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COMPUTERIZED DECISION SUPPORT SYSTEM AND DECISION QUALITY OF NURSES[1]

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ABSTRACT
This study investigates whether there is a difference in the decision quality when Operating Room nurses use a computerized decision support system (CDSS) based on normative decision modeling as well as nurses' confidence in making decisions based on their own judgement and aided by a CDSS called Lightyear. Decision quality was measured as agreement with the decisions of a panel of experts in Operating Room nursing. A post-test quasi experimental design was used, with a non-random convenience sample of nurses randomly assigned into one control (unaided) and one experimental group (computerized decision support system). Of this study did not demonstrate a significant difference in decision quality between the control and experimental group. No relationship was found between demographic variables and quality of decision. Subjects in the control group presented a higher degree of decision confidence. Subjects in the experimental group, who had a higher score in the correct. response score showed a lower degree of confidence when making decisions with Lightyear. This study raises important methodological considerations about the need of further studies that evaluate the use of CDSS based on normative modeling where subjects might be allowed to evaluate its effectiveness using the software in its full potential.

Keywords: Decision Support Techniques. Operating Rooms. Nursing. Computer Systems.

INTRODUCTION

Decision making is part of every step of the nursing process. Nurses are constantly faced with decision making situations in their professional lives. Many factors demand that the staff nurse make clinical decisions that are of high quality. Health care costs are constantly increasing and there is a consequent pressure from hospital administration and from the customers, the patients, to deliver care of the highest quality for the lowest price[1]. Staff nurses are usually in the position of making clinical decisions that have an impact on patients' recuperation and therefore might influence both their length and the cost of their stay. In addition, while nurses have become more autonomous in their decisions regarding patient care, they are having to face increased liability for those decisions as well. Therefore, it is vital that nurses make high quality decisions since optimal decisions may have result in better outcomes in terms of the care delivered to patients, patient satisfaction, and cost effectiveness.

Even though decision making is present in every step of the nursing process, it is most critical when the need of the patient has been identified and resources must be mobilized to meet that need[2]. The Operating Room nurse is frequently faced with having to make decisions, often times of prescriptive nature, requiring the nurse not only to assess and diagnose problems but also to implement nursing actions.

Behavioral decision making theories have tried to explain how nurses make decisions[3-5]. These explanations, however, do not clearly indicate how nurses could reach better decisions and thus affect the quality of the process and outcome of patient care. Another model of decision making, Normative Decision Theory (NDT), addresses decision making by indicating what decision makers should do rather than examining how decisions are made, thus it might be appropriate for prescribing strategies and

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actions designed to meet the goal of quality care by improving nurses' decision making.

Normative decision modeling, which is based on NDT, allows more extensive analysis and comprehension of the proposed problem, therefore the decisions made by nurses based on the suggestions offered by this model might be of higher quality than the ones made unaided. Likewise, computerized systems that guide the nurse in analyzing the problem situation might make normative models easier to use and thus be even more helpful in achieving better decisions. Normative decision models assert that a person's preference for specific alternatives can be captured in mathematical models that are quite independent of the content and context of the decision maker. This includes both personal values and uncertainty about a decision situation are inherent in the decision maker's perception of the problem. These mathematical models ensure that uncertainty and values are systematically evaluated when making a choice. Therefore, when associated with clinical nursing knowledge, normative decision models can appropriately capture nurse's perceptions in the decision making process[6].

Normative Decision Theory NDT is based on four concepts: uncertainty, expectation, utility and preference[7]. Uncertainty is a mathematical expression of the chance that an outcome will occur. Expectation is the expected value of each action which is computed as the mean of the probability distribution over a certain outcome. The optimal choice is the one that presents the highest expected value. Utility describes how much an individual desires a particular state relative to another state referring o the aspect of ordering the alternatives according to a particular set of characteristics previously established, and not according to personal favoritism.

There are many claimed advantages of normative models. They make explicit the decision maker's values on which the choice is based, and they formalize the decision situation. Therefore, evaluation of the problem is enhanced. The use of normative models also reduces the chances of biased influences and helps the decision maker to act according to his/her understanding of the problem. One of the most important advantages is that because they are context-free models, normative models can be applied to a variety of situations and by a variety of decision makers[2,6-8].

