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Implementation of an Artificial Intelligence Algorithm for sepsis detection

Implantação de algoritmo de inteligência artificial para detecção da sepse

Implantación de Algoritmo de Inteligencia Artificial para la detección de la sepsis

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ABSTRACT

Objectives: to present the nurses' experience with technological tools to support the early identification of sepsis. **Methods:** experience report before and after the implementation of artificial intelligence algorithms in the clinical practice of a philanthropic hospital, in the first half of 2018. **Results:** describe the motivation for the creation and use of the algorithm; the role of the nurse in the development and implementation of this technology and its effects on the nursing work process. **Final Considerations:** technological innovations need to contribute to the improvement of professional practices in health. Thus, nurses must recognize their role in all stages of this process, in order to guarantee safe, effective and patient-centered care. In the case presented, the participation of the nurses in the technology incorporation process enables a rapid decision-making in the early identification of sepsis.
Descriptors: Guideline Adherence; Nursing Informatics; Artificial Intelligence; Sepsis; Decision making.

RESUMO

Objetivos: apresentar a experiência de enfermeiros com inovações tecnológicas computacionais no apoio à identificação precoce da sepse. **Métodos:** relato de experiência de pré e pós-implantação de algoritmos baseados em inteligência artificial para a prática clínica em um hospital filantrópico, no primeiro semestre de 2018. **Resultados:** descrevem a motivação, para criação e uso do algoritmo, o papel do enfermeiro no desenvolvimento e na implantação dessa tecnologia e os seus efeitos no processo de trabalho da enfermagem. **Considerações Finais:** inovações tecnológicas precisam contribuir para a melhoria das práticas profissionais em saúde. Assim, enfermeiros devem reconhecer seu papel em todas as etapas desse processo, de modo a garantir o cuidado seguro, efetivo, centrado no paciente. No caso apresentado, a participação dos enfermeiros no processo de incorporação tecnológica potencializa a rápida tomada de decisão na identificação precoce da sepse.
Descritores: Fidelidade a Diretrizes; Informática em Enfermagem; Inteligência Artificial. Sepse; Tomada de decisões.

RESUMEN

Objetivos: presentar la experiencia de enfermeros con innovaciones tecnológicas computacionales en el apoyo a la identificación precoz de la sepsis. **M**étodo**s:** relato de experiencia de pre y post implantación de algoritmos basados en inteligencia artificial para la práctica clínica en un hospital filantrópico, en el primer semestre de 2018. **Resultados:** describen la motivación para la creación y uso del algoritmo; el papel del enfermero en el desarrollo e implantación de esa tecnología y sus efectos en el proceso de trabajo de la enfermería. **Consideraciones Finales:** las innovaciones tecnológicas necesitan contribuir a la mejora de las prácticas profesionales en salud, así que los enfermeros deben reconocer su papel en todas las etapas de este proceso, con el fin de garantizar el cuidado seguro, efectivo, centrado en el paciente. En el caso presentado, la participación de los enfermeros en el proceso de incorporación tecnológica potencializa la rápida toma de decisión en la identificación precoz de la sepsis.
Descriptores: Fidelidad a Directrices; Informática en Enfermería; Inteligencia artificial; Sepsis; Toma de decisiones.

INTRODUCTION

Sepsis is a significant health problem in Brazil, with death rates ranging from 982,294 in 2002 to 1,133,761 in 2010[1]. A recent systematic review of the worldwide incidence of sepsis in hospitals found that hospital mortality was 17% for sepsis and 26% for severe sepsis during the last decade[2]. This condition generates huge costs in the public and private sectors due to the need for sophisticated equipment, expensive drugs and qualified and adequate health care from the healthcare team.

