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Usability Testing of PROCEnf-USP: A Clinical Decision Support System

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Abstract

Decision support systems (DSSs) are recognized as important tools, capable of processing high volumes of data and increasing productivity. The usability of these tools affects their effectiveness. By evaluating the interactions between registered nurses (RNs) and the DSSs, this study explores how they impact RN decision-making. This study analyzed 24 months (2011-2012) of data collected in Brazil in two units of a large, public, urban hospital in São Paulo that uses a nurse documentation system with an embedded DSS based on NANDA-I. Using mixed effects logistic regression, this study analyzed the agreement between RNs and a DSS when selecting nursing diagnoses. Results suggest that the agreement is mediated by characteristics of the RNs (education and experience) as well as units and year of encounter. Surprisingly, disagreement between RN and DSS when selecting defining characteristics (DC) had positive effects on the odds of agreement on diagnoses. Our results suggest that DSSs support nurses' clinical decision making, but the nurse's clinical judgment is the mediating factor. More research is necessary.

Keywords:

Nursing Information System; NANDA-I; Nursing Diagnoses, Classification System; Behavioral Model.

Introduction

The Institute of Medicine compiled several reports that support the use of technology to improve the quality and the safety of healthcare [1-4]. Computers are able to structure information and communication, becoming an intellectual tool. In this context, decision support systems (DSSs) are recognized as important tools, capable of processing high volumes of data and increasing productivity. Nurse focused DSSs collect, store, process, retrieve, display and transmit information in real time to assist registered nurses (RNs) with their work.

Through the nursing process nurses continuously assess, diagnose, plan, intervene, and evaluate their patients. All the while, nurses document their steps. PROCEnf-USP (Electronic Documentation System of Nursing Process) is a DSS – a product of a project funded by the National Council of Scientific and Technological Development (CNPq), a Brazilian agency of the Ministry of Science and Technology, and by the University of São Paulo (USP). The project has three aims: to develop computer systems, to install them, and to evaluate them. The PROCEnf-USP was designed by a group of faculty, students, and nurses from the School of Nursing, the Informatics Department, and the University Hospital (HU) of the USP, Brazil. The PROCEnf-USP was implemented in the surgical and clinical units at UH of the University of São Paulo in 2006 [5].

The system offers the RN a set of questionnaires to guide the RN documentation when performing patient assessments. The questionnaire has drop down menus with answers. Using these answers, the system computes probabilities for defining characteristics (DC) and presents them to the nurse. The nurse responds by selecting the DCs deemed most important. Once again the system uses the nurse's input and computes a set of nursing diagnoses (Dx) that best fit the clinical scenario. In special instances, the responses at the assessment may trigger Dxs without triggering DCs. The algorithm is based on the International Nursing Diagnoses Classification (NANDA-I), [6] which is being embraced worldwide. The system therefore can influence the way nurses think about priorities and patient care [7].

Nurses prioritize a DC or Dx based on intrinsic nurse characteristics. The intrinsic characteristics of the nurse deemed as relevant contributors to the effectiveness and efficiency of an individual in the workplace are human capital characteristics, such as level of education and years of experience [3]. These assumptions predict that nurses who are more educated and with more years of experience make more accurate nursing diagnoses.

Using the Donabedian's [8] quality framework, quality is analyzed through a relationship between structures, processes, and outcomes. Kelley, Brandon, and Docherty [7] apply this framework to the study of the effect of electronic nursing documentation on the quality of patient outcomes (Figure 1). Patient health outcomes are thought to be derived from high quality processes (what is done by the nurse to the patient) and high quality structures (human capital, setting, and equipment used when caring for patients).

With that in mind, this study aims to test the usability of the PROCEnf-USP in clinical practice by evaluating the agreement between the RN and the DSS when selecting Dx. The overarching goal is to better understand how the system is used by the RNs to promote better RN decision-making, and consequently improve patient outcomes.

According to this model, the interaction between the RN and the DSS is a key process (Figure 1). Structural aspects affecting this interaction are the characteristics of the nurse and the environment where she practices. The model purports that although the NANDA-I DSS system may be highly accurate, it is only capable of impacting patient health outcomes through interventions mediated by the nurse [7]. When applying the model to the PROCEnf-USP, it suggests that the DSS calculates the most complete list of DC and Dx;

therefore presenting information that may not have been obvious to the nurse. The nurse then selects the DC and Dx deemed most important and continues on with the other parts of the nursing process.

Figure 1 – Donabedian according Kelley et al [8,9].

Materials and Methods

This study is a secondary data analysis of existing observational nurse documentation data collected at a large, public, urban hospital in São Paulo, Brazil between January 1, 2011 and December 31, 2012. The unit of analysis is the admission encounter (N=337, 056).

