



Computerized nursing process in the Intensive Care Unit: ergonomics and usability*

Processo de enfermagem informatizado em Unidade de Terapia Intensiva: ergonomia e usabilidade

Proceso de enfermería informatizado en Unidad de Cuidados Intensivos: ergonomía y usabilidad

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How to cite this article:

Almeida SRW, Dal Sasso GTM, Barra DCC. Computerized nursing process in the Intensive Care Unit: ergonomics and usability. Rev Esc Enferm USP. 2016;50(6):996-1002. DOI: <http://dx.doi.org/10.1590/S0080-623420160000700017>

* Extracted from the dissertation "Aplicação do processo de enfermagem informatizado a partir da CIPE® 1.0 em uma UTI geral", Universidade Federal de Santa Catarina, 2011.

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ABSTRACT

Objective: Analyzing the ergonomics and usability criteria of the Computerized Nursing Process based on the International Classification for Nursing Practice in the Intensive Care Unit according to International Organization for Standardization (ISO). **Method:** A quantitative, quasi-experimental, before-and-after study with a sample of 16 participants performed in an Intensive Care Unit. Data collection was performed through the application of five simulated clinical cases and an evaluation instrument. Data analysis was performed by descriptive and inferential statistics. **Results:** The organization, content and technical criteria were considered "excellent", and the interface criteria were considered "very good", obtaining means of 4.54, 4.60, 4.64 and 4.39, respectively. The analyzed standards obtained means above 4.0, being considered "very good" by the participants. **Conclusion:** The Computerized Nursing Process met ergonomic and usability standards according to the standards set by ISO. This technology supports nurses' clinical decision-making by providing complete and up-to-date content for Nursing practice in the Intensive Care Unit.

DESCRIPTORS

Nursing Process; Nursing Informatics; Information Systems; Electronic Health Records; Intensive Care Units.

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Received: 05/28/2016
Approved: 10/04/2016

INTRODUCTION

Information and Communication Technologies (ICTs) offer evidence of applicability in health praxis and encourage professionals to develop skills and knowledge to enrich and broaden their professional practice and social participation in different activity fields⁽¹⁻³⁾.

Given this scenario, it is understood that Nursing must adopt ICTs in its various contexts due to their potential benefits, such as: increased organizational efficiency and continuity of direct care to the patient; improved communication and clinical performance; improving clinical health records; reduced time spent on registration/clinical documentation in the Nursing Process; establishing indicators of patient quality/safety/outcomes of care; real-time and/or bedside access to patients' clinical data; developing electronic alert systems aimed at patient safety; decreasing cognitive workload^(2,4-16); among others.

In another aspect, studies about applicability and integration between ICTs and the Nursing Process point out negative aspects that need constant analysis. Among them, issues related to usability, repair and inadequate maintenance of ergonomically inappropriate equipment and technologies (being too heavy, distant from the bed, having an inadequate design, etc.)^(4,5,17).

In this study, ICTs support the development of Computerized Nursing Process (CNP) in Intensive Care Units (ICU), aiming to maximize the quality of care provided and contribute to patient safety. The CNP is structured based on the International Classification for Nursing Practice (ICNP[®]) version 1.0. It is a worldwide classification system structured to be computerized encompassing Nursing diagnoses, interventions and results through a seven-axes model⁽¹⁸⁻²¹⁾.

It is understood that the use of the Computerized Nursing Process in Intensive Care Unit Nursing Care requires continuous evaluation of its effectiveness and applicability, being specifically related to ergonomic and usability criteria.

Regarding ergonomic criteria (organization, content, interface and technical), the Brazilian Association of Technical Standards (*Associação Brasileira de Normas Técnicas* – ABNT) has developed several technical standards in conjunction with the International Organization for Standardization (ISO) intended for human-system interaction. These standards aim at greater safety, comfort, productivity and adaptation to working conditions for professionals who use ICT resources⁽²²⁾.

