Evaluation Of Clinician Response To Wireless Technology

Charlotte A. Seckman, MSN, RN, BC
Carol A. Romano, PhD, RN, C, CNAA, FAAN
Sue Marden, MS, RN
National Institutes of Health
Bethesda, Maryland

Abstract

The purpose of this study was to investigate the safety, use and response of clinical staff to wireless technology. A convenience sample of clinical staff was surveyed using a variety of assessment tools. The environmental assessment determined there was no interference between the wireless devices and the biomedical equipment on the patient care units. Survey results indicated a high level of acceptance for the wireless technology related to perceived usefulness, perceived ease of use, impact, adoption, advantage and future need. Results indicated a strong, significant relationship between adoption and perceived usefulness (r_s=.71 p<.01; r^2_s=.50).

Introduction

Wireless systems are a type of new technology that allows the healthcare provider greater flexibility and mobility for documenting care and accessing patient information without geographic constraints. This technology utilizes a radio-based frequency system to transmit data signals without any physical connections. A wireless system is often preferred over a "wired" bedside system because it is smaller and less obstructive when interacting with patients.[1] Executive and administrative staff look to wireless technology as a way to improve patient care, save money and gain efficiencies.[1,2] But despite all these advantages, wireless technology is slowly being integrated into the healthcare setting. [2,3,4,5,6,7]

Clinicians are often challenged to seek new ways to process and manage information. Explaining user acceptance and response to new technology is an on-going issue in informatics research. Davis[8] indicated, "Performance gains are often obstructed by users' unwillingness to accept and use available systems". What makes a clinician willing to use technology has been equated with the perceived quality of the system being implemented.[9,10,11] Evaluation of characteristics that help to determine the quality of a system are often difficult to define and measure.

I. LITERATURE REVIEW

Factors that determine how well new technology will be accepted in the healthcare environment are a major concern. Empirical studies related to user acceptance of information technology or wireless systems are few. Much of the literature focused on informational topics such as "guides" on selection and potential use.

Dillon, et al[9] develop measurement instruments for evaluating technology assessment and reported acceptance of a bedside computer system in terms of ease of use, perceived usefulness, and attitude. Willson[12] reported high use of bedside systems but the focus of this study was on the user's perception and not actual use. Suggestions for interventions to increase use were related to ergonomic factors and quality of hardware. White, et al[13] also evaluated a computerized bedside information system to determine its usefulness in addressing business problems related to nursing care to include an analysis of nursing time, chart reviews, a study of unplanned overtime and satisfaction surveys. The results compared the benefits of the computerized chart over paper documentation. Steutel, et al[14] conducted a longitudinal study to examine nursing staff attitudes toward a clinical information system. Results indicated that overall the nursing staff was progressively less satisfied with the computer system over time. The authors suggest that additional studies need to be done to better understand this phenomenon.

There were no systematic studies in the literature on wireless technology that addressed safety, frequency of use, usefulness or ease of use. There were no systematic studies on wireless technology that investigated the clinical impact of use and/or predictors of adopting new technology.

Purpose of the Study

The purpose of this study was to address safety, clinical impact, and frequency of use related to wireless technology. The research questions addressed in this study were:

1. What is the result of a technical assessment of wireless technology in the clinical environment?
2. How often is the wireless technology being used?
3. What is the perceived usefulness, ease of use and impact of wireless technology?
4. What is the perceived usefulness, ease of use and impact among clinical specialties?

1067—5027/01/$5.00

II. METHODOLOGY

Design, Setting, and Sample

This was a descriptive study using a self-report survey at a 250 bed East coast clinical research hospital. Staff from a variety of clinical units comprised the volunteer, convenience sample (N=82) for this study. Seventy-four of the participants (90%) were female and eight (10%) were male. Seventy-nine registered nurses, one physician, and two clerical staff completed the surveys. The mean age of the participants was 37 years. The majority of respondents (80%) indicated no prior experience using wireless technology for documentation while fifteen respondents (18%) indicated prior experience documenting clinical care with wireless technology. Clinical research staff members were from six units that included the following areas: medical/surgical, oncology, neurology, mental health, pediatrics and outpatient care. These areas were selected based on close proximity to other units using the wireless technology, patient census and number of staff members. The location was important because this provided a means to evaluate the range of the wireless signal and potential problems related to interference from multiple or competing devices. Census and numbers of staff were considered so as to test the use of the technology in busy clinical areas. One wireless device was available on each of the study units to physicians, nurses, clerical staff, nurse practitioners and other patient care providers.

