

Research Paper ■

Factors Affecting and Affected by User Acceptance of Computer-based Nursing Documentation: Results of a Two-year Study

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Abstract Objectives: The documentation of the nursing process is an important but often neglected part of clinical documentation. Paper-based systems have been introduced to support nursing process documentation. Frequently, however, problems such as low quality of documentation are reported. It is unclear whether computer-based documentation systems can reduce these problems and which factors influence their acceptance by users.

Design: We introduced a computer-based nursing documentation system on four wards of the University Hospitals of Heidelberg and systematically evaluated its preconditions and its effects in a pretest–posttest intervention study. For the analysis of user acceptance, we concentrated on subjective data drawn from questionnaires and interviews.

Measurements: A questionnaire was developed using items from published questionnaires and items that had to be developed for the special purpose of this study.

Results: The quantitative results point to two factors influencing the acceptance of a new computer-based documentation system: the previous acceptance of the nursing process and the previous amount of self-confidence when using computers. On one ward, the diverse acceptance scores heavily declined after the introduction of the nursing documentation system. Explorative qualitative analysis on this ward points to further success factors of computer-based nursing documentation systems.

Conclusion: Our results can be used to assist the planning and introduction of computer-based nursing documentation systems. They demonstrate the importance of computer experience and acceptance of the nursing process on a ward but also point to other factors such as the fit between nursing workflow and the functionality of a nursing documentation system.

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Nursing documentation is an important part of clinical documentation. Thorough nursing documentation is a precondition for good patient care and for efficient communication and cooperation within the health care professional team.

Nursing care is usually oriented toward the so-called nursing process. The nursing process provides a systematic methodology for nursing practice. It consists of six phases: (1) assessment of relevant patient information; (2) definition of nursing problems and resources of the patient; (3) derivation of nursing goals; (4) planning of nursing tasks; (5) execution and documentation of these tasks; and (6) evaluation of nursing care and possibly redefinition of the care plan.

Paper-based documentation systems have been introduced to support nursing process documentation. Frequently, however, large investments in documentation efforts, low quality and limited general acceptance of the nursing process have been reported.¹⁻⁴ Therefore, there have been some attempts and discussions about how to support the nursing process using computer-based documentation systems.⁵⁻⁸

Motivation is essential for learning, and important success factors for new computer-based system are, therefore, users' motivation and acceptance of new ways of working.^{9,10} User acceptance is often even seen as the crucial factor determining the success or failure of a new project.¹¹ This article concentrates on the question of what determines user acceptance of a new system.

Previously, the evaluation of user acceptance after the introduction of a computer-based nursing documentation system showed varying outcomes. For example, we found high acceptance scores on one ward after 3 months of use of a computer-based documentation system,¹² whereas Newton found very low acceptance after 3 months and again after one year of use of computerized care planning.¹³

It seems rather obvious that different factors such as functionality and usability of the documentation system, training and support, previous paper-based documentation processes, and other differences in the environment can influence a user's acceptance of a new computer-based system and thus its overall success. A detailed analysis of such factors is difficult due to the complexity of the often interrelated factors. A deeper knowledge of such factors, however, may help to plan the introduction of such a documentation system and to avoid project failures.

Various models describe the adaptation of computers in an organization. Lewin's field theory,¹⁴ for example, describes three main phases: unfreezing of old patterns, moving and experimenting with new behaviors and refreezing when new behavior becomes part of every-day business processes that are considered normal. Lorenzi¹⁵ described three kinds of organization change: first-order change with limited effects on staff and tasks, middle-order change with larger changes, and second-order change with dramatic changes in the overall organization. Both models were too general for our needs because they do not concentrate on user acceptance but rather on technology adoption in an organization in general.

A model that specially deals with user acceptance is the technology acceptance model (TAM) developed by Davis.¹¹ According to this model, user acceptance is strongly influenced by the perceived usefulness of a system. This perceived usefulness itself can be divided, according to Vassar,¹⁶ into four main parts: characteristics of the information system itself, characteristics of the users, characteristics of the task processes, and other environmental characteristics. Dixon¹⁷ extended the TAM model to the Information Technology Adoption Model (ITAM), further refining the individual characteristics of the users, using the notion of a "fit" between the IT and the user. For our study, we first concentrated on individual characteristics (such as computer knowledge, acceptance of computers, and acceptance of the nursing process) as important factors supposed to influence overall nurse user acceptance.

Nurses are often seen to be reluctant to use computers in areas closely connected to patient care for diverse reasons such as the fear of being alienated from the patient.¹⁸ Low acceptance of computers may make the introduction of computer-based systems difficult. However, it still seems unclear which level of acceptance of computers is necessary for the successful introduction of a computer-based documentation system.

Another important issue is the acceptance of the nursing process which can be supported by computer-based nursing documentation.¹⁹ However, unless nurses accept and understand the nursing process, computer support may be useless or even harmful. For example, nurses may now use predefined care plans without sufficiently adapting them to individual patients.^{3,6} Or, because of low understanding of the nursing process, nurses may complain about the now more time-consuming documentation¹³ without exploiting possible benefits. This can lead to user boycott as well. On the other hand, the use of com-

puters to support the nursing process may be a way to increase the acceptance of the nursing process, because it is now much easier than writing care plans by hand. The relationship between the acceptance of the nursing process and the success of computer-based systems still seems fairly unclear.

Several studies have evaluated the acceptance of nurses with regard to the nursing process and computers. For example, Scarpa,¹⁰ Burkes,²⁰ and Simpson²¹ analyzed nurses' attitudes with regard to computers in general; Vassar¹⁶ described nurses' acceptance of a specific nursing information system; and Bowman²² analyzed nurses' acceptance of the nursing process. Some authors described the changes of acceptance after the introduction of a computer-based system. For example, Bürkle,²³ Murphy,²⁴ Newton,²⁵ Sleutel,²⁶ and Walter²⁷ measured the changes of acceptance of computers in nursing after the introduction of a computer-based information system.

To our knowledge, however, no study has addressed the questions in which we were interested: analysis of how basic computer acceptance, acceptance of computers in nursing, and acceptance of the nursing process as potential success factors are correlated with the overall user acceptance and how they change over time. Each can be measured by individual acceptance scores.

Therefore, we decided to evaluate systematically preconditions and consequences of computer-based nursing process documentation at the Heidelberg University Hospitals, with special emphasis on the acceptance issue. We chose four different (psychiatric and somatic) departments and conducted a prospective time series study with three points of measurement.

Goal of the Article

The goal of this article is to present the results of this evaluation, to discuss the changes in acceptance after the introduction of a computer-based nursing documentation system, and to analyze the correlation among different influencing factors. The complete study results (detailed study plan, execution of study, complete raw data) are available in reference 28.