Seeking to contribute to the knowledge and management of Nursing care in the ICU, as well as to narrow the gap between intensive care nurses and computerized technology, this study aimed to analyze the ergonomic and usability criteria of the Computerized Nursing Process based on the International Classification for Nursing Practice, version 1.0, in an Intensive Care Unit, according to the standards of the International Organization for Standardization (ISO AWI TR 9241-1 and ISO 9241-10:1997)⁽²³⁾.

METHOD

A quantitative, semi-experimental before-and-after study with an equivalent group. The study was carried out at an adult ICU of a large hospital in the state of Santa Catarina/Brazil, from June to September 2011.

The intentional non-probabilistic sample by trial was composed of nurses, professors and systems programmers. The nurse population sample was composed of 11 professionals who worked in the Intensive Care Unit. The established sample was composed of eleven nurses, considering a level of significance ($p < 0.05$) for a 95% confidence interval without sample loss, as well as 4 professors specialized in Health Informatics and/or Intensive Care Informatics and 2 systems programmers, thus totaling 16 participants.

The inclusion criteria adopted in the study were: I) Nurses: being a nurse in the Intensive Care Unit, practicing for over 6 months; II) Professors: being a post-graduate professor, with a proven specialization in the area of Health/Nursing Informatics and/or Intensive Care Informatics; III) Programmers: being a systems programmer graduated in Computer Information Systems or Computer Science. The only exclusion criterion adopted was that the participant did not complete all the steps of the outlined protocol.

The research was conducted through five stages, as explained below:

1st step: Individual training of nurses in relation to the themes: Nursing Process stages; International Classification for Nursing Practice version 1.0 (axes and composition of nursing diagnoses, interventions and results); Electronic health records; Computerized Nursing Process based on the International Classification for Nursing Practice. This step was completed in two weeks.

2nd step: Elaboration of five simulated clinical cases, according to characteristics of patients assisted in the ICU, containing their previous history and all the data, information and clinical alterations of the human systems of fictitious patients. Clinical case 1 referred to a patient in the immediate postoperative period of a carotid endarterectomy; Case 2 presented a patient with ischemic stroke; in the third clinical case, the patient was the victim of an automobile accident that caused a traumatic brain injury with a fracture at the base of the skull and facial bones; Clinical case 4 referred to a patient who attempted suicide by carbamate intake; the fifth case addressed a patient who had been in a car accident, suffering a significant hip fracture.

3rd step: Nurses received a booklet containing clinical case 1 printed out, along with the items that make up the Nursing Process based on the International Classification for Nursing Practice version 1.0, thusly specified: Nursing history, clinical evaluation, nursing diagnoses and interventions for the respiratory, cardiovascular, neurological, gastrointestinal, renal and integumentary systems (six human systems). The participants were instructed to mark the items with an "X" which required completing in the Nursing Process. Subsequently, the nurses then received the booklet containing clinical case 2 with the same human systems and so on, until the conclusion of clinical case 5. We emphasize that

the researchers chose to only print out the human systems included in the five clinical cases, meaning that the booklet for data collection did not include the musculoskeletal, female reproductive, male reproductive or biopsychosocial systems.

4th step: On an average of 10 to 15 days after the end of the 3rd stage, the nurses evaluated the same clinical cases in the computerized system (Computerized Nursing Process). Participants (nurses, professors and systems programmers) were registered in the computerized system by registering an access login and password for each participant. The system was presented again to each nurse and they were guided as to how to complete it, from the identification pages and Nursing history of the patient, clinical evaluation, Nursing diagnoses, interventions of each human system, hydroelectrolytic balance and laboratory tests. Professors received an electronic message containing the clinical cases, identification login, password and detailed guidelines about the system.

