Nurses' Perceptions of Using Personal Digital Assistants in Tertiary Hospitals

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Personal digital assistants can perform multiple functions such as Internet search, documentation, calculating, and barcode scanning. This study examined nurses' perceptions of personal digital assistants used as a barcode scanner for medication administration, blood transfusions, and blood collection. A total of 236 nurses participated in the survey using the instrument developed by the researchers. The data collected were analyzed using descriptive statistics, one-way analysis of variance, and the Scheffe test. Written responses to the advantages and drawbacks of using personal digital assistants were categorized by meaning. The results showed that the nurses perceived more drawbacks than advantages in using personal digital assistants because of nonworking barcodes, prescription practice requiring additional scanning, poor interfacing between personal digital assistants and the EMR, and frequent Wi-Fi disconnection. The drawbacks resulted in delays in nursing workflow for patient care. Therefore, increasing the availability of barcode scanning for all medications applicable to personal digital assistant use, redesigning the practice of current prescriptions to eliminate additional scanning, and seamless interfacing between personal digital assistants and EMRs should be considered. This enables the nurses to use personal digital assistants more efficiently and effectively for patient care.

KEY WORDS: Barcode scanning, Device interfacing, Medication administration, Nurse, Personal digital assistants

A personal digital assistant (PDA) is a handheld device that is capable of accessing the Internet.[1] Personal digital assistants can perform multiple functions such as searching for drug interactions, laboratory values, and clinical guidelines on the Internet; calculating drug doses; scanning barcodes; sending and receiving patient data and images; and implementing point-of-care documentation.[2,3] Thus, the clinical benefits of using PDAs include increasing evidence-based practice, decreasing medication errors, and guiding nurses' clinical decision-making by making relevant information available at the point of care, as well as saving nurses' time by enabling electronic patient charting and decreasing the time that it takes nurses to research necessary information.[3,4] This handheld technology has the potential to enhance clinical workflow and improve patient safety and outcomes.[1,3]

Personal digital assistants have a barcode scanner function that works like barcode medication administration (BCMA) technology. Barcode medication administration technology identifies the barcode labeling of patients, medications, and medical records to administer the right dose of the right medication to the right patient at the right time.[5] When a BCMA device or barcode scanner is used appropriately, medication errors in healthcare settings can be reduced.[5] The process from medication prescription to administration requires a multidisciplinary approach. To systematically investigate adverse drug events, medication-use phases can be evaluated.[6] The phases are composed of five phases by which medication is given to a patient in the hospital.[6] The five phases include prescribing medication by a medical doctor, transcribing the medication into an electronic medication administration record or EHR, dispensing the medication by the pharmacy, administering the medication to the patient by a nurse, and monitoring the patient.[6] Thus, the medication-use process is complex with many steps and risk points for errors.[5] Previous studies have reported that approximately one-third of adverse drug events take place in the initial prescription phase and another third occur at the administration phase.[6,7] Because adverse drug events at the administration phase are more likely to reach the patient and, therefore, cause harm,[6] identifying the five "rights" of medication administration, which are the right patient, medication, time, dose, and route, has been historically incorporated into the nursing curriculum as the standard process to ensure safe medication administration and should be adhered to by nurses in clinical settings.[5]

There have been numerous studies on the use of PDAs by nursing students in classrooms and clinical practice.[2,3] Nursing students used PDAs to search for information such as drug reference information, clinical guidelines, laboratory standards, and medical dictionaries. They also used PDAs

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to calculate a dose, a body mass index, and risks related to diseases such as cardiac risk calculation.[2,3] Nursing students generally reported their positive experiences with using PDAs.[3] Other previous studies examined the use of PDAs by nurses at the point of care. The purpose of using PDAs by nurses was similar to that of students.[2,8–10] Nurses reported the advantages and risks associated with using PDAs. A small number of studies examined using PDAs for purposes other than the above. Personal digital assistants were used for implementing medical orders and nursing documentation[1] and, as a decision support instrument, collecting nursing-sensitive outcomes at the point of care.[11] Little research has been done on using PDAs as barcode scanners. Furthermore, there is a lack of recent studies on the use of PDAs in clinical practice. This may be due to the adoption of advanced technology such as smartphones and tablets. The tertiary hospitals involved in this study adopted PDAs with a barcode scanner function for medication administration, blood transfusions, and blood collection. The purpose of this study was to examine the nurses' perceptions of the use of PDAs interfacing with the EMR in tertiary teaching hospitals.