In addition, the clinical areas studied had several hardwired desktop computers available in the nurses' station. These computers connected to a local area network (LAN) and provided a variety of clinical applications for patient care including access to an electronic medical record and clinical documentation system, clinical resource materials, organizational manuals, policies and procedures, standards of care and many internet /web based resources. E-mail access was also available. A major aspect of this project was to conduct the pilot study using Mac iBook Wireless laptops that accessed all applications currently available on the hardwired devices on the local area network (LAN) thus evaluating the feasibility of a Wireless LAN and not differences in what information clinicians could access.

Procedure

The procedure for the study involved a technical assessment of the environment, development of security guidelines, user training, implementation, and completion of a self-report survey and user log. A technical assessment was conducted first to evaluate the safety of the environment and potential to support the wireless system. This assessment encompassed a review of sources of interference to detect the potential for incompatibility with biomedical devices and other environment obstacles. A frequency scan of the entire facility was conducted. Electrical leakage from the battery, battery life, range of signal coverage and security access specifications were also assessed.

Guidelines for use, security and maintenance of the wireless devices were developed and distributed to each pilot unit. Three of the units (medical/surgical, oncology and neurology) were provided with a mobile cart to secure the wireless laptop. The other three units secured the laptops at the nurses' station with a defined unlocking/removal procedure. Several unit in-services were provided on how to use the laptop, which included instructions for filling out the "use" log. A representative from each patient unit served as a liaison for issues related to the wireless laptops.

Data Collection Procedures

During the first four weeks of the pilot, participants were asked to record when, where and who used the wireless laptop on a "use" log. At the end of eight weeks, surveys were distributed to all nursing department staff on the pilot units via individual mailboxes to assess usefulness, ease of use and impact. Additional surveys were made available near the wireless laptop for non-nursing staff to respond. All received written instructions for completion and where to return information. Qualitative data was collected by the researcher through observation, interview and survey comments. Approximately 180 surveys were distributed with 82 returned (45%).

Instrumentation

Several instruments were used in this study and tested for reliability and validity. The first was *the Wireless Technology "USE" Assessment Tool* developed by the investigators to assess type of user, frequency of use and location of use via the self-report log. This tool also contained a section for comments about the technology and how it was used. The *Perceived Ease of Use and Usefulness Tool*[8], *Employee Adaptation Tool*[15] and questions related to advantage, complexity and future need were combined into one survey referred to as the Wireless Technology Pilot Questionnaire. The *Perceived Ease of Use and Usefulness Tool*[8] included ten items that rated the perceived usefulness of wireless technology and nine items that addressed the perceived ease-of-use of wireless technology. This instrument used a seven-point Likert scale for the 19 items that subjects used to rate their satisfaction. A low score reflected a negative

perception and high score reflected a positive perception. Clinical impact was assessed using the *Employee Adaptation Tool*[15]; which included five items that rated behavioral impact on job performance. This instrument used a 10-point Likert scale to assess agreement with items.

Advantage, complexity and future need were included as indicators of impact as well. It is also noted that prior work suggests these variables influence adoption.[16] Each of these variables were assessed using separate visual analog horizontal scales with a range of 0 to 10 with equal spaced numbers anchored by short phrases that depicted extreme states at each end. Adoption was measured using a one-item 7-point Likert scale to assess subject's intent to continue to use wireless technology.

Content validity was established for the Wireless Technology Pilot Questionnaire using the Index of Content Validity (CVI).[8,15] Two experts in the area of Nursing Informatics were asked to rate each item on the Wireless Technology Assessment Tool in terms of the relevance of items to responder's feelings and perceptions about the use of wireless technology for patient care support. Content validity was determined by comparing the responses. CVI was calculated at .90, which was considered acceptable.

Calculating Cronbach alpha assessed inter-item reliability for each section of the *Perceived Ease of Use and Usefulness Tool.* Cronbach alpha scores were .96 for perceived usefulness, .87 for perceived ease of use. These reliability scores are similar to those reported by Davis.[8,11] The subscale of the *Employee Adaptation Tool* was .91 for job impact. Cronbach alpha score was .94 for the entire instrument.