5th step: The programmers received the electronic message containing the identification login, password and detailed guidelines about the system. After completing the clinical cases, the nurses and professors filled out the evaluation instrument comprised of the criteria established by the International Organization for Standardization (ISO AWI TR 9241-1 and ISO 9241-10:1996) of systems for ergonomics and usability analyses of the Computerized Nursing Process.

Participating professors only completed steps 4 and 5 of the study. Systems programmers only evaluated the usability criterion of the Computerized Nursing Process according to their specialization.

The evaluation instrument consisted of 28 questions, distributed as follows: 4 ergonomic criteria of system interaction composed of 12 items for analysis (organization: 3 items; content: 2 items; interface: 4 items; technical: 3 items) and 1 usability criterion with 16 items. The items were

distributed on a scale of values with the following response categories: (5) Excellent, (4) Very Good, (3) Good, (2) Average, (1) Poor. The evaluation considered that the mean values between: 1 and 1.5 would be rated as poor; from 1.51 to 2.5, Average; from 2.51 to 3.5, Good; from 3.51 to 4.5, Very Good, and from 4.51 to 5, Excellent.

Descriptive statistics (absolute frequency, mean, standard deviation, maximum and minimum levels/limits) were used for data processing and analysis of quantitative data, along with inferential statistics (variance) for the establishment of statistical significance by comparing with the predetermined mean. A target-mean of "4" (Very Good) was established in relation to the obtained means for each criterion evaluated of the Computerized Nursing Process from the International Classification for Nursing Practices. The significance level of p -value < 0.05 was considered for a 95% confidence interval among the data found. Descriptive and inferential statistical tests (variance) were performed on Excel® worksheets.

The study development met national and international standards of research ethics involving human subjects. The provisions of Resolution No. 196/96 of the National Health Council were adopted through the signing of the Free and Informed Consent Form (ICF), the individuals' right to information and by respecting the freedom of the participants who, at any moment, could drop out of the study. The study was approved by the Research Ethics Committee of the hospital, protocol number 61/10.

RESULTS

Tables 1, 2, 3 and 4 show the ergonomic criterion evaluation of the system interaction categories: organization, content, interface and technical, respectively – referring to the Computerized Nursing Process based on the International Classification for Nursing Practice in Intensive Care Units, performed by nurses and professors.

Table 1 – Evaluation of the category "Organization" of Computerized Nursing Process according to standards established by ISO AWI TR 9241-1 and ISO 9241-10: 1997: Nurses and Professors – Florianópolis, SC, Brazil, 2011.

Ergonomic Criteria – Organization	Mean	Standard deviation	Limit	Mean	<i>p</i> -value
Organization and access of the files favor efficient execution	4.64	0.63	4.95	4.32	0.001
Ease of operation	4.35	1.00	4.85	3.85	0.113
Objectives of the system – Nursing care in the ICU using ICNP®	4.64	0.49	4.88	4.39	0.000
Overall mean	4.54				
Standard deviation	0.16				

Table 2 – Evaluation of the category "Content" of Computerized Nursing Process according to standards established by ISO AWI TR 9241-1 and ISO 9241-10: 1997: Nurses and Professors – Florianópolis, SC, Brazil, 2011.

Ergonomic Criteria – Content	Mean	Standard deviation	Limit	Mean	<i>p</i> -value
Clear, objective and up-to-date information	4.42	0.75	4.79	4.06	0.030
Content is interrelated and consistent with the area of Intensive Care	4.78	0.42	5	4.57	0.000
Overall mean	4.60				
Standard deviation	0.25				

Table 3 – Evaluation of the category “Interface” of Computerized Nursing Process according to standards established by ISO AWI TR 9241-1 and ISO 9241-10: 1997: Nurses and Professors – Florianópolis, SC, Brazil, 2011.