Research Questions

The overall goal of the study was to evaluate the preconditions and consequences of computer-based nursing process documentation with a special

emphasis on acceptance issues. In detail, we wanted to answer the following major questions:

1. To what extent is there a change in user acceptance of the nursing process before, during, and after the introduction of a computer-based nursing documentation system?
2. To what extent is there a change in user acceptance of computers in general before, during, and after the introduction of a computer-based nursing documentation system?
3. To what extent is there a change in user acceptance of computers in nursing before, during, and after the introduction of a computer-based nursing documentation system?
4. What is the level of user acceptance of the computer-based nursing documentation system itself?
5. To what extent are the acceptance scores of questions 1–4 correlated? What are the factors influencing the overall user acceptance?

Methods

Intervention

The software PIK (Pflegeinformations- und Kommunikationssystem, a German acronym for "nursing information and communication system") was chosen for the study and introduced on four wards of three different departments (Department of Psychiatry, Department of Pediatrics, and Department of Dermatology) of the University Hospitals of Heidelberg, Germany. This study was an integral part of a research project to learn more about nursing documentation systems. The study was organized to quantify the experiences in this project. The system was implemented to allow for a pilot study.

PIK was developed by a Germany-wide work-group, thus enabling us to participate in its development. PIK fully supports all phases of the nursing process. In 1997, when the decision for the project and this study was made, PIK was the only software product available in Germany dedicatedly supporting all six phases of the nursing process. Now other software products are available. However, because of the many years of experiences and development, PIK is still one of the products with the most elaborate functionality for nursing process support.

In PIK, the anamnesis is supported by offering flexible forms for data entry. Based on the information

Table 1 ■

Time of application for each of the three questionnaires and time of introduction of the computer-based nursing documentation system PIK on the four study wards

	First questionnaire (before)	Introduction of PIK	Second questionnaire (during)	Third questionnaire (after)
Ward A	Sept. 1998	Nov. 1998	Feb. 1999	*Aug. 20001
Ward B [†]	Sept. 1998	Nov. 1999	—	Aug. 2000
Ward C	May 2000	Oct. 2000	Jan. 2001	July 2001
Ward D	June 2000	Sept. 2000	Dec. 2000	June 2001

*The evaluation on this ward was initially terminated after the second questionnaire. After expanding the study on three other wards, ward A again joined in for the third questionnaire, about 11/2 years after the second one.

[†]Ward B was initially defined as control ward to ward A. In 2000, the ward decided to introduce PIK and therefore joined the study. Therefore, no second questionnaire is available.

gathered in the anamnesis, nursing care plans can be created for individual patients. To support this goal, typical nursing problems, goals, and tasks can be predefined and selected during the creation of the care plan. Typical combinations of problems, goals and tasks can even be combined in predefined nursing care plans. Later, during care planning, predefined items and standards can be selected and adapted to individual patient needs by adding or removing certain items. Based on this care plan, nursing tasks are executed and documented, usually incorporating a time axis into the documentation form. The system allows the documentation of planned tasks or other tasks, along with information about special observations or occurrences. In addition, nursing goals can be planned, checked, and documented. The procedure is nearly identical to that of task documentation. Finally, nursing reports can be written, usually containing free text. Individual nursing reports may be highlighted for other health care professionals.

The functionality described above covers the six phases of the nursing care process. PIK also offers functions for ward management (for example, patient management and use of general forms), for management of the predefined care plans, and for the use of nursing knowledge (such as nursing standards).

Study Design

The literature often points to the fact that the adoption of new information technology takes some time. Based on Lewin's field theory, measurements should try to include both the unfreezing and moving phases as well as a refreezing phase. However, there are no clear indications in the literature regarding how long each of these phases of the adoption of a nursing documentation system will typically last. This depends on many

factors (e.g., organization of introduction, complexity of functionality, skills of users, workflow integration). In the literature, measurements are typically done 1–6 months after and then again 6–12 months after the introduction of a system. For example, Newton did measurements at 3 and 12 months;¹³ Adaskin at 6 and 12 months;²⁹ and Sleutel at 1 and 6 months.²⁶ We decided to choose 3 and 9 months, knowing that we cannot be certain that we covered the moving and refreezing phases. We thus used a prospective intervention study with three time measurements:

- approximately 3 months before introduction (before)
- approximately 3 months after introduction (during)
- approximately 9 months after introduction (after)

The intervention was defined by the introduction of the selected nursing process documentation system (PIK) on the entire ward for all phases of the nursing care process. The study period was between August 1998 (pretest on the first ward) and October 2001 (posttest on the last ward). For organizational reasons, the measurements could not be conducted at the same time on all of the wards. Table 1 presents the detailed time schedule for each ward.

Measurements

We mainly used validated questionnaires to answer the questions of interest. To answer questions 1–4, we selected questionnaires presented by Bowman²² for acceptance of the nursing process, by Nickell³⁰ for acceptance of computers, by Lowry³¹ for acceptance of computers in nursing, and by Chin³² and Ohmann³³ for acceptance of the computer-based nursing documentation system itself. We carefully translated those questionnaires into German and checked the understandability in a pretest with about 8 users.

Table 2 ■

Some characteristics of the four study wards where a computer-based nursing documentation system has been introduced

	Unit	Patients' profile	Number of beds	Number of cases in 2000	Mean duration of stay	Number of nursing staff
Ward A	Psychiatry	Acute psychiatric diseases	21	399	20.7 days	19
Ward B	Psychiatry	Acute psychiatric diseases	28	655	13.7 days	17
Ward C	Pediatrics	Children under 2 years	15	600	4.5 days	13
Ward D	Dermatology	Diverse dermatological cases	20	589	9.6 days	12

All questionnaires were distributed to all nurses of the four wards before, during, and after the introduction of PIK. All questionnaires showed high reliability in our study. Cronbach's alpha reliability coefficient for all of our three measurements was 0.86 for the acceptance of the nursing process, 0.83 for the acceptance of computers, 0.78 for acceptance of computers in nursing, and 0.90 for the acceptance of PIK, indicating a high internal consistency.

As explained above, this study was part of an overall project to learn more about computer-based nursing documentation systems. To gain deeper insight into the user acceptance (especially with regard to question 4), we also conducted open focus group interviews with the nurses of all wards around the time of the third questionnaire. We interviewed 3–4 nurses from each ward and used the results of those interviews to explain similarities and differences between the four study wards that we found in the quantitative questionnaire study. The interviews were conducted by two external researchers and audiotaped.

