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COMMENTARY

Information technology for medication administration: assessing bedside readiness among nurses in Lebanon

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Abstract

Medication errors continue to be of great concern to hospitals. The use of Information technology (IT) for medication administration was recommended to assist nurses to administer medications safely, decrease the chance of medication errors, and contribute to patient safety. Such IT will be operational soon in some Lebanese hospitals. Users' readiness and acceptance to use such an IT application is crucial as it is a prerequisite for successful system implementation. This descriptive study used the Technology Acceptance Model to determine the level of nurses' readiness to use IT for medication administration in Lebanon. The sample included nurses working in three different major hospitals in Beirut. Data were collected on nurses' demographics, attitudes, perceived usefulness and ease of use of IT for medication administration. During the first 2 weeks of July, 2007, nurses manually or electronically were asked to voluntarily complete the questionnaire. Results showed that the users' attitude towards the use of the proposed IT is correlated with their perceptions on system usefulness and ease of use. Many showed a positive attitude towards system use and scored high on both perceptions. Yet around 20% of the nurses in the sample showed a negative attitude towards the use of the proposed system.

Key words: education-professional, evaluation, evidence-based practice, implementation, nursing.

Introduction

To date, Information Technology (IT) for medication administration has a far-reaching impact on the entire healthcare community ranging from decreasing the rates of medication errors and adverse drug events, to promoting patient's safety, and assisting the nurse in the medication administration process by checking the 5Rs (Right [patient, drug, dose, route and time]) at the point-of-care.

In Lebanon healthcare organisations are concerned about patient safety in an era witnessing a drastic increase in medication administration errors. Some hospitals aim to implement IT applications for medication administration to advance medication administration safety and decrease adverse drug events. Often problems arise during the implementation phase of a new IT system. Successful IT implementation in a healthcare organisation requires a preplanning stage that entails adequate preparation of the end users in order to achieve smooth system implementation. According to the literature successful system implementation requires that the end users have a positive attitude and positive perceptions of usefulness and ease of use with respect to the intended system.[1,2] Therefore, it is crucial to assess users' readiness towards the use of IT prior to system implementation.

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Background

In Lebanon several healthcare agencies are expected to have IT applications for medication administration in place in the near future. For many reasons, the shift from manual to electronic medication administration is an intimidating and expensive venture for healthcare agencies. The Food and Drug Administration estimates the cost to an average hospital of buying and implementing IT technology such as the bar coding system to be $13.7 million.[3] Moreover, not every registered nurse (RN) is enthusiastic about the use of IT for medication administration. User rejection to use the IT system can be a barrier to successful system implementation.[1,2] Many of the problems encountered when implementing IT systems are both organisational and behavioural, and may be attributed to attitudes towards the use of IT for medication administration or failure of the implementers to seek input from potential users.[4]

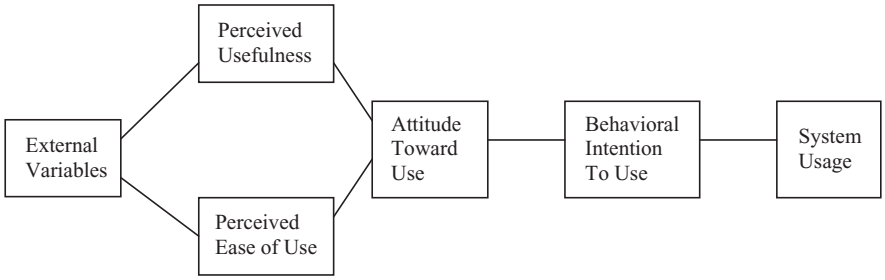

Figure 1 The Technology Acceptance Model (TAM).

The need to successfully implement IT for medication administration in an effort to decrease the rate of medication errors and optimise patients' safety has been identified internationally.[5,6] Like in many other countries, hospitals seeking accreditation in Lebanon need to respond to Joint Commission on Accreditation of Health Care Organizations requirements to improve medication use safety and minimise medical errors.