Ergonomic Criteria – Interface	Mean	Standard deviation	Limit	Mean	p-value
Interface between the user and the program – screen appearance	4.42	0.51	4.66	4.19	0.003
Logical structure of data – information appears logically structured to the users	4.57	0.64	4.89	4.25	0.003
The amount of information is sufficient for nursing care (data collection, diagnosis and interventions)	4.21	0.89	4.65	3.77	0.203
Visual comfort for system handling	4.35	0.49	4.57	4.14	0.00558
Overall mean	4.39				
Standard deviation	0.14				

Table 4 – Evaluation of the category “Technical” of Computerized Nursing Process according to standards established by ISO AWI TR 9241-1 and ISO 9241-10: 1997: Nurses and Professors – Florianópolis, SC, Brazil, 2011.

Ergonomic Criteria – Technical	Mean	Standard deviation	Limit	Mean	p-value
Data structure – the organization of data allows reasoning which is compatible with practice	4.42	0.51	4.67	4.18	0.004
Information security and privacy	4.85	0.36	5.04	4.67	0.000
Proper system functioning	4.64	0.63	4.95	4.33	0.001
Overall mean	4.64				
Standard deviation	0.21				

Organization and content criteria were considered “excellent” by the participants, obtaining means of 4.54 (± 0.16) and 4.60 (± 0.25), respectively, showing that the Computerized Nursing Process has sufficient and coherent data and Information regarding nursing clinical evaluation, diagnoses and interventions for its use in Intensive Care Units.

The interface criterion was composed of four evaluation items. It obtained the lowest mean (4.39; ± 0.14) and was evaluated as “very good” by the participants.

The technical criterion was composed of three evaluation items. It obtained the highest mean (4.64; ± 0.21), being considered “excellent” by the participants. The best evaluated item in this criterion was “security and privacy of information”, having a mean of 4.85 (± 0.36).

We highlight that only two items were not statistically significant of the 12 items evaluated in the Computerized

Nursing Process ergonomics category, obtaining p -value > 0.05 . In the organization criterion, the item *Ease of operation* presented a p -value = 0.113, and in the interface criterion the item *The amount of information is sufficient for nursing care (data collection, diagnosis and interventions)* presented a p -value = 0.203.

In the ergonomic evaluation of the Computerized Nursing Process, the overall mean (4.54 ± 0.10) showed that nurses and professors considered the system “excellent”. All four categories evaluated in this criterion obtained means above the predetermined target mean of “4”.

Table 5 shows the Usability evaluation of the Computerized Nursing Process from the International Classification for Nursing Practice in Intensive Care Units performed by nurses, professors, and systems programmers.

Table 5 – Evaluation of the “Usability” of Computerized Nursing Process according to the standards established by ISO AWI TR 9241-1 and ISO 9241-10: 1997: Nurses, Professors and System Programmers – Florianópolis, SC, Brazil, 2011.

Usability Evaluation Items	Mean	Standard deviation	Limit	Mean	p-value
The system screens are clear, easy to read and to interpret	4.57	0.81	4.921	4.222	0.005
The user is able to access the system/program easily	4.71	0.61	5	4.429	0.000
The menu is feasible and easy to use (the structure of the provided information is feasible and easy to use)	4.5	0.73	4.848	4.152	0.011
The menu meets the functions defined for the system’s goals	4.57	0.62	4.867	4.276	0.002
The program promotes efficient treatment for the problems of its dimension in the ICU	4.5	0.63	4.793	4.207	0.004
Exchange of information between the user and the program is efficient	4.5	0.63	4.795	4.205	0.004
The program has an appropriate limit of growth for the required use	4.5	0.72	4.84	4.15	0.011
The program allows for efficient management of the data it uses	4.35	0.71	4.68	4.02	0.038
Memory requirements do not prevent the program from running	4.85	0.44	5.02	4.68	0.000
The operating system required is available or can be obtained	4.64	0.6	4.93	4.35	0.000
The system offers data security	4.78	0.61	4.98	4.58	0.002