Data Analysis

The resulting quantitative acceptance scores from the questionnaires were compared using statistical analysis procedures. Three types of problems with regard to statistical testing were considered: (1) changes within a unit over time, (2) differences between units at fixed time points of the study, and (3) correlation. The testing of hypotheses related to (1) is done by using nonparametric tests for dependent observations: the Friedman test in the case of three time points and the Wilcoxon signed rank test in the case of two time points. We decided to use non-parametric tests because the questionnaires that we adopted have not been explicitly analyzed for normal distribution. In addition, the use of non-parametric tests allowed a common analysis concept for the study questions 1–4. Finally, nonparametrics are only slightly inferior to the t-test.³⁴

The observations are dependent because of the fact that a measurement is taken three times from the same investigational unit. The testing of hypotheses related to (2) is done by using nonparametric tests for independent observations: the Kruskal-Wallis test when three units are compared and the Mann-Whitney test when two units are compared. In order to handle multiple testing situations, the closure testing principle is applied. This implies that in the case of pairwise testing between three time points or three different groups, the alpha error of the pairwise comparisons does not have to be adjusted to multiple testing if the global test that looks for differences among the three time points or groups is significant on the defined alpha level. Correlations (3) were assessed by using the nonparametric Spearman correlation coefficient.

The audiotaped qualitative group interviews, which lasted about one hour each, were transcribed and analyzed, with the qualitative content analysis methods based on Mayring,³⁵ using empirically derived concepts to structure and analyze the data, especially taking into account user acceptance and factors influencing it.

Study Environment

To analyze our findings, it is important to present some background about our study wards.

Nursing management selected three of the four wards for this study. After internal discussion, the majority of nurses on all of the wards agreed to participate. Ward B volunteered to participate. On all four wards, diverse computer-based clinical application systems such as systems for patient administration, drug and meal ordering, staff scheduling, ward management, printing of stickers and reports, intranet/internet, and electronic mail have been in use for years.

Table 2 highlights some of the differences in the four study wards. Ward B was the largest ward with

Table 3 ■

Description of paper-based nursing process documentation before the introduction of a computer-based documentation system on the four study wards

	Previous paper-based nursing process documentation procedures
Ward A, Ward B	Nursing anamnesis and extensive care planning is conducted after admission of the patients. Planned tasks are documented daily. Nursing reports are usually written at least three times a day. Nursing documentation is only carried out in the ward office.
Ward C	A short nursing anamnesis and reduced care planning (containing only planned tasks) is conducted after admission of the patients. Planned tasks are documented daily. Nursing reports are usually written at least three times a day. Nursing documentation is done both in the ward office and in the patients' room.
Ward D	Nursing anamnesis and reduced care planning (containing only planning of some standardized tasks necessary for staff planning) is conducted after admission of the patients. Planned tasks are documented daily. Nursing reports are usually written at least three times a day. Nursing documentation is mostly done in the nurses' room, but also sometimes in the patients' room.

regard to beds and ward C the smallest. The highest fluctuation of patients was found on ward C (with 4.5 days), the lowest on ward A (with 20.7 days).

The documentation of the nursing process has been obligatory by law in Germany since 1985. However, not all six phases of the nursing process are documented in many areas. Our study wards varied significantly with regard to the typical procedures of nursing documentation. On wards A and B, the nursing care process had been established for several years. In contrast, on wards C and D, only parts of the nursing process have been documented. Table 3 summarizes the main differences.

Some of the nurses had prior computer experience (approximately half of the nurses stated that they were self-confident or rather self-confident with computers), but none had worked with computer-supported nursing documentation systems before the study. Table 4 shows the self-rated computer confidence.

Table 4 ■

Mean self-confidence with computers, three months before the introduction of a computer-based nursing documentation system*

	N	1	2	3	4	Mean and StdDev
Ward A	6	0	3	3	0	2.5 ± 0.5
Ward B	8	2	2	3	1	2.4 ± 1.1
Ward C	9	3	3	2	1	2.1 ± 1.1
Ward D	8	0	1	3	4	3.4 ± 0.7

*As reported by those 31 nurses on the four study wards which answered all available questionnaires, on a scale of 1 (= insecure) to 4 (= secure).

At the beginning of the study, 20 of the 41 nurses of the study wards were younger than 29 years, 11 were between 30 and 39 years, and 10 were older than 39 years.

All wards were equally equipped with computers: two in the ward office and one in an additional staff room. Equal training (2–3 hours in small groups) was provided for all nurses. On each ward, 1–3 nurses who volunteered were specially trained as key-users. In addition, all other health care professional team members (such as physicians, cotherapists, and social workers) received an introduction to PIK and were provided with an account. To achieve data integration and to enable the exchange of administrative patient data, the software had an interface with the communication server of the Heidelberg hospital information system.

Computer-based nursing documentation systems allow the storage of predefined problems, goals, tasks, and care plans to support efficient nursing care planning. Before the introduction of PIK, the wards organized the coordinated development of these items. Before the introduction, about 36 psychiatric care plans, 23 pediatric care plans, and 12 dermatological care plans were prepared.

Course of the Study

The computer-based nursing documentation system was introduced as planned. We conducted the study according to the study plan. Overall, approximately 70 nurses, who worked with the nursing documentation system during the course of the study, received the questionnaire. Fifty-six of them (80%) participated in the study and answered at least one questionnaire.

The return ratio of the questionnaires (number of questionnaires in relation to number of staff working on the wards at this point of time) was 82% for the first questionnaire, 86,5% for the second questionnaire, and 90,2% for the third questionnaire. Overall, 119 questionnaires were returned. Because of the high staff fluctuation, only 23 nurses answered all three questionnaires, 17 nurses answered two questionnaires (including the staff of ward B, which received only two questionnaires), and 16 nurses answered one questionnaire. In addition, 3–4 nurses from each ward were interviewed as a group around the time of the third questionnaire.

Data analysis took into account only those nurses who answered all three questionnaires to avoid bias due to staff changes. On ward B, no questionnaire was handed out 3 months after the introduction for organizational reasons. From this ward, therefore, only two questionnaires are available, and only nurses who answered both were included in data analysis. Overall, 23 nurses from wards A, C, and D (who answered all three questionnaires) and 8 nurses from ward B (who answered the two available questionnaires) were included in the analysis, making a total of 31 nurses (compare Figures 1–3).

Table 5 presents the self-reported daily usage of PIK for all four wards. It was mostly between one and two hours per day. The nurses who answered all of the questionnaires judged their self-confidence with PIK as rather high (see Table 6).

Results

We will start with the results in regard to the five study questions and discuss the interesting differences that we found.

1. To what extent is there a change in user acceptance of the nursing process before, during, and after the introduction of a computer-based nursing documentation system?

A mean acceptance score for each nurse was calculated (1 = minimum, 4 = maximum acceptance) based on the 18 items used from the questionnaire from Bowman.²² Afterward the mean scores were calculated for each ward. Only nurses who answered all available questionnaires were included. Overall, complete data are available from 31 nurses. Figure 1 presents the mean acceptance score for each ward for each of the three measurement points. It shows rather stable acceptance scores on three wards, but a heavy decrease on ward C.