Literature review

Healthcare organisations are adopting IT for medication administration in the hope of promoting the quality of medication administration process and advancing patient safety. The user attitudes towards this technology play a crucial role in the implementation phase. Some users might reject the use of the IT while others may exhibit greater acceptance for its use. Over the past decade IT researchers have given increased attention to user attitudes towards and acceptance of a new IT, realising that user rejection to use an IT can be a barrier to successful system implementation.[7–9] Researchers have developed a variety of models based on the behavioural intention models of social psychology to predict and evaluate users acceptance of a new IT, and to positively influence their attitudes towards its use. Along with these models is the Technology Acceptance Model (TAM).[2,5]

Technology Acceptance Model

The TAM (Fig. 1) is a predictive model introduced by Fred Davis in 1986, to particularly explain user acceptance of IT. TAM offers a theoretically grounded approach to the study of IT application acceptability that can be paired with usability evaluation. It allows researchers to effectively predict and explain user behaviour across a broad range of IT users. It provides basis for tracing the impact of external factors on user's internal beliefs, attitudes and intentions.[5] TAM is supported by Fishbein and Ajzen's Theory of Reasoned Action, a model that is concerned with the determinants of intended behaviours, and is specifically meant to explain computer usage behaviour.[10–12]

Technology Acceptance Model speculates that two particular beliefs, ease of use and perceived usefulness, as primary determinants for IT acceptance.[8,13,14] Acceptance is defined as 'the demonstrable willingness within a user group to employ IT for the tasks it is designed to support'(p. 2).[15] Perceived ease of use refers to 'the degree to which a person believes that using a particular system would be free of effort'(p. 2).[15] Relevant items of perceived ease of use include: easy to learn, easy to manipulate, understandable interaction, flexible to interact with, easy to become skilful and easy to use.[7] Whereas perceived usefulness refers to 'the degree to which a person believes that using a particular system would enhance his/her job performance'(p. 2).[15] Relevant items of perceived usefulness include: accomplish a task quickly, improve performance, increase productivity, enhance effectiveness, easier to do work and useful in work.[7] Davis selected these two constructs based on the assumption that potential users make a decision whether or not to use a proposed IT by evaluating the degree to which it will help them perform their jobs better, a variable referred to as perceived usefulness; or by identifying the amount of effort needed to learn how to use the IT, this variable is referred to as perceived ease of use and is the second variable that influences people's acceptance to use IT.[5,7]

Additionally, TAM assumes that IT usage is determined by user's behavioural intention, which is determined by user's attitude towards using the IT.[5] User's attitude towards using IT is defined as 'the degree of evaluative affect that an individual associates with using the target system in his or her job'(p. 6).[12] It describes the feelings of favourableness or unfavourableness towards the system. The attitude towards using IT is a function of the two beliefs, perceived usefulness and perceived ease of use. The individual's attitude and internal beliefs are, in turn, influenced by various external factors such as: system's technical design characteristics,[2,16] user involvement in system development,[17] the nature of the implementation process,[18] and cognitive style.[19]

The Bar Coding Medication Administration system: IT of choice

The Bar Coding Medication Administration (BCMA) technology has evolved to act as a point-of-care safety system that looks out for potential errors and safeguards the medication administration process where none previously existed.[9,20,21] The system can be mainframe-based, with laptops or computers on wheels used as the point-of-care devices. The software can be accessed from any networked terminal in the hospital. Only legitimate users can have access to the system through special passwords. Bar code scanners are connected to each computer to scan medications and wrist-

bands. All computers communicate real-time via a wireless network. The information will be current because it will be real-time rather than gathered and downloaded. The software will interface with pharmacy software to validate and display medication orders. The physician order entry software will interface directly with the pharmacy software and the ordered drugs will come straight from the pharmacy.[20]

Upon scanning the patient's wristband, the nurse can access the list of active medication orders for the patient. A bar code reader scans each medication. Then the system will validate whether the medication is ordered timely and in the correct dosage.[21,22]

The Veterans Affair Medical Center at Colmery-O'Neil reported a decrease in medication errors after the implementation of a BCMA system. In 1993 and with the use of the manual medication administration system the reported error rate was 0.0217% (21.7 incident reports for each 100 000 units of medication administered). In 2001 and with the use of the BCMA the error rate dropped to 0.003% (3.0 incidents reports for each 100 000 units of medication administered). Errors caused by administering the wrong medication to a patient decreased by 75.47%, errors caused by administration of the wrong dose decreased by 61.97%, administering medication to the wrong patient decreased by 93.48%, administering medication at the wrong time decreased by 87.41%, and there was a 70.34% decrease in missing to administer medication to patient.[23] This leads us to agree that a BCMA system is the IT of choice for a safer medication administration process.