Normative decision models may be useful in nursing because they address aspects of decision problems faced by the nurse such as uncertainty of outcomes and multiple criteria. This analytical approach to decision making requires that the decision maker think. Therefore, the understanding of the individual elements of the decision making process and how they interrelate should lead to improving the judgement capabilities of the decision maker[8]. Normative models have been successfully employed by management, business, and the medical field and advocates of the normative model challenged researchers to consider it for nursing decision making[6, 9-11]. In a variety of areas, researchers have indicated the superiority of decision quality, in terms of diagnostic accuracy and meeting established gold standards, when employing normative models[12-14]. Few studies using normative models, however, have been conducted over the past years either in nursing management or in clinical areas.

A number of nursing investigators have addressed the use of normative models in management, diagnostic, and ethical decisions[2,9,11]. The objective of this research was to help clarify whether the application of computerized normative models improves the quality of decisions of OR staff nurses in clinical decisions It also evaluated nurses' decision confidence when using a Computerized Decision Support System (Lightyear) based on normative decision modeling or using their own judgment to arrive at a decision.

METHODS

A two group, post-test, quasi-experimental design was used to examine the difference in the quality of decisions made by Operating Room nurses. The subjects, in a laboratory environment, were faced with four decision situations requiring prescriptive actions. Their decisions were made either unaided or using the computerized decision support system. The study was conducted during the winter of 1991 at a tertiary University Hospital, in Cleveland,

Ohio, USA.

The use of a laboratory has been defended in studies where computer based information-decision systems are used to support decision-making[12]. It enables the researcher to define a specific type of decision, its complexity, and the decision-making environment. Most research that evaluates the effectiveness of decision analysis[9-11] and of CDSS[12] on the quality of decisions were performed in laboratory settings.

A non-random convenience sample of Operating room nurses was utilized for this study. Selection criteria required that all subjects had either a Diploma, Associate Degree in Nursing (ADN), Bachelor of Science in Nursing (BSN), Master of Science in Nursing (MSN) or a Nursing Doctor Degree (ND) and had more than one year of experience in the OR. No computer experience was required[3,11,15].

The independent variable was decision-making strategy, defined in this study by the means or decision aids the nurse depend on to arrive to a decision. The operational definition of decision-making strategy was how the nurse makes the decision: if unaided and based solely on her own judgment for making decisions or using Lightyear in a laptop computer. The dependent variable, quality of decision, was defined as the extent to which the nurses' choices of best intervention are in accord with the choices of a panel of experts. The operational definition was the number of options chosen by the nurse that agree with those chosen by a panel of expert nurses as being the best choice for nursing intervention in the total of four cases.

Demographic variables were: age, sex, educational background and years of experience in nursing, years of experience in the OR. The explanatory variable was Decision Confidence of the nurses concerning making decisions unaided and using Lightyear as measured on the Decision Aid Reaction Tool, a 22-question evaluation of reactions to a decision aid.

Research tools used were: Case Studies (both in writing and in films); Demographic Data Form; Mock situation for training; and Clinical Cases Instrument, covering four case studies.

Case Studies have been extensively used in the study of decision making, decision analysis and CDSS[10,16-17]. The questions on the cases involved the establishment of mutually exclusive Alternatives, Establishment of Criteria e assurance of Content Validity established by a panel of experts in Operating Room Nursing. The Decision Aid Reaction Tool, a five-point Likert scale tool for evaluating Decision Support System Success Factors, aimed to evaluate the subjects' reactions towards making decisions unaided and using a computer. This tool addressed two dimensions: Overall Satisfaction and Decision Making Satisfaction with a Cronbach's alpha coefficient of reliability is .7953. Video films provided visual stimuli for the clinical cases[18]. The computer software, Lightyear, Computer Decision Support Software[19], based on normative modeling and is classified as a multiple criteria model in Decision Analysis[6]. The underlying process consists of a six-step problem solving process: (a) identifying the name of the problem; (b) generating alternative solutions; (c) identifying criteria for evaluating the alternatives; (d) weighing the criteria; (e) rating the alternatives against the criteria, and (f) computing the best solution and reviewing the result

Permission was obtained from the Frances Payne Bolton School of Nursing and from the Institutional Review Board for human subjects participation from University Hospitals to conduct the study. Nurses from the Operating Rooms were invited to participate and randomly assigned to control and experimental groups. All activities took place either in the library conference room or at the Humphrey conference room at University Hospitals. Instructions were given verbally to all participants in the same way by the investigator, who followed a written protocol. Time spent in the training session was recorded by each participant.