Table 5 ■

Mean daily usage of PIK in hours, as reported by the nurses on the four study wards who filled out both the second and third questionnaires*

	N	Second questionnaire	Third questionnaire
Ward A	6	0.7 ± 0.4 h [†]	1.0 ± 0.7 h
Ward B	14	—	1.9 ± 1.0 h
Ward C	9	1.4 ± 0.4 h	1.1 ± 0.3 h
Ward D	7	1.4 ± 1.6 h	1.3 ± 0.8 h

*Second = during introduction, third = after introduction of a computer-based nursing documentation system.

[†]It should be mentioned that on ward A, during the second questionnaire, only half of the patients were documented with PIK (the others were paper-based), because of the randomized study design on this ward at this point of time.¹² To get a comparable number, the given figure should be approximately doubled.

Table 6 ■

Mean self-confidence with the computer-based nursing documentation PIK, as stated by the nurses on the four study wards which filled out both the second and third questionnaires*

	N	Second questionnaire	Third questionnaire
Ward A	7	3.0 ± 0.6	3.6 ± 0.5
Ward B	14	—	3.4 ± 0.5
Ward C	9	3.1 ± 1.1	3.6 ± 0.5
Ward D	9	3.7 ± 0.7	3.8 ± 0.4

*Second = during introduction, third = after introduction of a computer-based nursing documentation system, on a scale of 1 (= insecure) to 4 (= secure).

The Friedman test showed significant differences in the three scores on ward C. Using the Wilcoxon test, we found that on ward C the differences between the first and second questionnaires were significant ($p < 0.01$). The differences between the second and third questionnaire were also significant ($p < 0.05$).

Overall, we found rather high initial acceptance scores on all wards before the introduction of the computer-based documentation system. In the psychiatric wards (A and B), where the nursing process was nearly completely documented, the initial acceptance scores were not much higher than on the somatic wards (see Figure 1). This result is partly different from reports in the literature. Using the same questionnaire, Bowman²² found a mean value of 2.5 on a ward just introducing the nursing process and 3.3 on a ward that was experienced with the nursing process ($n = 74$) (reducing the

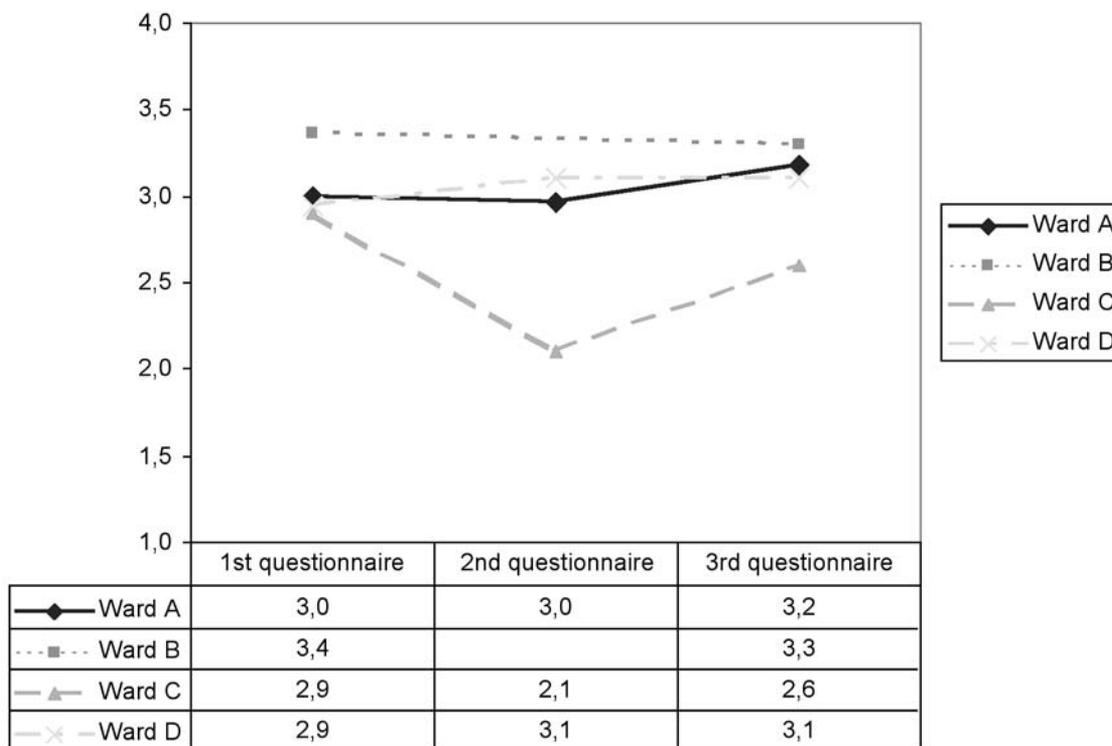


Figure 1. Median acceptance scores of the nursing process (1 = minimum, 4 = maximum) on the four study wards for each of the three measurement points (first = before introduction second = during introduction, third = after introduction of a computer-based nursing documentation system). Only the 31 nurses who answered all available questionnaires are included.

5-point Likert scale to a 4-point one, to allow comparability). The rather high values on somatic wards C and D, which were inexperienced with the nursing process, are, therefore, surprising. They show quite an optimistic attitude with regard to the nursing process that the nurses had learnt at school but that had not been realized in the nursing documentation on those wards. One reason may be that the nurses already knew that a computer-based system to support nursing process documentation was going to be introduced, perhaps leading to some discussions and reflection on the topic.

The mean value did not significantly change on three of the four wards after the introduction of the computer-based documentation system. We found a slightly significant increase in the acceptance of the nursing process on ward A, shortly after the introduction of the nursing documentation system. After extending the study to four wards and to more nurses and introducing a third measurement point, we could not support those findings. We found a significant decrease in the acceptance score of the nursing process on ward C in the second questionnaire, which increased again in the third questionnaire without reaching the initial level again. Possible rea-

sons are discussed below. Obviously, in our study of a computer-based documentation system had no effect or a negative effect on the acceptance of the nursing process as a basis for nursing care.

2. To what extent is there a change in user acceptance of computers in general before, during, and after the introduction of a computer-based nursing documentation system?

A mean acceptance score for each nurse was calculated (1 = minimum, 4 = maximum acceptance) based on the 19 items of the questionnaire from Nickel.³⁰ Afterward the mean scores were calculated for each ward. Only nurses who answered all available questionnaires were included. Overall, complete data for all three questionnaires is available from 31 nurses. Figure 2 presents the mean acceptance score for each ward for each of the three measurement points. It shows rather stable acceptance scores on each ward. The Friedman test showed no significant differences in the three scores on the wards.