Nurses' attitude towards the use of IT for medication administration

Studies assessing nursing satisfaction showed that 97% of nurses' users of IT technology for medication administration agreed that the system decreased the risk for medication errors.[24] Further studies showed that nurses overall satisfaction increased 0.3 points on a 5-point Likert scale a year after using the system.[25] Other studies found that nurses showed dissatisfaction with the system when they faced problems generated with IT use.[26,27] The most prominent problem was lack of system flexibility.[28] This made some nurses consider the IT to be ineffective or inefficient, and started to bypass the required steps in using the system which defeated its purpose.[28–30]

Methodology

Aim of the study

The purpose of this study is to determine the acceptance level of the potential users with respect to using IT for medication administration in Lebanon.

Armed with knowledge of nurses' attitudes and perceptions towards the ease of use and usefulness of IT for medication administration, implementers will be able to predict potential users' rejection rate to system use, and will shed light on certain system implementation barriers which in turn will help to produce better IT implementation guidelines. Moreover, it will help system designers and researchers to develop better methods for improving technology design, for evaluating IT systems and for predicting how users will respond to new technology.[1]

Research questions

The research questions addressed in this study are:

1. What are the nurses' attitudes towards the use of IT for medication administration?
2. What are the nurses' perceptions regarding ease of use of IT for medication administration?
3. What are the nurses' perceptions regarding usefulness of IT for medication administration?
4. What are the effects of previous experience of IT use in clinical practice on nurses' attitudes and perceptions?
5. Is perceived ease of use of IT for medication administration positively related to nurses' attitudes towards the use of that IT?
6. Is perceived usefulness of IT for medication administration positively related to nurses' attitude towards the use of that IT?
7. Is perceived ease of use of an IT system a more important determinant of users' attitudes towards the use of that IT system than perceived usefulness?

The use of the TAM will help to determine and clarify the different variables in question.

Design and sampling

The research study is a descriptive design to assess RNs' attitudes towards the use of IT medication administration applications in the clinical setting, and to examine factors that may influence nurses' attitudes and the implementation of the IT medication administration system. The study was conducted in three major hospitals in Beirut. These three hospitals were chosen as they are planning to deploy IT for medication administration application in the near future. A total of 300 RNs working in the three hospitals at the time the data were collected were invited to voluntarily participate in the survey. The sampling method was convenience sampling of all RNs who are the potential users of IT for medication administration in the three selected hospitals.

Development of the study measure

The author developed a 29-item survey instrument that contained instructions asking the respondents rate their perceived ease of use, perceived usefulness and attitude towards using IT for medication administration. The questionnaire began with 12 demographic questions that identified the RN work place (labeled as Institution-A, Institution-B and Institution-C), nursing area (open, critical care), age group (<30 years, or ≥30 years), gender (male, female), education background (Baccalaureate Technique (BT)/Diploma, Bachelor of Science in Nursing (BSN)/Technique Superior in Nursing (TS)/License Technique in nursing (LT), or Masters degree (MS)), years of nursing experience (<3 years, or ≥3 years), participant's previous involvement in any medication errors (Yes, No), participant's usage of any clinical information system (list any?), level of computer skills (poor to average, good, excellent), participant's exposure to Nursing

Informatics concepts(Yes, No), and whether the participants think that they might become involved in a medication error in the future because of using the manual medication administration process(Yes, No, and Why?); followed by six items measuring nurses' perceived usefulness, six items measuring their perceived ease of use and five items measuring their attitudes towards the use of IT.

Questions on nurses' perceived IT usefulness and ease of use were developed by the author based on the items identified by Davis in his Model.[2] Six items on usefulness: (i) work more quickly; (ii) improve job performance; (iii) increase productivity; (iv) effectiveness; (v) makes job easier; and (vi) usefulness were used to develop six questions to assess nurses' perceived IT usefulness; another six items on ease of use: (i) easy to learn; (ii) controllable; (iii) clear and understandable; (iv) flexible; (v) easy to become skilful; and (vi) easy to use;[2] were used to develop six questions to assess nurses perceived ease of IT use.

Nurses' perceived usefulness and ease of use of IT for medication administration were assessed using the 12 mentioned items measured on a 5-point Likert scale, ranging from strongly agrees to strongly disagree. A positive perception on the usefulness of the proposed IT is indicated by higher scores of the scale and a negative perception is indicated by lower scores. A positive perception on ease of use of the proposed IT is indicated by higher scores of the scale and a negative perception is indicated by lower scores.