In recent years, there has been great interest in the development of machine learning algorithms[3-5] that can enhance health professional's capacity for early diagnosis, taking into consideration the results of sepsis treatment, even when an institutional protocol already exists. In the scenario of Artificial Intelligence (AI), Machine Learning (ML) stands out. In short, ML is the science of getting computers to learn and act like humans do, and improve their learning over time in an autonomous way, by feeding them data and information in the form of observations and real-world interactions. Machine learning algorithms can figure out how to perform important tasks by generalizing from examples[4]. In health, this technology assists decision making in a precise way. Using algorithms and based on the analyzes of the ML, the machine presents accurate statistical predictions[5]

In the context of early identification of sepsis, the role of nurses in the evaluation of signs and symptoms is already well recognized in worldwide literature[3-6]. Considering a broader context, nursing scientific research on the topics of human resources management, patient safety and quality of hospital care show a connection between these factors, as well as with organizational culture and management[7], in the early identification of signs that may put at risk patient safety. In this perspective, nurses must use indicators related to clinical and administrative data as an important approach to documenting and monitoring the care offered and its outcomes.

To achieve the goal of using information to support decision making, nurses (as well as other health professionals) should have information literacy. Information literacy is a problem-solving approach that has evolved by learning about information sources, that has been associated with information technology, technical skills, and databases and that, recently, has developed through the lenses of critical thinking skills, collaboration, communication and social practice via the web, affective competencies, and lifelong learning[8].

The area of nursing that deals with the issue of information literacy is Nursing Informatics, which has a promising prospect of growth in Brazil and in the world, given the innovative potential of the implementation of health informatics tools that can contribute to the optimization of nursing process in all its dimensions. Nursing informatics contributes significantly to clarifying the components necessary for the representation of nursing practice: assessment, problems, interventions and outcomes, and the standards and strategies for achieving efficient exchange of information[9] related to patient care.

In this perspective, a partnership between professionals from the company Laura®, which is a computer technology to support the early identification of sepsis in philanthropic hospitals, and researchers of the Nursing Graduate Program at Universidade Federal do Paraná (UFPR) was established. Among the AI and ML techniques of the Robot Laura®, there are machine learning methods for structured data[5], which have been used in databases of information systems of philanthropic hospitals throughout the country, with the objective of reducing the number of deaths due to sepsis by its early identification.

The objective of this partnership was to deepen the study of variables that may be related to the early identification of sepsis; to study the influence of AI algorithms in the decision-making of health professionals; and to demonstrate the contribution of this technology for the nursing practice with patients with sepsis. Thus, with the cooperation between professionals in the areas of health and computer science, it is possible to access and analyze in depth the database related to care for the patient with sepsis.

Observing the potential of Artificial Intelligence in the health care to these patients, it is relevant to reduce the time from the processing of data on the diagnosis and interventions for sepsis, and consequently, nurses have an important role in this process.

OBJECTIVES

To present the nurses' experience with technological tools to support the early identification of sepsis, before and after implementation, as well as in hospital clinical practice.

METHODS

This is an experience report of professional practice situations related to the performance of nurses in their professional activities, before and after the implementation of informatics tools based on AI to support decision-making in health. During the first half of 2018, a field study with direct observation and semi-structured interviews was developed to learn about the work process of nurses working at Laura®. In their activities, they have direct contact with programmers and with the healthcare teams in the hospitals, in order to facilitate the adoption of the technology. The activities assessed in the field study and described in this report occurred from March to July 2018, in a philanthropic hospital of a capital in the south of Brazil. This study is part of the research project "Artificial Intelligence and Management of Patients with Sepsis: Influence on Decision Making, Interventions and Nursing Outcomes", which follows the ethical precepts of Resolution 466/2012 of the National Health Council and was approved by the Research Ethics Committee of the Federal University of Paraná.

RESULTS

The description of this experiment is divided in three moments: the motivation for the development of the algorithm, as a result of an interview with the creator of the Robot Laura®; the role of nurses before and after the implementation of health informatics tools to support the early identification of sepsis; and the effects of the incorporation of this tool in the work process of clinical nurses, as a result of interviews and direct observations of the professional practice of the nurses of the company Laura®.