Overall, we did not find any changes in the acceptance scores during the study. The mean scores were rather

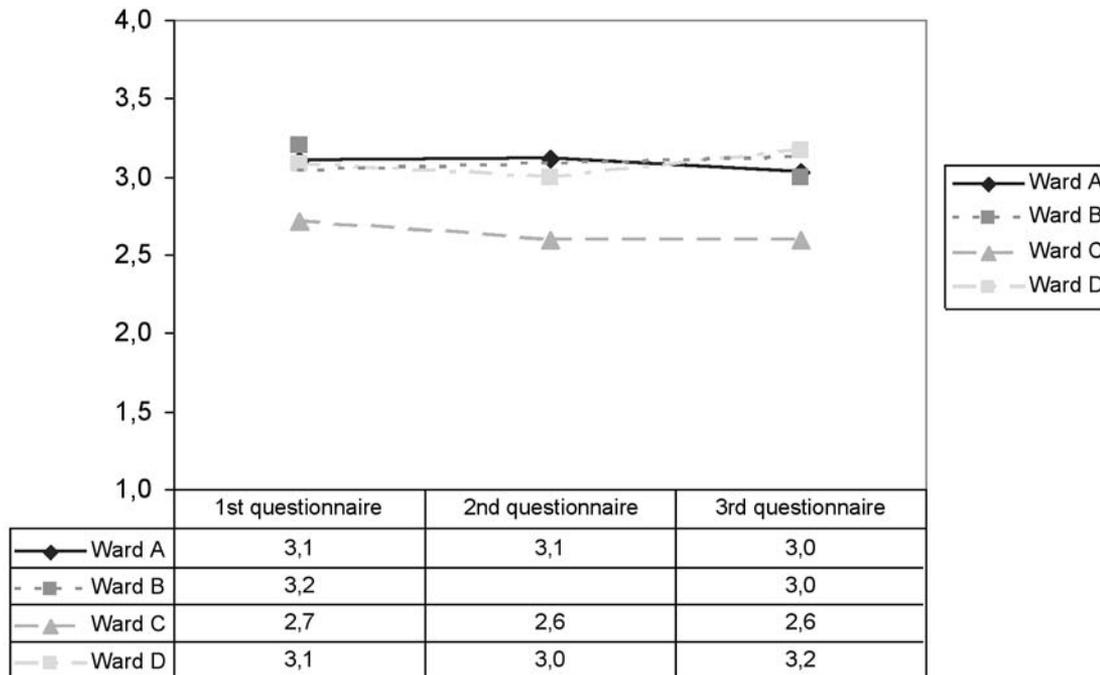


Figure 2. Median acceptance scores of computers in general (1 = minimum, 4 = maximum) on the four study wards, for each of the three measurement points (first = before introduction second = during introduction, third = after introduction of a computer-based nursing documentation system). Only the 31 nurse who answered all available questionnaires are included.

high on all wards. The constant mean scores match the results of other researchers. For example, Gilhooly³⁶ found no changes in the attitudes of nurses toward computers two months after the introduction of an intensive care unit system. Brown³⁷ found no changes in the anxiety levels of physicians toward computers three months after the introduction of a clinical information system. In general, the introduction of computers in nursing does not seem to have a measurable influence on the general acceptance of computers.

3. To what extent is there a change in user acceptance of computers in nursing before, during, and after the introduction of a computer-based nursing documentation system?

A mean acceptance score for each nurse was calculated (1 = minimum, 4 = maximum acceptance) based on the 19 items of the questionnaire from Lowry.³¹ Afterward the mean scores were calculated for each ward. Only nurses who answered all available questionnaires were included. Overall, complete data for all three questionnaires is available from 31 nurses. Figure 3 presents the mean acceptance score for each ward for each of the three measurement points. It shows stable or even rising values on three wards, and again a heavy decline on ward C. The Friedman

test showed significant differences in the three scores on ward C. Using the Wilcoxon test, on ward C the differences between the second and third questionnaire were significantly different ($p < 0.01$).

Overall, we were able to find medium-to-high acceptance scores of computers in nursing before the introduction of PIK, which continuously increased on three wards after its introduction. A difference in acceptance scores in regard to the experience with computer-based documentation can also be found in other studies. For example, using nearly the same questionnaire, Getty³⁸ found a mean value of 2.2 for users who have never used computer-based care planning (but were expected to do so in the future), and 2.8 for users working with computer-based care planning for at least two years ($n = 29$; reducing the 5-point Likert scale to a 4-point to allow comparability). The differences in our case are lower, which may be due to the fact that the users mostly worked less than one year with the computer-based documentation system.

Again, the scores on ward C declined in the second questionnaire, after which they rose again to the initial level. It is not typical to find decreasing acceptance scores after the introduction of a new computer-

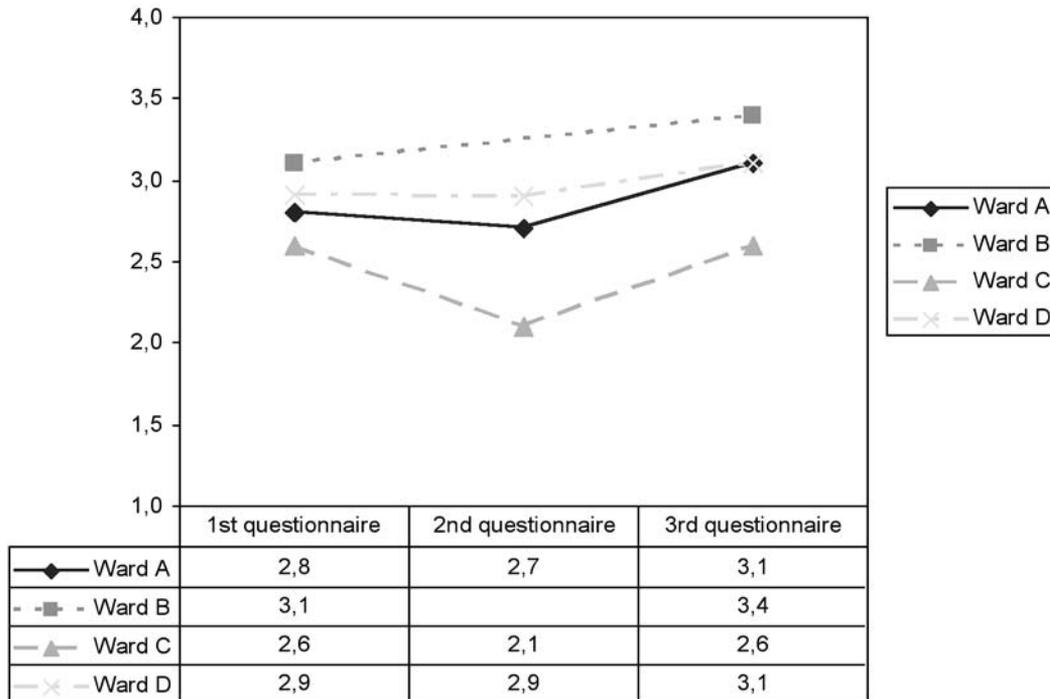


Figure 3. Median acceptance scores of computers in nursing (1 = minimum, 4 = maximum) on the four study wards, for each of the three measurement points (first = before introduction second = during introduction, third = after introduction of a computer-based nursing documentation system). Only the 31 nurses who answered all available questionnaires are included.

based system. For example, Murphy²⁴ found a significant decrease in the mean attitude scores concerning a patient care information system 3 months after its introduction.