Attitude towards using IT was measured by the five pairs of standard 7-point semantic differential rating scales as suggested by Ajzen and Fishbein for operationalising attitudes towards behaviours;[14] All things considered, my using IT for Medication administration in nursing practice is: good/bad, wise/foolish, favourable/unfavourable, beneficial/harmful and positive/negative, on a 7-point scale ranging from 1 (bad, foolish, unfavourable, harmful, negative) to 7 (good, wise, favourable, beneficial, positive). The instrument asked participants to rate the five items according to how they feel about using an IT application for medication administration by making a check mark in the place that best describes their opinion. Higher scores on the scale indicate a positive attitude of the potential user towards using the proposed IT in the future.

Validity and reliability of the questionnaire

The scales were reviewed by two experts for face and content validity. The reviewers' comments were integrated in the revised questionnaire. Construct validity was assessed by factor analysis which was done with the principle component extraction method and varimax rotation.

All six items of the domain usefulness loaded on one component with the minimum loading for item number 3 (loading = 0.66), and the maximum loading for item number 2 (loading = 0.86). The Cronbach's α for the six items was (0.88).

As for the second domain 'ease of use', the items loaded on two components. The items (#1, 3, 4 and 5) loaded on one component with loadings varying from 0.71 to 0.80. The remaining two items (#2 and 6) loaded on the second component with loadings equal to 0.87 and 0.88. Nonetheless, the Cronbach's α for the six items was equal to 0.73, and one component was used for the six items on ease of use.

Items for the attitude domain loaded on a single component with loadings from 0.87 to 0.93. The Cronbach's α for these items was equal to 0.95.

Sample and procedures

Approval from the administration of the three hospitals and the American University of Beirut institutional review board were secured. Then the investigator approached the nursing directors at the three institutions and asked them to invite their current RNs to voluntarily participate in the study. A contact person for each hospital was designated who would be responsible for distributing and collecting the questionnaires. A cover letter prepared by the investigator was sent with the questionnaire describing the goal of study, name of the contact person, time frame for completing and returning the questionnaire and the procedure to be followed. This provided a sample of 276 nurses who are potential users of the proposed IT in the three institutions. Participation in the study was voluntary and nurses were assured that their responses are anonymous.

Data analysis

Descriptive statistics were used to analyse all items on the questionnaire. All statistical analyses were performed with the statistical software programme SPSS.

Pearson correlations were used to examine the relationship among the three domains. Assessment for mean differences was performed and the standardised difference in means was used to evaluate the bivariate associations of the general sample characteristics with the domain scores. Multivariate associations were evaluated using multivariate regression models and goodness of fit was assessed using the *R*-square. All analyses were carried at the 0.05 significance levels.

As for the first open ended question on participant's previous use of any IT in clinical nursing practice, a listing of all the answers was used to identify 10 categories. The frequencies of the identified categories were calculated (Table 1).

As for the second open ended question on reasons for the perception of becoming involved in medication administration error with the use of the manual medication administration process, a listing of all mentioned reasons was used to identify 12 mentioned reasons. The frequencies of the identified reasons were calculated (Table 2).

Results

The general characteristics of the 276 participants are summarised in (Table 3), more details are found in Table 1, with respect to participants' previous experience with IT use in clinical practice. Table 2 lists the reasons reported by the participants for perceiving self-involvement in medication error (ME) with the use of manual medication administration process.

Table 1 Use of IT in clinical practice

	Total	%
Haemodynamic monitoring	64	79.01
Documentation	48	59.26
Medication order	48	59.26
X-ray	42	51.85
Lab data	38	46.91
Management/admission	35	43.21
Patient acuity	29	35.80
Inventory	21	25.93
Literature review	20	24.69
CAI-patient	2	2.47
	81	100

CAI, Computer assisted instraction.

Table 2 Reasons for perceiving self involvement in medication administration error due to manual process

	Total	%
Wrong route	6	4.29%
Wrong patient	9	6.43%
Wrong medicine	9	6.43%
Wrong dose	15	10.71%
Wrong time	8	5.71%
Wrong transcribing	28	20.00%
Poor handwriting	34	24.29%
High nurses workload	12	8.57%
Wrong documentation	21	15.00%
Distraction	5	3.57%
Lack of needed information to administer meds	7	5.00%
To err is human	31	22.14%
	140	100%

The computed domain scores (Table 4) were summarised as follows: usefulness of IT for medication administration had a mean and SD of 3.81 $\pm$ 0.71 and with a min = 1.17 and a max = 5.00, ease of use of the IT had a mean and SD of 3.44 $\pm$ 0.58 and a min = 2.00 and a max = 5.00, and the attitude towards IT use had a mean and SD of 5.44 $\pm$ 1.18 with a min = 1.00 and a max = 7.00.