METHODS

Settings and Participants

A cross-sectional descriptive study design was used. The setting was two tertiary teaching hospitals including Chonnam National University Hospital with 1130 beds and Chonnam National University Hwasun Hospital with 705 beds. They adopted EMRs in 2002 and 2004, respectively, and PDAs in 2021. The PDAs interface with the EMR. A convenience sample of the nurses who used PDAs for more than 6 months in the tertiary teaching hospitals was surveyed. The participants used the PDAs for medication administration, blood transfusions, and blood collection. Although the administration of blood transfusions and blood collections was not the nurses' job, the nurses were responsible for documenting them in the EMR. The research participation advertisement and the link to the questionnaire were posted on the online text messaging system of the hospitals. The questionnaire was created in Google Forms, which is survey administration software (Google, Mountain View, CA, USA). If a nurse clicked on the link to the questionnaire, the nurse would see the information about the purpose of the study, the data collection method, the time required to complete the questionnaire, and information on anonymity and voluntary participation in the study and then would be asked to indicate her or his consent to participate in the study. The data were automatically collected into Google Sheets between July and August 2021. The participants received a coffee coupon worth five dollars as a token of gratitude for completing the questionnaire.

Measurement of Perceptions of Personal Digital Assistant Use

The researchers developed a 26-item instrument to measure the nurses' perceptions of using PDAs. This new instrument was based on the EMR quality assessment instrument developed by the researcher[12] and the perceived usefulness and ease of use instruments developed by Davis.[13] Twenty-six items were modified with a few wording changes for easy and clear understanding and reduced to 25 items according to the recommendation of three clinical nurses who had used PDAs for more than 6 months. One of the three nurses had a doctoral degree, and two had a master's degree. They were also asked to rate the content validity of the 25-item instrument. The item-level content validity index for individual items and the scale-level content validity index for the overall scale were both 1.00, indicating a very acceptable level.[14] Finally, the 25-item instrument was completed.

The 25-item instrument was composed of system quality (12 items), information quality (one item), service quality (two items), new mistakes due to using PDAs (one item), patient safety (two items), perceived usefulness and ease of use (six items), and overall satisfaction (one item). The items were rated on a 5-point Likert scale (1, strongly disagree; 2, disagree; 3, neutral; 4, agree; and 5, strongly agree). Higher scores indicated positive perceptions of PDA use. Ten negative items were scored reversely. Cronbach's α was 0.873 in this study. Lastly, to supplement quantitative data, two open-ended questions asking about the advantages and drawbacks of PDA use were included.

Characteristics of the Participants and Personal Digital Assistant Use

The demographic and clinical characteristics of the participants were collected using seven items including age, sex, level of education, position, years of nursing practice, working ward, and the average number of patients per nurse. The information on PDA use was collected using eight items including the number of training sessions on PDA use, satisfaction with training on PDA use, the average number of times a PDA was used while on duty, interference with PDA use, and problems with PDA use for injectable medications, non-injectable medications, blood transfusions, and blood collection.