Motivation for the development of the algorithm

The speech of the creator and systems analyst of the Robot Laura® is transcribed below. He gives an outline of his experience

as family member and companion in a Neonatal Intensive Care Unit (ICU). This experience led him to study sepsis, its causes, the work processes and the information flow in an ICU, and to propose a computational technology that would enable an early detection, a proper treatment and even avoid cases such as the one that caused his daughter's death. This trajectory is told to the assistance teams, as part of the process of implementation of the tool in hospitals:

> *18 days of my life made me stop to pay attention to how much people dedicate themselves and give themselves up in different ways and end up powerless to solve certain situations by the absence of tools, by the lack of resources. Not by lack of will, not by lack of competence, not by lack of love. For 18 days I saw professionals of different profiles, different ages, men, women, newly graduates, people with long careers, all giving everything they had. I saw them defying death day after day. What I did not see was the ability to gather, to empower themselves with information that would give them a real picture of what was happening. And at the end of those 18 days I saw my daughter passing away, because of a problem that no one had seen, because there was a delay in collecting information, because there were results that took too long to reach the people who could make decisions. And these people were there, they wanted to make those decisions, they wanted to make it happen... When they finished collecting the parameters, when everyone gathered the information, they realized that of those 5 children hospitalized, 2 were in sepsis and the two evolved to death... So, when we talk about Sepsis, we talk about time. The worst feeling ever is being unable to see what is putting you at risk. When someone is a threat to you, you empower yourself in some way, you react. But when it comes silently, when it does not show itself and you can not see it, how do you fight it?... we see the opportunity to create something that can regulate this. This is what we have done in the last 6 years, we created a robot that is just like sepsis, as invisible as Sepsis. A robot with the same capacity as Sepsis; while sepsis surprises us, the robot surprises sepsis and those that are not seeing the inherent risks. Today, the robot Laura® has the ability to identify, in real time, the data that humans would take hours to identify. A data mining robot that manages to enter into the hospital system, into the laboratory system, and, in a completely auditable way, can deliver these data to the professional who will make the necessary decision, and than he has the elements and the conditions to save a life... Our objective, our goal, is to prevent people from dying due to lack of time. Today, we have the robot Laura®, to give what is lacking to health professionals, to give people the ability to decide more quickly, that's what robots are for, that's what technology is for.* [...] (Jacson Fressatto[10]).

The role of nurses before and after the implementation of health informatics tools

The participation of nurses begins in the development phase of the system, or pre-implementation phase, when they share scientific, theoretical and practical knowledge of the health area with technology professionals[11]. These information guide the team of developers not only in the creation, but also in the improvement of the proposed informatics solutions, since they convey the user experience, enabling the convergence between the needs of the health professionals and the possibilities of the technologies[11] and facilitating the adoption of the tool in professional nursing practice.

In the actual implementation process, the nurses act conduct an initial moment of awareness-raising with the healthcare teams, when they explain the process of conception of the tool, its mission, its functionalities, its impact on the nurses' work process and the actions that are expected from the team so that the early identification of possible cases of sepsis is effective. Communicating the overall benefits of the implementation and of a new technology is fundamental to help the members of the staff – those who will effectively use the technology – to stay engaged and work together to achieve the success of a project[11]. Among the skills to be build up by nurses in this implementation phase are communication, empathy, attentive listening, and technical knowledge about the tool and the nursing work process in that specific hospital context.

Once the tool is already implemented and monitoring the records of all professionals and patients to search for patterns that may indicate sepsis, it is necessary to monitor the proper insertion of records from the patients, and eventual difficulties in the use of the tool by the end-users (health and nursing professionals). At this stage, the Laura® nurses act in two ways: the first is proactive; the nurses establish a routine of rounds in the various hospital units, in a process oriented to the user and for the user, in which they demonstrate availability during the time spent with the user, as well as in their attitude: attentive listening, respect, consideration, patience, at-the-elbow support, acknowledgment of advances and identification of demands for improvement[11]. The second stage is more reactive; in this stage, the nurses communicate with key users (nursing supervisors, members of quality committees or of the hospital infection service) by electronic mail, to receive any doubts, training requests and/or suggestions for improvement.

It is important to note that the Laura® nurses are not informatics specialists. They were touched by the story of baby Laura, and trained for the described activities as new challenges arrived, which included understanding the functioning of the algorithm – with a detailed understanding of the hardware and software – and developing organizational skills, in the sense of interacting with the healthcare teams, experiencing the theories of change management process and providing in-service training.