The correlation coefficients between the computed scores are reported in a two-dimensional correlation matrix (Table 5). All three domains were significantly correlated with one another ($P < 0.01$ for all). The strongest correlation was for usefulness and attitude ($r = 0.655$) followed by ease of use and attitude ($r = 0.409$), and usefulness and ease of use ($r = 0.361$).

The bivariate association of the general characteristics with the domain scores (Table 6) showed that ease of use was affected by institution ($P = 0.000$), age ($P = 0.015$), level of education ($P = 0.008$), level of computer skills ($P = 0.000$), exposure to Nursing Informatics (NI) ($P = 0.066$), and fear of becoming involved in ME ($P = 0.005$). Per cent differences in scores are shown in Table 7. Nurses working at Institution-A scored 0.7 standard deviations higher than those at Institution-B, and 0.6 standard deviations higher than those

Table 3 General characteristics of the participants

	n	%
Gender		
Males	66	23.9
Females	210	76.1
Total	276	100.0
Age groups		
20–29	227	82.2
30–39	38	13.8
40–49	6	2.2
50 and above	5	1.8
Total	276	100.0
Education		
BT/Diploma	28	10.1
BSN/TS/LT	227	82.2
Masters	20	7.2
Others	1	0.04
Total	276	100.0
Years of service (years)		
<3	133	48.2
3–6	72	26.1
>6	71	25.7
Total	276	100.0
Institution working at		
Institution-A	156	56.5
Institution-B	82	29.7
Institution-C	38	13.8
Total	276	100.0
Nursing Unit working on		
Open unit	155	56.2
Critical care	121	43.8
Total	276	100.0
Computer skills		
Null	0	0
Poor	10	3.6
Average	54	19.6
Good	154	55.8
Excellent	58	21.0
Total	276	100.0
Ever used IT in clinical practice		
Yes	103	37.3
No	173	62.7
Total	276	100.0
Ever exposed to nursing informatics		
Yes	145	52.5
No	131	47.5
Total	276	100.0
Ever involved in ME		
Yes	125	45.3
No	151	54.7
Total	276	100.0
Might be involved in ME		
Yes	151	54.7
No	125	45.3
Total	276	100.0

BSN, Bachelor of Science in Nursing; BT, Baccalaureate Technique; LT, License Technique in nursing; ME, medication error; TS, Technique Superior in Nursing.

Table 4 Summary statistics of the computed domains

	Mean ± SD	Median	Min	Max
Usefulness	3.81 ± 0.71	3.83	1.17	5.00
Ease of use	3.44 ± 0.58	3.50	2.00	5.00
Attitude	5.44 ± 1.18	5.70	1.00	7.00

Table 5 Correlation among the domain scores

	Usefulness	Ease of use	Attitude
Usefulness	1.00	0.361**	0.655**
Ease of use.		1.00	0.409**
Attitude			1.00

**Correlation is significant at the 0.01 level (2-tailed).

Table 6 Means and standard deviation of the domain scores by sample characteristics. Bivariate association of the general characteristics with the domains scores

	Usefulness	Ease of use	Attitude
Institution			
Institution-C	3.4 ± 0.66	3.3 ± 0.47	5.0 ± 1.27
Institution-B	3.7 ± 0.71	3.2 ± 0.52	5.1 ± 1.22
Institution-A	4.0 ± 0.67	3.6 ± 0.59	5.7 ± 1.08
P-value	0.000	0.000	0.000
Age (years)			
20–29	–	3.4 ± 0.57	–
≥30	–	3.6 ± 0.61	–
P-value	NS	0.015	NS
Education			
BT/diploma	–	3.3 ± 0.58	–
BSN/TS/LT	–	3.4 ± 0.56	–
Master	–	3.8 ± 0.73	–
P-value	NS	0.008	NS
Years of experience (years)			
<3	–	–	5.3 ± 1.26
≥3	–	–	5.6 ± 1.08
P-value	NS	NS	0.019
Computer skills			
Poor to average	3.6 ± 0.68	3.4 ± 0.52	5.2 ± 1.16
Good	3.9 ± 0.66	3.3 ± 0.51	5.4 ± 1.10
Excellent	3.9 ± 0.84	3.8 ± 0.67	5.8 ± 1.33
P-value	0.013	0.000	0.018
Exposure to NI			
Yes	3.9 ± 0.66	3.5 ± 0.59	5.6 ± 1.02
No	3.7 ± 0.75	3.4 ± 0.57	5.2 ± 1.30
P-value	0.045	0.066	0.009
Might be involved in ME			
Yes	4.0 ± 0.66	3.5 ± 0.60	5.6 ± 1.1
No	3.6 ± 0.70	3.3 ± 0.55	5.2 ± 1.2
P-value	0.000	0.005	0.001

