be strongly present [4]. Here, aspects such as complexity of care, the severity of the patient's disease, large amount of drugs and invasive devices, and the multiple procedures performed, make the ICU environment quite vulnerable to adverse events. It raises the question: how to develop a system to register and analyze quality indicators specific for critical care nursing? It is believed that the use of computerized tools can contribute to obtaining desirable results related to health practices, providing patient safety and decreasing the occurrence of adverse events. This study aims to describe the development of a computerized Quality Indicators Nursing System (SIQenf) for an Adult Intensive Care Unit.

This is a methodological study and technological production designed for the ICU of a university hospital in southern Brazil. It had the participation of a systems analyst and fifteen nurses in intensive care. The inclusion criteria of the study participants were, a) to be a critical care nurse to validate quality indicators and their related factors and also to use the computerized system; b) Systems Analyst - graduate in Computer Science or Information Systems. The period of data collection (system development period) was from February to April 2014. Data were entered into the system by the nurses that accepted to participate in the study. They were registered and received a username and password, maintaining the anonymity of the participants. For the development of the system, some of the best practices of the Unified Process methodology were used [5]. This process is divided into four phases: inception, elaboration, construction and transition. The inception phase identified the requirements that were described in terms of use cases, and presented which features and functions are desirable for each class of users [6, 7]. Use cases can be represented by Use Case Diagrams (Figure 1).



Figure 1- SIQenf use case diagram

The content validation of quality indicators in nursing was performed at this phase and also its related factors (causes) with the ICU nurses who participated in the study. Eight indicators were selected: 1) Fall Incidence; 2)Incidence of non-planned tracheal extubation; 3)Loss of Oro / Nasogastroenteral tube; 4) Incidence of Pressure Ulcer; 5) Medication error; 6) Near miss related to Drug Administration; 7) Phlebitis Incidence and; 8) Lost of Central Venous Catheter. After the definition of the desired indicators, the participants also identified 73 related factors (causes) of the indicators. These indicators were selected because they are used in various health organizations and because research shows the incidence rates of them in intensive care areas [8-15].

In the elaboration phase, the system was modeled using the Unified Modeling Language (UML). In the construction phase the software components that will make each use case operational for the end users were developed. And in the last phase of transition, a training was carried out with all the nurses of the study, enabling them to use the computerized system. For the development of the system the object-oriented programming language Java Enterprise Edition 7 object (Java EE 7) was used. An Apache Tomcat server was used for the Java application and we also used the Java Server Faces framework (JSF) for the development of the web interface. As a Database Management System (DBMS), a relational open source MySQL version 5.6 was chosen. The study was approved by the Ethics Committee of the University where the study was conducted.

# Results

The system was named SIQenf (Nursing Quality Indicator System) and was developed for use in an intensive care unit. The SIQenf aims to support the healthcare practice, allowing the measurement of quality of patient care through the use of quality indicators, and to assist in management and research.

### System Functional Characteristics

#### Login screen

Each nurse that participated in the study received an username and password. The system is accessed through the Internet address: giate.ufsc.br/SIQenf.

#### Home Screen

The System Home screen consists of a menu at the top of the screen that has the following functions: Home, New Record, Record, Census Report, Annex and Exit.

#### New Entry screen

The SIQenf allows nurses to record the quality in nursing indicators (Figure 2) and its related factors (causes), selected from among eight indicators: (1) Fall Incidence; (2) Incidence of unplanned extubation of endotracheal cannula; (3) Incidence of unplanned Oro/Nasogastroenteral tube removal; (4) Incidence of Ulcer Pressure; (5) Medication error; (6) Near miss Drug Administration; (7) Incidence of Phlebitis and; (8) Unplanned retrieval of Venous Catheter Central.



Figure 2 - New registration screen

By accessing this screen, nurses can view the indicators recorded on the current date. The "Filter Time" function reports the desired period and search the recorded indicators.