4. What is the level of user acceptance of the computer-based nursing documentation system itself?

The general user acceptance of PIK was medium to high. The majority of all nurses (21 of 27 nurses) stated in the second questionnaire that they wanted to continue to work with PIK in the future. This number increased in the third questionnaire (38 of 43 nurses). Table 7 shows the details. Statistical analysis showed significant differences between wards C and D in the second questionnaire, and between wards B and C as well as C and D in the third questionnaire (all $p < 0.05$). Overall, the acceptance scores are quite high and rising on three wards. Again, on ward C the scores are low and stayed low.

The detailed questions on the effects of PIK also revealed some interesting differences among the four study wards (especially between ward C, which showed lowest scores, and the other three wards). Table 8 shows some of these differences.

Based on the mean of 19 items from the questionnaire from Chin³² and Ohmann,³³ overall PIK acceptance scores for each nurse and for each ward were calculated (1 = minimum, 4 = maximum acceptance). Table 9 presents the mean overall PIK acceptance scores for each ward for both measurement points. Once again it shows the lowest values on ward C.

5. To what extent are the acceptance scores of questions 1–4 correlated? What are the factors influencing the overall user acceptance?

Using Spearman's correlation index, we analyzed the correlation among the different acceptance scores. Before the introduction of PIK, the acceptance scores of computers in general ($r = 0.58$) and of computers in nursing ($r = 0.45$) are significant positively correlated with the nurses' years of computer experience (see Table 10).

We also analyzed the correlation between the three acceptance scores before the introduction of PIK with the overall acceptance of PIK during and after its introduction. For the most part, we found significant positive correlation of the overall PIK acceptance in the third questionnaire with the initial three accept-

Table 7 ■

Mean values and standard deviation with regard to the question, "Do you want to continue working with PIK for nursing process documentation?"*

	N	Second questionnaire	Third questionnaire
Ward A	5	2.8 ± 1.1	3.4 ± 0.6
Ward B	14	—	3.6 ± 0.5
Ward C	6	2.2 ± 1.3	2.3 ± 1.2
Ward D	8	3.3 ± 0.5	3.8 ± 0.5

*As stated by the nurses on the four study wards which filled out both the second and third questionnaire (second = during introduction, third = after introduction of a computer-based nursing documentation system), on a scale of 1 (= absolutely no) to 4 (= absolutely yes).

ance scores of nursing process, computers in general, and computers in nursing. Table 10 shows the details.

Thus, we found that a high acceptance of the computer-based nursing documentation system after a longer period of use (9 months or more) is positively correlated with high initial acceptance scores of nursing process, computers in nursing, and computers in general. After 3 months of use a positive correlation was found only with the acceptance of computers in nursing. We also saw that the years of computer experience are positively correlated with both initial computer acceptance scores. Similar correlations have been found by other researches. For example, Scarpa¹⁰ found a positive correlation between computer experience and computer acceptance, and Brown³⁷ found a positive correlation between computer usage and computer attitude.

We have been interested in factors leading to the successful introduction of a computer-based nursing documentation system. The correlation indicates that the years of computer experience and the acceptance of the nursing process are strongly related to the overall acceptance of the computer-based system after 9 months. Figure 4 summarizes the relationships found among the different individual characteristics of the users of a nursing documentation system.

Further Analysis of the Reaction of Ward C

On ward C, most of the acceptance scores initially declined in the second questionnaire and increased again in the third questionnaire (see Figures 1 and 3). Beginning with high acceptance scores comparable to the other wards, the nurses on ward C seemed to have experienced great disappointment when the

Table 8 ■

Mean values and standard deviation of the effects of PIK*

	N	Second questionnaire	Third questionnaire
PIK saves time.			
Ward A	7	3.1 ± 0.4	3.0 ± 1.0
Ward B	14	—	3.1 ± 1.0
Ward C	9	1.2 ± 0.4	2.0 ± 0.7
Ward D	9	1.7 ± 0.9	2.2 ± 1.1
PIK provides a better overview on the course of patient care.			
Ward A	7	1.9 ± 0.7	2.6 ± 0.5
Ward B	14	—	2.7 ± 0.6
Ward C	9	1.0 ± 1.1	1.0 ± 0.9
Ward D	8	2.6 ± 0.7	2.2 ± 0.8
PIK burdens me in my work.			
Ward A	7	1.9 ± 0.7	1.3 ± 0.5
Ward B	14	—	1.4 ± 0.8
Ward C	8	3.3 ± 0.7	2.0 ± 1.1
Ward D	9	1.8 ± 0.8	1.2 ± 0.7
PIK makes documentation easier.			
Ward A	7	2.3 ± 1.0	3.4 ± 0.8
Ward B	14	—	3.6 ± 0.5
Ward C	8	1.6 ± 0.7	2.6 ± 1.2
Ward D	9	3.1 ± 1.2	3.3 ± 0.7

*As stated by the nurses on the four study wards which filled out both the second and third questionnaire (second = during introduction, third = after introduction of a computer-based nursing documentation system), on a scale of 1 (= absolutely no) to 4 (= absolutely yes).

nursing documentation system was introduced, both with regard to the usefulness of the nursing process and of computers in nursing. The question now becomes: Why are the findings on ward C so distinct from the others?

First of all, we can see that computer experience (see Table 4) was much lower before the introduction of the computer-based system compared with the other wards. According to Figure 4, this may explain in part why user acceptance was so low. However, could insufficient computer knowledge be the only reason for such a dramatic drop in various acceptance scores during the second questionnaire?