BSN, Bachelor of Science in Nursing; BT, Baccalaureate Technique; LT, License Technique in nursing; ME, medication error; NI., Nursing Informatics; TS, Technique Superior in Nursing.

at Institution-C. Nurses in their 30s and above scored 0.3 standard deviations higher than nurses in their 20s. Nurses with MS scored 0.6 standard deviations higher than those with BSN/TS/LT, and 0.86 standard deviations higher than those with BT/diploma. Nurses with an excellent level of computer skills scored 0.8 standard deviations higher than those with good computer skills and 0.7 standard deviations higher than nurses with poor to average computer skills. Furthermore, on the same item nurses exposed to NI scored 0.2 standard deviations higher than those who were not exposed. In addition, those who fear of becoming involved with ME scored 0.3 standard deviations higher than those who did not fear of becoming involved.

Moreover the bivariate association of the general characteristics with the domain scores showed that respondent's attitude was affected by institution ($P = 0.000$), years of experience ($P = 0.019$), level of computer skills ($P = 0.018$), exposure to NI (=0.009), and fear of becoming involved with ME ($P = 0.001$). Nurses working at Institution-A (Table 7) scored 1.1 standard deviations higher than those working at Institution-B, and 0.6 standard deviations higher than those working ay Institution-C. Nurses with ≥3 years of experience scored 0.3 standard deviations higher than those with <3 years of experience. Nurses with excellent computer skills scored 0.3 standard deviations higher than those with good computer skills, and 0.5 standard deviations higher than those with poor to average skills. On the same item, nurses with previous exposure to NI scored 0.3 standard deviations higher than those with no previous exposure. And finally nurses who fear of becoming involved in ME scored 0.3 standard deviations higher than those who do not fear of becoming involved.

The multivariate regression analysis (Table 8) was performed on the three domains. The determinants for the IT usefulness score were location of work (Institution-A had on average a 0.31 higher score than Institution-C), computer skills (those with good/excellent computer skills had on average a 0.183 higher score than those with average/poor skills), perceiving self becoming involved in ME (for every unit increase in perceiving self becoming involved in ME a 0.242 unit increase was reported in usefulness), ease of IT use (for every unit increase in ease of use a 0.108 unit increase was reported in usefulness), and attitude towards IT use (for every unit increase in attitude a 0.334 increase was reported in usefulness. This model had an R-square of 47.5%. The most important determinants for the ease of use score were age (those ≥30 years old had on average a 0.301 higher score on ease of use than those <30 years old), education (BSN/TS/LT had on average a 0.283 higher score than BT/diploma, and MS had on average a 0.477 higher score than diploma on ease of use), years of experience (for every unit increase in years of experience a 0.153 unit decrease was reported on ease of use), computer skills (those with excellent skills had on average a 0.359 higher score than those with average to poor skills), usefulness of IT (for every unit increase in usefulness a 0.133 unit increase was reported in ease of use), and attitude (for a 1 unit increase in attitude a 0.1 unit increase was reported in ease of use). This model

Table 7 Percentage difference and standardised difference in the means of the general characteristics with the domain scores

Variables	Difference in means	SD-average	Standardised difference in means	Difference %
Institution				
Usefulness				
Instit A with instit B	0.3	0.7	0.4	8.1
Instit A with instit C	0.6	0.7	0.9	17.6
Ease of use				
Instit A with instit B	0.4	0.6	0.7	13
Instit A with instit C	0.3	0.5	0.6	9.1
Attitude				
Instit A with instit B	0.6	0.6	1.1	11.8
Instit A with instit C	0.7	1.2	0.6	14
Age				
Ease of use				
Participants ≥30 with <30	0.2	0.6	0.3	5.9
Education				
Ease of use				
MS with BSN	0.4	0.6	0.6	11.8
MS with Diploma	0.5	0.7	0.8	15.2
Years of experience				
Attitude				
Participants ≥3 with <3	0.3	1.17	0.3	5.7
Computer skills				
Usefulness				
Excellent with Good	0	0	0	0
Excellent with 'average to poor'	0.3	0.8	0.4	8.3
Ease of use				
Excellent with Good	0.5	0.6	0.8	15.2
Excellent with 'average to poor'	0.4	0.6	0.7	11.76
Attitude				
Excellent with Good	0.4	1.2	0.3	7.4
Excellent with 'average to poor'	0.6	1.2	0.5	11.5
Exposure to NI				
Usefulness				
Exposed with non-exposed	0.2	0.7	0.3	5.4
Ease of use				
Exposed with non-exposed	0.1	0.58	0.2	2.9
Attitude				
Exposed with non-exposed	0.4	1.16	0.3	7.7
Fear of becoming involved in ME				
Usefulness				
Answered yes with No	0.4	0.68	0.6	11.1
Ease of Use				
Answered yes with No	0.2	0.575	0.3	6.1
Attitude				
Answered yes with No	0.4	1.15	0.3	7.7