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Usability Evaluation Items	Mean	Standard deviation	Limit	Mean	p-value
The system does not accept missing/non-existent data	4.78	0.61	4.98	4.58	0.002
The hardware requirements are compatible with reality	4.71	0.6	5	4.42	0.000
The system is integrated with a Database	4.57	0.81	4.96	4.17	0.011
It can be easily adapted to other environments	4.85	0.4	5.02	4.68	0.000
It can be easily installed in other environments	4.85	0.34	5.02	4.68	0.000
Overall mean	4.64				
Standard deviation	0.15				

In the usability criteria, three items of the evaluation showed a higher mean (4.85) and p -value = 0.000, namely: *Memory requirements do not prevent the program from running; It can be easily adapted to other environments; It can be easily installed in other environments.* The item which received the lowest score was *The program allows for efficient management of data it uses*, obtaining a mean of 4.35 (\pm 0.71) and a p -value of 0.038.

In the usability evaluation, the overall mean of 4.64 (\pm 0.15) showed that nurses, professors and systems programmers considered the Computerized Nursing Process "excellent" from the International Classification for Nursing Practice. All 16 evaluated items in this criterion obtained means higher than the predetermined target mean of "4".

DISCUSSION

Limitations of this study's results are related to the small non-probabilistic intentional sample by judgement that it represents; however, it was possible to deepen the analysis of the ergonomics and usability of the Computerized Nursing Process when applying the five clinical cases of fictitious patients to the participants.

The analysis results obtained in this study show that the ergonomic and usability criteria of the Computerized Nursing Process were positively evaluated by the participants. The system includes new scientific knowledge and strengthens sound clinical decision making, considering that participants demonstrated the agility of the system's application and handling; the presence of all human systems for evaluation; clear and objective content for Nursing practice in Intensive Care Units; and the use of International Classification for Nursing Practice, version 1.0.

In the ergonomic criteria of the Computerized Nursing Process, only two items were not statistically significant, although they were considered "very good" by the participants: *Ease of operation* (organization category) and *The amount of information is sufficient for nursing care* (interface category).

Regarding the item *Ease of operation*, as the Computerized Nursing Process is a computerized system that has not yet been implemented in professional practice, some characteristics of the participants can influence the evaluation, such as: available knowledge about navigating the system, users' computational abilities, behavior of these users in relation to the graphical interfaces of the systems in order to achieve

effective action in accomplishing its tasks or to recover information for decision making^(1,4-5).

In the item *The amount of information is sufficient for nursing care*, the participants emphasized the sheer volume of data and information contained in the Computerized Nursing Process. This computerized information system was developed with the aim of providing nurses with a range of possibilities for Nursing care, according to the complexity of the numerous clinical situations presented by the patients in intensive care. In order to treat this as an information system for critical and at-risk patients and a central element of Nursing care and decision making, it is impossible to disregard data and information related to the evaluation, diagnosis and interventions that underlie Nursing practice.

It is worth noting that the Computerized Nursing Process was structured from the International Classification for Nursing Practice, version 1.0. This terminology is part of the Reference Terminology Models for Nursing (designed in 2003, and known as ISO 18.104), and it encompasses the elements of Nursing practice. In other words, what nurses do with certain human needs to produce certain results (Nursing diagnoses, interventions and results). It is a unified language that expresses the elements of Nursing care^(18,19).

Among the principles that integrate the life cycle of health information development systems, ergonomics and usability are prominent^(1,13,24-27). The International Organization for Standardization defines usability as a quality or characteristic of a product, denoting whether it is efficient, effective and satisfying. It also defines usability as an ergonomic approach and a group of objective techniques that integrate the creation of such products, based on the user-centered design⁽²⁴⁾. Thus, the International Organization for Standardization provides the definition of usability that is subsequently used for ergonomic criteria related to computerized information systems.

On the other hand, Ergonomics applied to computerized systems seeks to study how the interaction between the different components of the system occurs in order to elaborate parameters to be inserted in the design of applications that guide the users and which contribute to task execution^(24,26).