### **Census screen**

To calculate the indicator it is necessary to insert a new census, i.e., the daily number of hospitalized patients, the number of intubated patients, the number of patients with oro/nasogastroenteral tubes, the number of patients with a risk for ulcer pressure, the number of patients with peripheral venous access and the number of patients with central venous catheters.

#### **Report Screen**

On this screen it is possible to generate the general report indicators (Figure 3), which is available in Portable Document Format (PDF), where the value of all indicators is calculated using their respective formulas, and provides the index (%) and graph of each indicator in the selected period. On this screen it is also possible to select individual report indicators, and this report will show the definition of the indicator, its formula, and its value in the period.



Figure 3 - General Indicators Report

#### Annex Screen

In this screen it is possible to download the Braden Scale, which must be used daily in the ICU to assess the risk of pressure ulcer development. This scale has a maximum score of 23 and a minimum of 6 points. It evaluates the following aspects: sensory perception, moisture, physical activity, mobility, nutrition, and friction and shear [16]. In the system a Braden score  $\leq 16$  was adopted for risk of development of ulcer pressure.

# Discussion

SIQenf was developed in order to facilitate the measurement of quality and evaluation of patient safety in intensive care, since the indicators allow us to measure the level of health actions.

The idea of developing a computerized system of indicators rather than a manual system emerged in order to facilitate the management of nursing care, since the computer facilitates the integration of data, information and knowledge [17]. It represents a resource to facilitate nursing registration, making it faster and more accurate, providing nursing and other professionals updated and reliable information, and has the potential to transform the quality of care and establish links between nursing care and results for the patients [18-19]. There are a significant number of studies, predominantly international, seeking information technology solutions to improve patient safety and to bring this issue to the area of intensive care. Research shows there are a high number of errors and adverse events in the ICU, and emphasizes the importance of assessing nursing care in this scenario [20-22].

Studies have assessed the quality of care and patient safety in the ICU through nursing quality indicators, where the incidence of medication errors, loss of nasogastroenteral probe, loss of central venous catheter and incidence of pressure ulcers were highlighted, however these surveys were developed using manual systems for the analysis of indicators [23-25]. In Brazil, the number of studies using computerized systems for detecting adverse events and evaluation indicators is still low. As an example, one study described the steps of building a computerized system for managing nursing care indicators of the Hospital São Paulo, using the following indicators: incidence of unplanned extubation, hypothermia, skin lesions, loss of urinary catheter, loss of central venous catheters, peripheral venous catheters loss, loss of drain tube, loss of the gastrointestinal tract tube, patient falls and pressure ulcers [26].

It can be observed that most information systems in the patient safety area focus on reporting events and to improve the safety of the patient, it should go beyond the registration report and use, and therefore identify data security risks, develop interventions to mitigate these risks, and evaluate whether interventions have reduced or prevented the damage [27].

The use of SIQenf can make it possible to detect adverse events, to record and analyze the quality indicators, as well as the major factors that are involved and that contributed to their occurrence. Thus, in the future preventive measures may be applied to minimize or even reduce the incidence of these indicators in the intensive care unit, through training, continuing education and safe interventions based on scientific evidence.

# Conclusion

The use of information technology by nurses has been an increasingly constant practice, in clinical environments, management, teaching, or research. This integration of information technology and nursing facilitates the management of health information and contributes to the quality of patient care. On this basis, this paper describes the development of a computerized system of Nursing Quality Indicators (SIQenf) for the ICU, which supports the nursing care practice, which can measure the quality of care and evaluate patient safety through the detection of adverse events and monitoring quality indicators in nursing. It is believed, however, that SIQenf is more than a tool for reporting events, as it can contribute to the promotion of quality and strengthening patient safety in the ICU. It records and calculates the indicators and their related factors (causes), making it possible to understand the main problems related to patient safety in intensive care and make interventions to decrease these problems, as well as help in the search for solutions and excellence in nursing care. In addition, it is also possible through the reports to identify the main incident indicators according to the period and to compare them with other ICU indicators. For future work, this system will undergo an evaluation period of ergonomic criteria and

usability, and will subsequently be implemented in the ICU for which it was developed.

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