The introduction of the computer-based system, regarding training and support, was organized quite similarly on all four wards. The reported daily usage of the system (see Table 5) and the self-confidence with its use (see Table 6) were also fairly equal on all

Table 9 ■

Mean overall acceptance scores of PIK, as stated by the nurses on the four study wards who filled out both the second and third questionnaire*

	N	Second questionnaire		Third questionnaire	
		Mean + Std.Dev.	Median	Mean + Std.Dev.	Median
Ward A	7	2.9 ± 0.5	3,0	3.2 ± 0.5	3,2
Ward B	14	—	—	3.5 ± 0.4	3,5
Ward C	9	2.3 ± 0.5	2,5	2.9 ± 0.4	3,0
Ward D	9	2.8 ± 0.3	2,8	3.3 ± 0.4	3,3

*Second = during introduction, third = after introduction of a computer-based nursing documentation system, on a scale of 1 (= minimum) to 4 (= maximum).

wards, as well as the general acceptance of the nursing process (see Figure 1). But there is an important difference in the preconditions between the psychiatric and the somatic wards: The nursing process had been documented only partially on wards C and D (see Table 3). The introduction of a computer-based nursing documentation system increased documentation, because it forced increasingly complete documentation of all steps of the nursing process (e.g., complete care plan for each patient). Therefore, both wards complained about an increase in the amount of time needed for documentation.

However, overall acceptance was high on ward D (see Table 9). There must be further factors leading to the negative acceptance scores on ward C besides the much lower self-confidence with computers (see Table 4). To answer this question, the results of the focus group interviews were quite helpful. The analysis of these interviews points to the following factors: On ward C, documentation of nursing tasks

was carried out 24 hr/day because of the young patients (mostly infants) and their great need for care. Thus, the overall amount of documentation is much higher than on the other wards. In addition, patient fluctuation is also highest on ward C (see Table 2). However, a complete nursing anamnesis and nursing care plan must be established for each new patient, which is time-consuming and again increases the amount of documentation. Furthermore, the nurses on ward C are in an older age group. Older nurses may not have been sufficiently prepared in the theory and practice of using the nursing process. In addition, older nurses with many years of nursing experience may not have been so eager to adapt to new ways of documentation, fearing that an increased amount of time needed for documentation would reduce the amount of time for patient care.

Another difference is the number of key users. Whereas ward D had three key users, ward C had

Table 10 ■

Correlation between the three acceptance scores (nursing process, computers in general, computers in nursing) and the nurses' years of computer experience, and the overall acceptance score of the computer-based nursing documentation system PIK, during and after its introduction.

	Years of experience with computers (first questionnaire) (n = 39)	Overall acceptance of PIK during introduction (second questionnaire) (n = 27)	Overall acceptance of PIK after introduction (third questionnaire) (n = 30)
Correlation between . . .			
Acceptance of nursing process (first questionnaire)	No correlation	No correlation	Positive Correlation (r = 0.55*)
Acceptance of computers in general (first questionnaire)	Positive Correlation (r = 0.5*)	No correlation	Positive Correlation (r = 0.43+)
Acceptance of computers in nursing (first questionnaire)	Positive Correlation (r = 0.45*)	Positive Correlation (r = 0.45+)	Positive Correlation (r = 0.54*)

*p < 0.05; †p < 0.01.

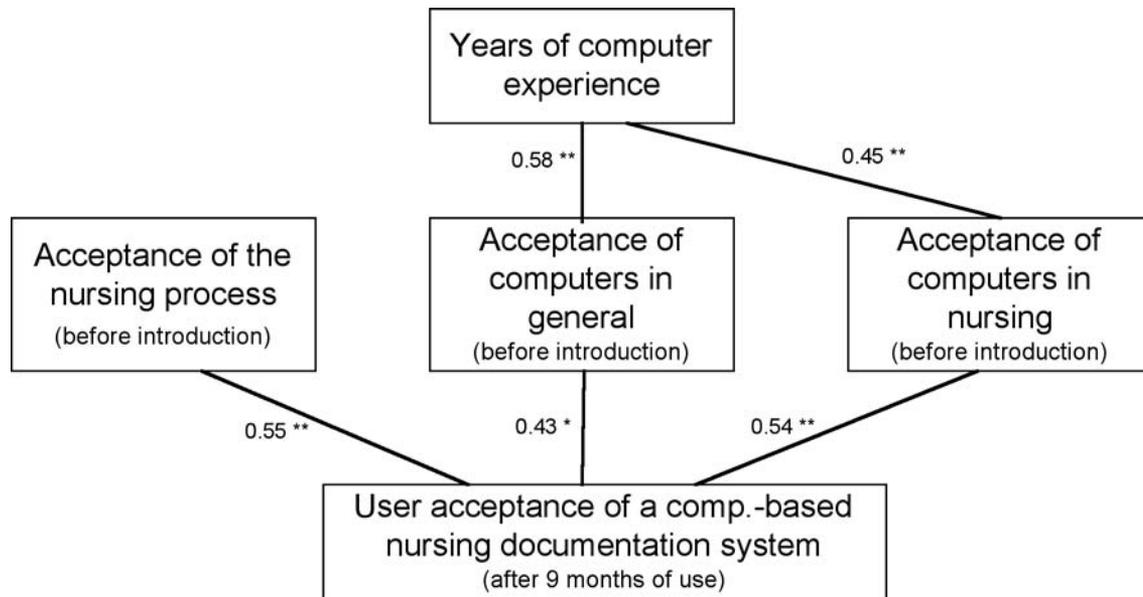


Figure 4. Correlation among years of computer experience, three acceptance scores (nursing process, computers in general, computers in nursing) before the introduction, and the overall acceptance score of the computer-based nursing documentation system PIK after 9 months of use (visualization of the results presented in Table 10). The lines indicate a positive correlation. The correlation index and the significance level (* = $p < 0.05$; ** = $p < 0.01$) for the correlation is indicated beside each arrow.

only one or two, and those key-users were not so active as on the other wards. Also, on ward C, during the introduction of the nursing documentation system, the workload was rather high because of a staff shortage. Finally, on ward C nursing documentation had previously been carried out in the patients' rooms. However, during our study, computers were installed only in the ward office. No mobile computers were available, which led to double documentation (e.g. intermediary documentation on pieces of paper), change of communication patterns (more oral communication, less written communication), and information losses.

Overall, the nurses on ward C were quite disappointed with the effects of the computer-based nursing documentation system. They questioned its usefulness. Nurses complained heavily about an increase in the amount of time needed for documentation and a poorer overview of the course of patient care; they felt burdened by the system (see Table 8). This led not only to low acceptance scores of the documentation system, but also to a heavy decline in the acceptance scores of the nursing process in general and of computers in nursing in the second questionnaire. The acceptance scores of the documentation system itself were also low (see Table 9). However, this disap-

pointment did not effect the general acceptance of computers (see Figure 2).

During the third questionnaire, the scores on ward C increased again. Obviously, the ward learned to adapt the system to its needs. For example, the first results of a documentation analysis show that the size of care plans was largely reduced during the course of the study, leading to a shorter list of tasks to be documented regularly. Organizational changes led to nurses charting not only at the end of a shift, but also during shifts. In addition, because of the transparency of their daily work, which the computer system could now demonstrate, the nurses' attitude toward nursing documentation in general also improved. The nurses also became more self-confident in using the computer, especially the keyboard. In the end, all wards, including ward C, decided to continue working with the computer-based documentation system, which is now running routinely on all four wards.