Using all 24 months, this study analyzed the effects of several RN characteristics on the agreement between the RN and the DSS when selecting a nursing diagnosis, given the assessment data documented by the RN. A generalized linear mixed effects model for binomial family (mixed effects logistic regression) was conducted to assess the odds of agreement given the variables in the model [10,11] (Table 1).

The outcome (dependent) variable was represented by a dichotomous variable created by combining the four possible options. Agreement = yes, when the diagnosis was calculated by the DSS and selected by the nurse OR when the diagnosis was not calculated by the DSS and not selected by the nurse. Disagreement = no, when the diagnosis was calculated by the DSS but not selected by the nurse OR when the diagnosis was not calculated by the DSS but it was selected by the RN.

There were 18 nurses who documented using PROCEnf-USP between 2011 and 2012. RN variables included in the model were: age, level of education, years working at the HU, experience with research, and hours of continuing education in the past year. In addition, type of clinic (medical or surgical) and patient assessment data were included in the model.

Patient data were represented in terms of defining characteristics (DC). Selection of key DCs is the gold standard for nursing diagnosis selection accuracy [12]. Dummy variables representing four combinations of agreement between the DSS and the nurse in the selection of key DCs were created. They represented (a) when the DC was calculated by the DSS and selected by the nurse (62.71%), (b) when the DC was calculated by the DSS but not selected by the nurse (12.68%), (c) when the DC was not calculated by DSS but it was selected by the nurse (23.05%), and (d) when the DC was not calculated by the DSS and was not selected by the nurse (1.57%).

Results

Results from the analysis of our model by year of encounter 2011 (N=166,061) and 2012 (N=170,995), as well as the analysis of both years combined suggest that agreement between the DSS and the nurses regarding the selection of a nursing diagnosis was statistically significant affected by the year of the encounter, the number of hours of continuing education a nurse received, the unit in which the nurse worked, and the nurse's decision-making regarding the selection of DC (Table 2). Agreement occurred in 73.48% (N=247,656) of the time.

The analysis of all 24 month combined is presented in Table 2. The odds of agreement between the DSS and RN when selecting a priority Dx decreased by 7.2% (IC 95%; 0.927-0.929) between 2011 and 2012. The odds increased by 1.3% (IC 95%; 1.001-1.026) for each hour of continuing education the nurse received in the past 12 months, and by 12.8% (IC 95%; 1.071-1.188) if the RN was working at surgical unit compared with working at medical unit.

The odds of agreement between the DSS and the RN when selecting a Dx was also affected by the agreement between the RN and the PROCEnf-USP when selecting DCs. Compared with agreement characterized as 'DC calculated by DSS and selected by the RN,' 'DC calculated by the DSS but not selected by the RN' increased the odds of agreement in the selection of the Dx 37.4 times (IC 95%; 34.56-40.58), and 'DC not calculated by the DSS but selected by the RN' increased the agreement by a third or 36.8 % (IC 95%; 1.33-1.40).

In contrast, compared with agreement characterized as 'DC calculated by DSS and selected by the RN', 'DC not calculated by the DSS and not selected by the RN' reduced the odds of agreement when selecting a priority nursing diagnosis by 99.4% (IC 95%; 0.005-0.008).

Level of education (BSN vs. MS/PhD), participation in research (Yes/No), years of experience at the HU, and age were not significant, and therefore did not affect the odds of agreement between the RN and the DSS when selecting Dx (Table 2).

Table 1 – Variables included in the model

		N	%
Education	MSN/PhD	6	33.33
	BSN	12	66.67
Research	Yes	9	50.00
	No	9	50.00
Clinic	Surgical	10	55.56
	Medical	8	44.44
	Mean	**SD**	**Range**
Continuing education	36.11	24.04	1-79
Age	36.94	7.40	28-48
Experience HU	10.33	6.01	2-20

Table 2 – Mixed Model Effect Logistic Regression 2011-2012

Fixed effects	**B**	**SE**	**Odds Ratio**	**IC 95% Inf–Sup**
Age	-0.013	0.037	0.987	0.917-1.062
Education	0.313	0.287	1.368	0.779-2.402
Research	-0.276	0.225	0.759	0.488-1.179
Years at HU	0.056	0.048	1.057	0.963-1.161
Continuous edu.	0.013**	0.006	1.013	1.001-1.026
Surgical Unit	0.121**	0.026	1.128	1.071-1.188
DC calculated but not selected by the RN	3.623**	0.041	37.450	34.564-40.576

DC not calculated but selected by the RN	0.313**	0.014	1.368	1.331-1.405
DC not calculated and not selected by the RN	-5.070**	0.102	0.006	0.005-0.008
Year	-0.075**	0.001	0.928	0.927-0.929

** P<0.01

Discussion

The most important finding of this study is that the agreement between the decision support system (DSS) and the registered nurse (RN) when selecting a nursing diagnosis (Dx) is dependent on the agreement between RN and DSS when selecting defining characteristics (DC), but not in the way it was anticipated. We expected that the agreement in the selection of Dx was dependent on the "literal" agreement between the DSS and RN regarding the selection of defining characteristics (DC). However, we found that varying degrees of agreement regarding DC may provide agreement between the RN and DSS when selecting a Dx.