BSN, Bachelor of Science in Nursing; MS, Masters degree; NI., Nursing Informatics.

had an *R*-square of 32.7%. The determinants for the attitude score were years of experience (those with ≥3 years had on average 0.261 higher score than those with <3 years), usefulness (for every unit increase in usefulness a 0.949 unit increase was reported in attitude, and finally ease of use (for every unit increase in ease of use a 0.387 unit increase was reported in attitude). The *R*-square for this model was 47.2%.

Discussion

In this study we used the TAM model in our approach to evaluate the acceptance of IT usage among potential users. We used the scale by Davis to measure the two constructs of the TAM: perceived usefulness and perceived ease of use, which are considered to be important factors in determining acceptance of IT. Additionally TAM considers user's attitude

Table 8 Multivariate regression models

Variables	Beta	± SE	*P*-value
Usefulness			
Intercept (constant)	1.014	±0.033	0.002
Institution			
➢ Institution-B vs. Institution-A	0.004	±0.077	0.955
➢ Institution-C vs. Institution-A	–0.310	±0.099	0.002
Education			
➢ BSN/TS/LT/MS vs. BT/diploma	–0.199	±0.105	0.060
Computer Skills			
➢ Good/excellent vs. 'average to poor'	0.183	±0.077	0.018
Fear of becoming involved in ME	0.242	±0.066	0.000
Ease of use	0.108	±0.060	0.073
Attitude	0.334	±0.029	0.000
$R^2 = 47.5\%$			
Ease of use			
Intercept (constant)	2.055	±0.241	0.000
Institution			
➢ Institution-B vs. Institution-A	–0.267	±0.070	0.000
➢ Institution-C vs. Institution-A	–0.124	±0.096	0.196
Age			
➢ Age ≥30 vs. <29	0.301	±0.090	0.001
Education			
➢ BSN vs. BT/diploma	0.283	±0.104	0.007
➢ MSN vs. BT/diploma	0.477	±0.145	0.001
Years of Exp			
➢ ≥3 vs. <3	–0.153	±0.067	0.024
Computer Skills			
➢ Good vs. 'average to poor'	–0.072	±0.077	0.346
➢ Excellent vs. 'average to poor'	0.359	±0.092	0.000
Usefulness	0.133	±0.056	0.018
Attitude	0.101	±0.033	0.003
$R^2 = 32.7\%$			
Attitude			
Intercept (constant)	0.006	±0.384	0.987
Years of Exp			
➢ ≥3 vs. <3	0.261	±0.104	0.012
Exposure to NI			
➢ Exposed vs. non-exposed	0.177	±0.105	0.092
Usefulness	0.949	±0.078	0.000
Ease of use	0.387	±0.096	0.000
$R^2 = 47.2\%$			

Significant at 0.05 level, all other coefficients significant at 0.001 level.
BSN, Bachelor of Science in Nursing; BT, Baccalaureate Technique; LT, License Technique in nursing; MS, Masters degree; MSN, Masters degree in Nursing; NI., Nursing Informatics; TS, Technique Superior in Nursing.

towards using a given system as a critical determinant of whether the user will truly and effectively use the IT application, where as attitude towards using IT is considered a function of the two beliefs; perceived usefulness and perceived ease of use. We used the scale by Ajzen and Fishbein to measure the user's attitude towards the proposed system.

Overall the results recommend that the TAM provided an adequate model of IT usage for the potential users in the three institutions, accounting for a reasonable proportion of the variance in level of acceptance to use the proposed IT.