RESULTS AND DISCUSSION

Sample consisted of 36 individuals, 18 in the control and 18 in the experimental group. The experimental group consisted of one man and seventeen women. The control group consisted of two men and sixteen women. Subjects ranged in age from 26 to 56 years with a median age for both groups of 34.5.

A t-test for independent means showed no significant difference in age between the groups (t= -1.11, p=.277). The control and experimental

groups had similar educational backgrounds. The sample consisted of 5 subjects with ADN, 14 with a Diploma in Nursing and 17 with a BSN degree. No subject had a ND or MSN degree. Chi-square statistics were used to test for homogeneity. A comparison of test results for the control and experimental group indicates that the two groups are statistically similar on educational background (Chi=3.00, p=.222).

The experimental group had a mean of 11.83 (SD= 8.62) years of experience in the OR and the control group had a mean of 10.72 (SD= 5.18) years. A t-test for an independent sample showed no significant difference in the years of experience in the OR between groups (t=-.47, p=.643).

Quality of decision was defined in this study as the total number of decisions for best intervention made by nurses which agreed with the decisions of the panel of experts.

The mean number of correct responses in the control group was 2.27 (SD=.895) and the experimental group was 2.50 (SD=.924). Independent t-test for the total correct responses score of the two groups was not statistically significant (t= -.73, p=.468). Chi-Square Test for the number of subjects achieving each total correct responses score by group did not show a statistically significant difference between groups (x2=4.628, p=.201, df=3). The result of this Chi-Square test was based on combined scores. Therefore, the results of this study did not support the proposed hypothesis that there would be a difference of decision quality between the two groups.

Chi-square statistics was performed to evaluate the scores obtained in each case study by group. There was no statistical significance between the two groups in cases one, two and three. Case four showed a statistically significant difference in the scores presented by the experimental group (p=.044).

A Pearson product moment correlation was computed for the total sample to examine the correlation of correct score and age, years of experience as a nurse and years of experience in the OR, showing no statistical correlation between these variables.

Analysis of Variance (ANOVA) showed that there was no statistically significant difference of correct responses scores and the different educational background .

The mean and SD of the scores obtained by each group in the Decision Aid Reaction Tool was evaluated. A 5-point Lickert Scale was used. Positive reactions towards the strategy employed by the subjects indicate a higher confidence in making decisions using the strategy. The control group had a mean of 52.83 (SD 7.80) and the experimental group a mean of 64.33 (SD 10.66). T-test for the Decision Aid Reaction Tool Scores between groups, showed that the control group had higher decision confidence at a statistically significant level (p=.001).

A plot displaying the relationship between the Decision Aid Reaction Tool Score and the Correct Responses Score in the case studies however, highlights that subjects in the experimental group, who had lower degree of confidence while using the decision aid, had a higher degree of accuracy in the responses of the case studies. On the other hand, subjects on the control group, who showed higher confidence in their decision- making, had lower scores in the response of the case studies. A Pearson Correlation of Correct Responses in the case studies and Decision Aid Reaction Tool Scores showed no statistical difference between the two groups (-.154).

The results are substantiated by another study[11], where no relationship with nursing students' previous health care experience and their optimal clinical decision making was found. Furthermore this study does not support other studies in which such a relationship was found[3, 15].

Analysis of Variance did not show a significant difference between the correct response score and educational background. This research did not indicate the existence of any relationship between different educational background and quality of decision. These findings are consistent with the results one study[11] and inconsistent with other findings[15]. The sample in this study, however, differed from the samples used in the other studies. Only OR nurses were used in this research and they are not representative of the whole population of practicing nurses.