Analyzing the usability and ergonomics of the Computerized Nursing Process from the International Classification for Nursing Practice has allowed us to carry out a detailed evaluation regarding its use and application in the context of ICUs, as well as to highlight their qualities,

effectiveness and satisfaction of participants/users through the criteria established by the International Organization for Standardization standards.

CONCLUSION

All the analyzed items for ergonomic and usability criteria of the Computerized Nursing Process were higher than the predetermined target mean of “4”. Ergonomic criteria of organization, content and technical were considered

“excellent”, while the interface criterion was considered “very good” by the evaluators. The usability of this computerized system was evaluated as “excellent” by nurses, professors and programmers. We conclude that this technology integrates logical data, information, clinical evaluation, diagnoses and nursing interventions, making it possible for nurses to use it in Intensive Care Units since it has complete and updated content and is based on the International Classification for Nursing Practice version 1.0.

RESUMO

Objetivo: Analisar os critérios de ergonomia e usabilidade do Processo de Enfermagem Informatizado a partir da Classificação Internacional para as Práticas de Enfermagem, em Unidade de Terapia Intensiva, de acordo com os padrões da *International Organization for Standardization* (ISO). **Método:** Pesquisa quantitativa, quase-experimental do tipo antes e depois, com uma amostra de 16 participantes, realizada em uma Unidade de Terapia Intensiva. Coleta de dados realizada por meio da aplicação de cinco casos clínicos simulados e instrumento de avaliação. A análise dos dados foi realizada pela estatística descritiva e inferencial. **Resultados:** Os critérios organização, conteúdo e técnico foram considerados “excelentes”, e o critério interface “muito bom”, obtendo médias 4,54, 4,60, 4,64 e 4,39, respectivamente. Os padrões analisados obtiveram médias acima de 4,0, sendo considerados “muito bons” pelos participantes. **Conclusão:** O Processo de Enfermagem Informatizado possui padrões ergonômicos e de usabilidade de acordo com os padrões estabelecidos pela ISO. Esta tecnologia apoia a decisão clínica do enfermeiro fornecendo conteúdo completo e atualizado para a prática de Enfermagem em Unidade de Terapia Intensiva.

DESCRITORES

Processos de Enfermagem; Informática em Enfermagem; Sistemas de Informação; Registros Eletrônicos de Saúde; Unidades de Terapia Intensiva.

RESUMEN

Objetivo: Analizar los criterios de ergonomía y usabilidad del Proceso de Enfermería Informatizado mediante la Clasificación Internacional para la Práctica de Enfermería, en Unidad de Cuidados Intensivos, de acuerdo con los estándares de la *International Organization for Standardization* (ISO). **Método:** Investigación cuantitativa, cuasi-experimental del tipo antes y después, con una muestra de 16 participantes, realizada en una Unidad de Cuidados Intensivos. Recolección de datos llevada a cabo mediante aplicación de cinco casos clínicos simulados e instrumento de evaluación. El análisis de datos fue realizado por la estadística descriptiva e inferencial. **Resultados:** Los criterios de organización, contenido y técnico fueron considerados “excelentes” y el criterio interfaz, “muy bueno”, logrando promedios de 4,54, 4,60, 4,64 y 4,39, respectivamente. Los estándares analizados obtuvieron promedios por encima de 4,0, considerándolos “muy buenos” los participantes. **Conclusión:** El Proceso de Enfermería Informatizado cuenta con estándares ergonómicos y de usabilidad según los estándares establecidos por la ISO. Dicha tecnología apoya la decisión clínica del enfermero, proporcionando contenido completo y actualizado para la práctica de Enfermería en Unidad de Cuidados Intensivos.

DESCRIPTORES

Procesos de Enfermería; Informática Aplicada a la Enfermería; Sistemas de Información; Registros Electrónicos de Salud; Unidades de Cuidados Intensivos.

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