More specifically, results of the computed domains revealed an overall positive perception of IT usefulness and ease of use, as well as positive attitude towards the proposed system in the three institutions, yet these results suggest that there are some significant differences in the relative influence of the determinants of IT usage. Some user characteristics were associated with the three domains in similar ways while other characteristics were associated with one domain only. User's computer skills, exposure to NI, and the perception of becoming involved in a ME in the future because of the use of the manual system, were found to influence most the user's perceptions and attitude in our system.

Nurses working in Institution-A which is in the preparatory phase for acquiring hospital accreditation and magnet certification, demonstrate the highest acceptance level of IT usage as predicted by the variables in the model among the three institutions. Nurses working in Institution-A scored (Table 7) on usefulness 8.1% higher than those in Institution-B, and 17.6% higher than those in Institution-C, also they scored on ease of use 13% higher than those in Institution-B, and 9.1% higher than those in Institution-C, in addition they scored on attitude 11.8% higher than those in Institution-B, and 14% higher than those in institution-C. Not surprisingly, nurses in Institution-A have the highest acceptance level among all participants. Knowing that Institution-A is preparing for accreditation and magnet certification, suggests that the external variable – structured training programs and continuing education sessions – targeting nurses to qualify for accreditation and magnetisation has positively influenced their perceptions and attitude, and made them sense best the actual role of the proposed IT in providing quality care and advancing patient safety that are antecedents for becoming an accredited and magnetised healthcare organisation.

Furthermore, results also suggest that there are significant differences in the relative influence of the usage depending on computer skills. The higher the computer skills the better the perceptions and attitudes exhibited towards IT usage. This is consistent with the notion that users with any IT experience can employ the knowledge gained from their prior experiences to form their intentions.[15]

Furthermore, these results also suggest that there are some significant differences in the relative influence of the determinants of usage depending on exposure to NI science. Nurses exposed to NI showed better perceptions and attitudes than unexposed nurses. This could be explained as that acquiring knowledge about the impact of technology on nursing practice and especially the role of the proposed IT in decreasing medication errors and improving patient safety have positively influenced the participants perceptions and attitude towards the system.

More importantly, results suggest significant differences in the relative influence of the determinants of usage depending on user's perception of becoming involved in ME in the future with the use of the manual medication administration process. Those who perceived of becoming involved in a ME revealed higher acceptance level than those who declined. This suggests that the awareness of the manual process flaws and the contributed MEs have a strong effect on the inten-

tion to use the particular IT in job performance to advance patient safety and improve quality care.[2]

The successful use of an IT requires the users to achieve positive attitude and positive perceptions of usefulness and ease of use towards that IT.[31] Some potential users believed that the proposed IT to is not useful enough for them in administering bedside medications although it may be easy to use and this will outweigh the benefits of usage. Whereas, other potential users believed that the proposed IT is useful, and at the same time they believed that the system can be hard to use and those showed higher intention to accept to use the proposed IT than users who considered it not useful. Furthermore, those who considered the proposed IT to be useful and easy to use showed the highest intention to use the IT, and are the most ready users to accept to use that proposed IT.

Conclusion and recommendations

It is crucial to help nurses acquire a positive attitudes and awareness of the usefulness and ease of use of IT that could play a major role in reducing medication errors and promoting patients' safety. Nurses' positive attitude, perceived usefulness and perceived ease of use will act as facilitating factors for healthcare organisations that are planning to implement IT for medication administration. Adequate preparation of end users prior to system implementation will limit system implementation barriers and may open doors for health institutions to effectively and successfully implement this technology to reach the Joint Commission 2006 goal to improve the safety of using medications.

The differences among the three groups in the in the relative influence of the various determinants of IT usage suggest alternative ways to effectively manage the system implementation phase. Based on the results of this study (47.5% of the participants in our sample reported no exposure to NI, and 24% with poor to average computer skills, and 45.3% were unable to sense the gaps of the manual medication administration process and to identify the related ME that might trap them), we recommend the following to the administrators of the healthcare organisations prior to system implementation in order to improve the acceptance level and achieve smooth and successful system implementation:

1 Consider nurses' attitudes, perceived ease of use and perceived usefulness towards the use of the proposed IT.
2 Provide NI courses, seminars or workshops targeting those not yet exposed to NI, as well as those were not able to sense the gaps of the manual medication administration process and the impact of ME. Broaden nurses' knowledge about the role of the proposed IT in promoting patient safety.
3 Facilitate access to computer labs and provide free training sessions to improve computer skills.
4 Adequately train nurses to use the proposed IT.

With these recommendations we hope to increase the acceptances rate of the proposed IT among potential users and guarantee their willingness to adopt and use that IT in their day-to-day work practice.

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