The research hypothesis that there would be a difference in decision quality when OR nurses

used a computerized decision support system based on normative modeling compared to the control group was not supported in this investigation. Even though the mean for correct score was higher in the experimental group than in the control group, a t-test showed no statistically significant difference between the study groups.

Another study that presented similar results to this one evaluated and interactive program named DECAID[20]. It was used by a group of students in solving a case problem while another group solved the problem unaided. Three raters evaluated written analysis prepared by the students and no significant differences in performances were detected.

This present study did not support the results of one field study with nurse managers[6], where a multiple criteria model was used and the CDSS had an impact on the nurses' decision making behavior. This study, however, addressed decision quality in a multidimensional approach with a completely different design, though it might not be appropriate to compare results of both studies.

Some studies in the management field obtained a different result. One research[17] evaluated the effectiveness of CDSS-aided decisions relative to decision made without CDSS over an eight-week period. In that study, the experimental groups made significantly more effective decisions in the business simulation game than the control groups. The group using the CDSS investigated more alternatives and exhibited a higher confidence level in their decisions than the control group.

Two review articles of laboratory studies on the effectiveness of CDSS on managerial decision quality[12,17] presented studies with contradictory results. Even though, the CDSS used in those studies were not based on multiple criteria models, they showed how laboratory studies have had mixed results concerning decision quality, decision time and decision confidence.

It was noted that the control group had a significantly higher score (p=.001) on Decision Confidence, as measured by the Decision Aid Reaction Tool, being consistent with the findings of another study[12].

It is interesting to observe the plot comparing the number of correct responses and the Decision Aid Reaction Tool Score. Even though a Pearson correlation was not statistically significant, it is noticeable that subjects in the experimental group, who had a higher score in the correct responses score in the case studies showed a lower degree of confidence when making decisions with Lightyear. On the other hand, subjects in the control group who had a lower score in the correct responses score, demonstrated to be more confident in their decisions.

This observation might be further indication that having to deal with a new technology may have had an influence in the perceptions of nurses in the experimental group. Even though they scored higher than subjects in the control group, they did not feel confident enough that the options they chose were adequate. On the other hand, subjects in the control group who had a low score in the case studies showed over confident in their decisions. This result is further indication that nurses need decision aids that augment their decision making capabilities[2,6-7].

CONCLUSIONS

Both groups were shown to be homogeneous in the following variables: Age, gender, educational background, years of experience in nursing and years of experience in the OR. This research did not indicate the existence of any relationship between different educational background and quality of decision

The research hypothesis that there would be a difference in decision quality when OR nurses used a computerized decision support system based on normative modeling compared to the control group was not supported in this investigation. Even though the mean for correct score was higher in the experimental group than in the control group, a t-test showed no statistically significant difference between the study groups.

A limitation of this study is that it was conducted in a laboratory environment and results can not be generalized to real life situations. Another critical limitation of this study was that due to research design and restraining factors the positive capabilities of the

CDSS were not brought out. Six basic factors were identified which may have interfered with the results of this study, limiting their generalizability: (a) impossibility to fully use the software as a thinking tool; (b) pre-establishment of alternatives and criteria; (c) learning effect; (d) time frame for the experiment; and, (e) content of the case studies.

Results of this investigations present some important methodological guidelines for future research evaluating the effectiveness of CDSS based on normative modeling in nursing. It is critical that subjects be allowed to explore and utilize the software in its full potential, thus enabling the investigators to appraise its effectiveness.

Further research is required where subjects are allowed to propose their own alternatives and criteria when analyzing the decision situation. This will grant subjects the opportunity of entering into the computer their own approach and perspectives of the problem. Likewise, the freedom to reevaluate their options, criteria and ratings should be granted to subjects. They should be allowed to take the most advantage of the features in the software, such as also establishing rules, getting detailed evaluation of the scores in each alternative and criteria and using other modes of representing the values besides the graphic mode.

A study design that permits a period of training on the use of the computer and of the software prior to the experiment itself might be critical for the evaluation of its effectiveness. It is also important to assure that participants understand the concepts of rating the alternatives against the criteria. It might also be interesting to design a case study in which subjects can have access to more information if they find it pertinent.