Data Analysis

Data were analyzed using descriptive statistics, qualitative analysis of user comments, and reported technical problems. Due to the skewness of the distributions, all data for this study were analyzed by means of nonparametric statistics.

III. RESULTS AND DISCUSSION

Technical Assessment

The environmental assessment determined there was no interference between the wireless device and the biomedical equipment on the patient care units at a frequency of 2.4 GHz. Electrical leakage from batteries was checked and none reported. Security measures were implemented and included the same encryption as used with the wired network. Restricting physical access to the devices at the unit level, appropriate password protection and securing hardware via locks were also strategies used.

Use of Wireless Technology

Clinical research staff members from six patient units reported 351 episodes of use over a four-week period. Nurses were the most frequent users of the wireless technology at 86.9%. Many other clinicians were observed using the wireless laptops without documenting on the log suggesting that the incidence of use was probably much higher than recorded. Over half the time (53%) the wireless laptops were used at the nurse station. This may have been due to the fact that the laptops were faster and more convenient than the wired desktop computers; it may also have been because the wireless laptops were the only device available at the time.

Use of the wireless laptop on rounds, in the conference room or other locations with groups occurred frequently (30%). The researcher observed numerous staff using the wireless laptop on rounds to discuss patient and research protocol progress. This activity was also under reported. Use was mostly over fifteen minutes per episode (60%). Reported use in patient rooms, compared to other locations on the patient care units, was less than six percent.

Staff comments noted that the wireless technology was easy to use, had fast access to applications and they liked the portability. Minimal technical problems and no interference with other biomedical equipment were reported. Clinicians resisted removal of the technology at the end of the pilot and indicated that patients were also requesting use of the wireless computers.

Clinical Response

Descriptive statistics for the subscales of perceived usefulness, perceived ease of use, impact and other single measure items for adoption, advantage, future need and complexity are shown in Table 1. For all variables except complexity, the higher the score the more favorable the perception of the wireless technology. These results indicate a high level of acceptance for the wireless technology. Of note is that the most frequently reported rating was the maximum favorable level on the scale. Also of interest is the consistency with which all three indicators of impact (advantage, future need and complexity) reflected favorable responses.

TABLE 1: DESCRIPTION OF VARIABLES				
Variable	**Mean**	**SD**	**Min**	**Max**
Perceived usefulness	5.8	1.09	2.5	7
Perceived ease of use	5.6	977	3.4	7
Impact	7.8	1.91	2.8	10
Adoption	6.4	.839	4.0	7
Advantage	8.3	2.19	1.0	10
Future Need	8.6	2.23	1.0	10
Complexity	2.9	2.25	1.0	10

Descriptive statistics were also applied to determine perceived usefulness, perceived ease of use and impact across the clinical specialties (Table 2). All clinical specialty scores were high for usefulness, ease of use and impact, which indicates a favorable response.

TABLE 2: CLINICAL SPECIALTIES					
Variables	**Groups**	**Mean**	**SD**	**Min**	**Max**
Perceived Usefulness	Oncology	6.3	1.01	4.0	7.0
	Med/Surg	5.2	.79	4.2	6.8
	Mental Health	5.8	.86	3.6	7.0
	Neurology	6.1	.90	4.3	7.0
	Pediatrics	5.0	1.40	2.5	6.8
	Outpatient	6.0	1.27	3.2	7.0
Perceived Ease of use	Oncology	6.2	.76	4.9	7.0
	Med/Surg	5.2	.82	3.4	6.1
	Mental Health	5.5	1.09	3.6	7.0
	Neurology	5.8	1.05	3.7	7.0
	Pediatrics	5.3	.64	4.6	6.6
	Out Patient	5.7	1.08	4.2	7.0
Impact	Oncology	8.6	1.57	6.0	10.0
	Med/Surg	6.4	1.62	2.8	8.0
	Mental Health	8.2	1.75	3.2	10.0
	Neurology	7.8	2.18	2.8	10.0
	Pediatrics	7.0	1.81	3.2	9.6
	Out Patient	8.0	1.90	4.6	10.0