As described in the methods, patient data were represented in the model through DC. There are four possible combinations of agreement between the RN and DSS on the selection of DC. One combination can be characterized as being the true agreement (i.e. when the DSS calculates a DC and the RN selects it). Two combinations are in fact disagreements with a 50:50 split between the DSS and the RN and one combination ,a false agreement, neither calculates nor selects a DC.

These variations in agreement occur when the RN completes the nursing assessment phase of the encounter, but does not complete the documentation thoroughly. Since the documentation is the basis for the calculation of DCs, the system is bound by the information inputted. Therefore, when selecting or ignoring a DC, nurses are editing the data from the assessment phase.

For instance, in 23.05% of the admission cases between 2011 and 2012, the RN selected a DC that was not calculated by the PROCEnf-USP, but ultimately agreed with the system when selecting a Dx. In fact, in these instances there was an increase of 36.8% in agreement between DSS and the RN in the selection of Dx. This supports the idea that the RN is the mediator for nursing diagnostic decision-making. The RN may skip the step of entering the data, bypassing the NANDA-I algorithm, and going straight to the diagnosis.

Conversely, in 12.68% of the admission encounters between 2011 and 2012, the RNs did not select a DC calculated by PROCEnf-USP, but ultimately agreed with the system in the selection of a Dx. In fact, in these instances the odds of agreement increased by a large margin, 37 times. By ignoring a DC calculated by the DSS but agreeing with the DSS on the priority diagnosis, the nurse is suggesting that the DC calculated by the DSS is less important that it appears. It is possible that the RN is providing contextual information that was not captured in the documentation.

In 1.57% of the admission encounters between 2011 and 2012, the RN did not select and the DSS did not calculate a DC. In those instances there was a decrease in agreement by 99.4%. The algorithm is designed to allow the DSS to bypass the DC and directly suggest a Dx given dichotomous assessment questions. It is possible that in these instances, the DSS did not calculate a DC, but suggested a Dx. Since the DSS did not calculate the DC, the RN was less like to select it on their own, and consequently less likely to agree with the Dx calculated.

When the nurse adds information or ignores information, the RN's decisions are influenced by something other than the DC. The model suggests that RNs' human capital characteristics, such as experience working at that unit and hours of continuing education may have had an impact. Our results support that. For each additional hour of continuous education a nurse received in the past 12 month, there was an increase of 1.3% in the odds of agreement between the RN and DSS when selecting a nursing diagnosis. At University Hospital, nurses received a mean of 36.11 hours per year of continued education. Although some of the topics included informatics, nursing taxonomy, and nursing documentation, most topics were not specific for DSS usage. They provided or reinforced clinical knowledge, which is essential for clinical reasoning development [13].

The odds of agreement was 12.8% higher in the surgical unit than in the medical unit. Although this finding appears to be positive, it is of concern. Patient turnover is higher in the surgical unit than it is in the medical ward; the average length of stay is shorter, but patient profiles are very similar. Therefore RNs are required to work faster during the assessment. They have less time to be in contact with their patients, but are experiencing similar clinical conditions. It is possible that RNs in the surgical units are thinking that they know a priori what their patients' problems are. The RNs at the surgical unit may be collecting patterns of patient data, inputting them in the DSS, and then agreeing with the system. In 2012 the odds of agreement between the RN and the DSS decreased by 7.2% when compared to 2011. This may be a result of inexperience, given that in 2012 the medical unit had four new RNs who transferred from other units of HU [14].

Conclusion

The agreement between the RN and the DSS when selecting defining characteristics (DC) significantly affects the odds of agreement between the RN and the DSS when selecting nursing diagnoses (Dx), but not as anticipated. The system offers the structure for nurses to collect data and analyze information by offering opportunities for nurses to accept or reject DC and Dx. These interactions between the RN and DSS are mediated by the RN characteristics; such as years of experience and continuing education. These characteristics are proxies for clinical reasoning and clinical judgment. Systems such as PROCEnf-USP are especially helpful to students, new nurses, or expert nurses in a new environment. Future studies should compare the documentation of the novice RNs and students to those of more experienced RNs. These results along with future studies in this field will contribute to the refinement of the Dx classification based on real clinical environment evidences.

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