There are too many variables involved in a decision situation, too many different types of problems and too much variety in the characteristics of decision makers. A real life situation can better capture all attributes and nuances of a decision situation, even though controlling variables might be extremely difficult. The purpose of researching CDSS in nursing is the expectation that they might support nurses role in caring for patients and extent their abilities in that role. Therefore, it seems important that research involving the use of CDSS also be conducted in real life situations. It would be interesting to evaluate the use of a multiattribute model in real life environment in clinical decision situations .

Multiple criteria models can be applied in different environments and decision situations. Hence, they can capture the particularities of various settings and users. Because they can be used in common personal computers and laptop computers, multiattribute models can prove to be a helpful and inexpensive decision support tool for nurses. Research evaluating the use of multiple criteria models in real life situation are more economically feasible than expert systems, and thus nurse researchers in CDSS should take advantage of this.

Finally, a statement that captures some of the importance of the study of decision making and the means to support this role in our lives: "Faced with decisions, decisions, decisions, one is tempted to ask: Is there not an easier way?" This investigator is tempted to say: "Let’s find out..."

SISTEMA COMPUTADORIZADO DE APOIO A DECISÃO E QUALIDADE DECISÓRIA DE ENFERMEIROS

RESUMO

Este estudo investiga se existe diferença na qualidade da decisão, quando enfermeiros de Centro Cirúrgico utilizam um Sistema informatizado de Apoio a Decisão (SCAD), com base em modelos de decisão normativa, bem como avalia sua confiança na tomada de decisões baseadas em seu próprio julgamento e auxiliado por um SCAD chamado Lightyear. A qualidade da decisão foi medida de acordo com as decisões de um painel de especialistas em Enfermagem em Centro Cirúrgico. Um estudo experimental pós- teste foi utilizado, com uma amostra de conveniência de enfermeiros, distribuídos aleatoriamente em um grupo controle (sem auxilio) e um grupo experimental (SCAD). Os resultados não demonstraram diferença significativa na qualidade da decisão entre o grupo controle e experimental. Não foi encontrada relação entre variáveis demográficas e de qualidade da decisão. Sujeitos do grupo controle apresentaram um maior grau de confiança de decisão e os do experimental, que tinham uma pontuação mais elevada nas respostas corretas, apresentaram um menor grau de confiança na tomada de decisões com Lightyear. Importantes considerações metodológicas são levantadas

sobre a necessidade de novos estudos que avaliem o uso de SCADs baseado em modelos normativos que avaliem sua eficácia, utilizando o software em seu pleno potencial.

Palavras-chave: Técnicas de Apoio à Decisão. Salas Cirúrgicas. Enfermagem. Sistemas de Computação.

SISTEMA COMPUTADORIZADO DE APOYO A DECISIÓN Y CALIDAD DECISORIA DE ENFERMEROS

RESUMEN

Este estudio investiga si existe diferencia en la calidad de la decisión, cuando enfermeros del Centro Quirúrgico utilizan un Sistema Computadorizado de Apoyo a Decisión (SCAD), basado en modelos de decisión normativa, así como evalúa su confianza en la toma de decisiones basadas en su propio juicio y auxiliado por un SCAD llamado Lightyear. La calidad de la decisión fue medida de acuerdo con las decisiones de un panel de especialistas en Enfermería en Centro Quirúrgico. Un estudio experimental post test fue utilizado con una muestra de conveniencia de enfermeros distribuidos aleatoriamente en un grupo control (sin auxilio) y un grupo experimental (SCAD). Los resultados no mostraron diferencia significativa en la calidad de la decisión entre el grupo control y experimental. No se encontró relación entre variables demográficas y de calidad de la decisión. Los sujetos del grupo control presentaron un mayor grado de confianza de decisión y los del experimental, que tenían una puntuación más alta en las respuestas correctas, presentaron un menor grado de confianza en la toma de decisiones con Lightyear. Importantes consideraciones metodológicas son levantadas sobre la necesidad de nuevos estudios para evalúen el uso de los SCADs basados en modelos normativos que evalúen su eficacia, utilizando el software en su pleno potencial.

Palabras clave: Técnicas de Apoyo a la Decisión. Quirófanos. Enfermería. Sistemas de Computación.

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