In summary, factors such as previous and changed documentation procedures (place, quantity), number and fluctuation of patients, age of nurses, and number of key users may also influence user acceptance. After some time (in our case about 9 months), a reorganization of procedures and getting used to the system can reduce problems experienced in these areas.

Discussion

As stated, we found the questionnaires that we reused from the literature of high reliability. The return rate of 80% or higher on each ward can be seen as sufficient. We do not expect a participation bias, because most of the nurses who did not participate were absent during the time of the study (e.g., on holidays or ill). To our knowledge, only one nurse explicitly refused to participate.

The validity of the questionnaires is more difficult to address. What we can see is that different questionnaires point in the same direction (e.g. rising scores on three wards, declining scores on ward C). This can be seen as evidence for validity. The results of the interviews also support the quantitative findings (especially the problems on ward C). Finally, the different acceptance scores are correlated with the final question on whether the wards want to continue with the system. All wards wanted to continue with the system and are working with it now (July 2002). Overall, although we have no absolute proof, we believe that the validity of our instruments is quite sufficient.

The evaluation situation was not stable during the course of the study. The high fluctuation of nurses reduced the number of available participants. The computer-based system PIK was steadily updated and improved in the last three years to overcome software or hardware problems or to introduce new functionality. Many of these improvements were necessary because of the increased data volume to be managed by the system; others were related more to functionality, which was not broadly used on our wards. We thus do not expect a strong influence of these changes on our acceptance scores. For example, on ward A, which started with a rather preliminary version of the system in 1998, the acceptance scores are quite similar to those of the other wards (see Figures 1 and 2).

The basic (mandatory) functionality used by the wards was similar. Some functionality could be used voluntarily (e.g., regular checking on nursing aims). We do not expect that the differences in using this voluntary functionality largely affected the acceptance scores and see them rather as consequence of acceptance rather than its predecessor.

All evaluation studies are limited in that the results are a priori valid only in the area where the evaluation took place. The question becomes whether our (quantitative) results are transferable to other departments and to other documentation systems (external validi-

ty). We think that the chosen software product PIK has functionality that is typical of a computer-based nursing documentation system and would expect similar results with other types of software. However, this cannot be proved without further studies. Compared with other wards and hospitals, our four wards seem to be quite "normal" in regard to computer experience, motivation, age, and workflow. However, four wards cannot clearly represent all possible combinations of factors. We can demonstrate, however, that in regard to the acceptance of the nursing process, our wards were representative of the overall hospital. This holds true because a broader analysis of the acceptance of the nursing process of 72 randomly selected nurses of the overall university hospital with about 100 wards,³⁹ using nearly the same questionnaire, found a mean of about 3 (of 5 points), which matches the initial scores on our four wards. Whether the results can be transferred to other hospitals can be evaluated in further studies.

This article concentrates on acceptance issues. We were motivated by literature stating that user acceptance is an important precondition, but also an indicator for system success, and we wanted to learn more about it. High user acceptance of an information system, however, does not necessarily mean that the introduction was successful or that a system works successfully. The definition of system success is quite elusive, and different criteria may be weighted differently by the different stakeholders. Delone,⁴⁰ for example, describes six main categories for success: comprising system quality, information quality, information use, user satisfaction, individual impact, and organizational impact.

Based on the quantitative questionnaires, we identified some important factors influencing user acceptance, such as computer knowledge and previous acceptance of the nursing process. This was possible because of the way in which the study was designed. When we found interesting distinctive features on ward C, we continued with a qualitative interview study. Our analysis of the reaction of ward C have thus been obtained by more explorative empirical research. We found heavy disturbances in the nursing workflow after the introduction of the computer-based system.

The findings on ward C can be well explained by the work on task-technology fit by Goodhue.⁴¹ Task-technology fit is the correspondence among task requirements, individual abilities, and the functionality of the information technology. On ward C, this fit was far from perfect, because the functionality of the com-

puter-based system did not well support nursing documentation and communication tasks. During our study, the nurses adapted their tasks and improved their computer skills, which increased the fit and reduced the problems. In addition, after the study the number of available computers as well as the number of key users increased on ward C. The results of our quantitative questionnaire study concentrated on the individual abilities of the users (e.g., computer knowledge, acceptance of nursing process), whereas the qualitative interview study pointed to the task requirements and the functionality of the system.

We saw a sharp decrease in acceptance scores on ward C. It is quite usual that the adaptation of a new computer-based system (i.e., the moving phase) takes some time. It is thus possible that on the other wards, a similar decrease may have occurred after the introduction of the computer-based systems, but was compensated for when we conducted the measurements after 3 months. However, we do not suspect this explanation, because from the other wards, no greater problems were reported during the first weeks and months.

The example of ward C shows three important points:

1. Each ward is quite unique in regard to the factors that can influence user acceptance and the overall task-technology fit as indicators of the overall system success of information technology. In this study, we were able to quantify at least some of those factors, and to identify qualitatively a few others. However, much research still needs to be done in this area to gain a complete picture of all the factors that must be taken into account for planning and introducing information technology.

2. In our case, the combination of quantitative and qualitative evaluation methods was quite useful. The quantitative questionnaires helped to analyze and quantify the influence of some previously identified factors. The qualitative interviews, in turn, helped to get hints about further factors influencing the effect. Those new emerged factors could now be investigated in further (quantitative) studies.

3. The introduction of information technology in health care offers tremendous opportunities for patient care but can also have negative effects. Some nurses on ward C stated that the system took time away from patient care. Based on our study, it is at least possible that insufficient information technology can have a direct negative effect on the patient

(e.g., time pressure leading to errors or information losses due to unavailability of information at the patient's bedside). Thus, the introduction and operation of information technology should be thoroughly monitored to improve it. A systematic assessment of health information technology is the precondition for the better support of patient care.

Conclusion

We have presented some results of the systematic, long-term evaluation of a computer-based nursing documentation system on four wards of the University Hospitals of Heidelberg, Germany, focusing on acceptance issues. The results of our quantitative questionnaire study concentrated on the individual abilities of the users, and we found that computer knowledge and previous acceptance of nursing process are significant predictors of final user acceptance. Our qualitative interview study then pointed to the task requirements and the functionality of the system as further important factors that can be explained by the theory of task-technology fit.

Our results can be used to assist the planning and introduction of computer-based nursing documentation systems. They also show the significance of systematic and long-term evaluation studies of information technology in health care in order to provide information systems that truly support (rather than hamper) health care professionals.

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