Three separate Kruskal-Wallis tests were conducted to determine if there were differences among clinical specialties relative to perceived usefulness, perceived ease of use and impact. The Kruskal-Wallis test is the non-parametric alternative to the one-way ANOVA. When compared to the F test, the Kruskal-Wallis has a power efficiency of 95.5%.[17] The Kruskal-Wallis test is more powerful than the one way ANOVA when the normality of distribution assumption is violated.[18] The results of the Kruskal-Wallis test indicated that there were significant differences among the six clinical specialties with regards to perceived usefulness ($\chi^2_{K\text{-}W}$ =15.4; p = .009) and impact ($\chi^2_{K\text{-}W}$ =11.4; p =.045). There were no significant differences among the six clinical specialties with regards to perceived ease of use ($\chi^2_{K\text{-}W}$ = 8.04; p=.154). Further analysis to determine specific differences was not conducted.

The Spearman rank-order correlation (Spearman rho) was applied to measure the degree of association between adoption and perceived usefulness, perceived ease of use, impact, advantage, future need and complexity. Spearman rho is a non-parametric alternative to the Pearson product moment correlation (Pearson r). It is used when the assumptions of the Pearson r test have not been met adequately.[18] When the assumptions underlying the proper use of Pearson are met, the efficiency of Spearman rho in rejecting the null hypothesis is approximately 91% when compared to Pearson r .[17] The numeric value of Spearman rho closely approximates the Pearson r. Also, the squared value of Spearman rho is considered to be an estimate of the coefficient of determination, r^2.[18]

The results of the Spearman rho analyses are presented in Table 3. As indicated in the table, the strength of the relationship between adoption and perceived usefulness was strong and significant (r_s = .71 $p < .01$; r^2_s = .50). Perceived usefulness explained 50% of the variance in adoption scores. Though significant, the strength of the relationships between adoption and perceived ease of use (r_s = .51 $p < .01$; r^2_s = .27), advantage (r_s = .55 $p < .01$; r^2_s = .31) and future need (r_s = .52 $p < .01$; r^2_s = .28) were moderate. Perceived ease of use, advantage and future need each explained a similar amount of variance in adoption scores at 27%, 31% and 28%, respectively. Low to weak relationships were found between adoption and impact (r_s = .46 $p < .01$; r^2_s = .21) and adoption and complexity (r_s = -.33 $p < .01$; r^2_s = .11). All relationships were positive except complexity. This indicates that the more the user perceived the technology as useful, easy to use and having impact on their job the more likely the adoption to the technology. As expected, complexity negatively correlated with adoption confirming the more complex the technology the less likelihood of adoption.

TABLE 3: CORRELATIONS OF VARIABLES WITH ADOPTION		
Variable	**Spearman (r_s)**	**Variance Explained (r^2_s)**
Perceives usefulness	.711*	.50
Perceived ease of use	.515*	.27
Impact	.460*	.21
Advantage	.558*	.31
Future Need	.527*	.28
Complexity	-.331*	.11

*Correlation is significant at the .01 level (2-tailed)

V. CONCLUSION AND RECOMMENDATIONS

Use of wireless technology did not interfere with patient care and provided flexibility for clinicians. No technical barriers or interference at frequency of 2.4 GHz were found in assessed patient care areas. Clinical response was favorable and indicated acceptance and adoption of wireless technology. These results are consistent with a similar study that found ICU and CCU nurses perceived bedside computer systems easy to use and useful.[9] It is recognized that this study was limited by its small sample size, low response rate and homogeneous sample. The portability of the wireless offered advantages over bedside computers in that staff could use them on

rounds and in conference rooms. This also suggests that the use of fewer portable computers as opposed to multiple stationary bedside devices needs to be further explored.

Differences between the clinical specialties may be related to the use of a cart with the wireless device. Some units chose not to use carts. This suggests that variations in workflow process in different clinical areas may direct how new technologies are or can be used. Because the laptops were small and portable, security for the laptops was an issue. Although for this study staff were able to unlock the computers from the nurses station, locking them to desks defeated the purpose of being portable and convenient to use. The carts provided security and mobility but they could easily disappear as well. Other security methods for the hardware need to be explored.

In summary, wireless technology to support clinical information management needs is a reasonable option to bedside or stationary wired technologies. Further study is needed to compare use of wireless devices with bedside and hardwired options, and to explore the impact, need and usefulness in ambulatory care settings. Also needed is exploration of the clinical use of this technology for patients and consumers as well as for providers.

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