Nursing clinical practice with an informatics tool for decision support

The Robot Laura® is a specialized system for the evaluation of clinical deterioration. Its objective is to integrate data systems in order to collect and organize data and then perform complex statistical calculations, compare results with prediction bands and conclude with precision on the presence or not of favorable conditions for the occurrence of a risk event. Programmers 'teach' the hospital's sepsis protocol to Robot Laura® (for this, the hospital must have a pre-determined protocol for the care of patients with suspected sepsis, including variables related to alteration of vital signs and laboratory results) and train it in a real environment – the computer system of the hospital. Based on this, (which also includes guidelines on how care staff should act when identifying changes), the robot indicates which patients may be at high, medium and low risk for developing sepsis. Also, it communicates this information to the professionals responsible, calls the Rapid Response Teams (TRR) and monitors the mean

time for patient care. It is important to reinforce that the Robot Laura® indicates this risk based on the data and information of the patients (identification of vital signs changes and clinically detectable organic dysfunctions) registered by the healthcare teams, according to the standard care protocol for patients with sepsis in force at the hospital (based on the Modified Early Warning Score – MEWS, the parameters are: Respiratory Rate < or equal to 20 rpm; Heart Rate > 90 bpm; Systolic Blood Pressure < 90 mmHg; Urine Output < 0.5 ml/kg/h; Temperature < 36º C or > 38º C or impaired level of consciousness). Thus, it is always recommended that all the alert cases are analyzed and validated by the hospital's health professionals.

Considering the task of the Robot Laura®, it is fundamental that the data from the patients (those included in the institutional sepsis protocol) are available for analysis as soon as possible, ideally at the same time they are collected by the health professional. The same should occur with data from the information systems of the clinical analysis laboratories and other services that can provide data related to the care protocol for patients with sepsis.

It is known that the documentation of the care provided and of the clinical evolution of patients admitted to any health service is both an obligation and a necessity for the continuity of care. However, it also represents a challenge: doctors and nurses are trained to act proactively and to solve critical clinical situations before recording their execution in the information system[11]. Thus, it is necessary to improve the process of collecting and recording patient data in hospital information systems, whether they are computerized or not. This contributes to the continuity and quality of patient care and is also an ethical and professional commitment. At the same time, it should be noted that the dynamics of nurses' work in hospital services is intense in terms of flow of information and people, control of productive processes (related to intermediate and final activities), infrastructure, among others.

Finally, the experience of the Laura® nurses in their contact with healthcare teams that already use the informatics tool for decision support points out that the algorithm contributes to increase their level of satisfaction with their professional practice. They emphasize that

> *In addition to optimizing the early decision-making process in cases of sepsis, it (re)approximates health professionals to their 'life saving' mission, and (re)places the nurse and his staff in an strategic position in the care process, advocating the sharing of information aimed at a patient-centered care* (Nurse1).

The results of this experience are in the improvement of the performance of healthcare teams by the use of the tool, and the improvement of the tool itself. These potential benefits occur despite technological challenges, such as infrastructure in relation to computer terminals, bedside data recording equipment, tablets, smartphones and Wi-Fi networks; challenges of individual proficiency of health professionals in the use of hardware and software; and distrust in the accuracy of technology, among other challenges that influence the success of projects like this one.

FINAL CONSIDERATIONS

The observations described in the field study point out that the use of a decision support tool in the clinical practice of nurses enhances their role in the early identification of sepsis and provides visibility and professional satisfaction. Thus, corroborating what is already pointed out in literature on the impact of technologies in the professional practice of nurses, it is necessary to develop explanatory studies to create evidence about these descriptive findings. This is already planned in the continuity of the research project to which this report is linked.

It should be reiterated that the subject of Nursing Informatics includes the basis, the knowledge and the procedures that support the nurse for an action directly related to the current state of computerization of part of the health services and to its future. This way, nurses of the 21st century must know the possibilities of action in scenarios of technological innovation, since their participation in all stages of this process can contribute to a safer, effective, technology-based and patient-centered care. The appropriation of this knowledge should be a path to be followed by all those who wish to develop competence to integrate clinical, managerial, teaching and research practice in health care settings with the creation, implementation and evaluation of technological innovations in health and nursing.

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