Data Analysis

IBM SPSS Statistics version 25.0 (IBM Inc., Armonk, NY, USA) was used for the data analyses. The Likert-scale questionnaire responses were normally distributed with a P value of .118 in the Kolmogorov-Smirnov test. The data on the characteristics of the participants and PDA use and the Likert-scale questionnaire responses were analyzed using descriptive statistics including frequency, percentage, mean, and SD. The internal consistency reliability of the Likert-scale questionnaire was examined by computing Cronbach's α

Table 1. Characteristics of the Nurses and PDA Use (N = 236)

Category		n	%
Characteristics of the nurses			
Age, y	20s	155	65.7
	30s	61	25.8
	40s	19	8.1
	50s	1	0.4
Sex	Male	11	4.7
	Female	225	95.3
Education	Bachelor's degree	208	88.1
	Master's course	17	7.2
	Master's degree	9	3.8
	Doctoral course	2	0.8
Position	Nurse	221	93.6
	Charge nurse	14	5.9
	Unit manager	1	0.4
Years of nursing practice	<1	23	9.7
	1 to < 2	27	11.4
	2 to < 3	40	16.9
	3 to < 5	54	22.9
	5 to < 7	35	14.8
	7 to < 13	33	14.0
	13 to < 20	14	5.9
	20–28	10	4.2
Ward	Medical	86	36.4
	Surgical	73	30.9
	Pediatric	4	1.7
	Delivery room	2	0.8
	Emergency room	5	2.1
	ICU[a]	66	28.0
Average number of patients per nurse	1–5	73	30.9
	6–10	52	22.0
	11–15	59	25.0
	16–20	42	17.8
	21–25	3	1.3
	30 or more	7	3.0
PDA use			
No. trainings on PDA use	None	31	13.1
	1	127	53.8
	2	50	21.2
	3	21	8.9
	4 or more	7	3.0
Satisfaction with training on PDA use	Satisfied	49	20.8
	Neutral	133	56.3
	Not satisfied	54	22.9

(continues)

Table 1. Characteristics of the Nurses and PDA Use (N = 236), Continued

Category		n	%
Average no. times a PDA was used while on duty	No use	20	8.5
	1–2	108	45.8
	3–4	38	16.1
	5–6	27	11.4
	7–10	15	6.4
	15 or more	27	11.4
Interference with PDA use	Frequently	92	39.0
	Sometimes	114	48.3
	Rarely	30	12.7
Problems with PDA use for injectable medications	Very frequently	58	24.6
	Frequently	80	33.9
	Sometimes	46	19.5
	Rarely	52	22.0
Problems with PDA use for non-injectable medications	Very frequently	104	44.1
	Frequently	53	22.5
	Sometimes	50	21.2
	Rarely	29	12.3
Problems with PDA use for blood transfusions	Very frequently	47	19.9
	Frequently	55	23.3
	Sometimes	78	33.1
	Rarely	56	23.7
Problems with PDA use for blood collection	Very frequently	33	14.0
	Frequently	54	22.9
	Sometimes	73	30.9
	Rarely	76	32.2

[a]Includes medical, surgical, neonatal, and emergency ICUs.

coefficients. One-way analysis of variance was used to analyze differences in the Likert-scale questionnaire responses according to the characteristics of the participants and PDA use. The Scheffe test was used for post-hoc analysis. To analyze the written responses on the advantages and drawbacks of PDA use, the researchers read the responses line-by-line and divided them by meaning. Similar responses were combined into one meaning.

Ethical Statement
The study was approved by the Chonnam National University Institutional Review Board (approval number: 1040198-210624-HR-092-02). The co-researcher obtained permission for conducting the nurses' survey from the nursing departments.

RESULTS
Characteristics of the Participants and Personal Digital Assistant Use
Of the 250 participants who responded to the questionnaire, 236 participants (94.4% response rate) were included in the analysis, and 14 participants were excluded due to duplicate responses. Table 1 shows the descriptive statistics of the

participants and PDA use. More than half (65.7%) of the participants were in their 20s. Most participants were female (95.3%), a general nurse (93.6%), and had a bachelor's degree (88.1%). Years of nursing practice, working ward, and the average number of patients per nurse showed diverse distributions among the nurses. More than half of the participants received a one-time training session on PDA use (53.8%) and presented neutral satisfaction with the training session (56.3%). The most frequent use of the PDA was one or two times during working hours (45.8%), and PDA use was sometimes hampered by other things (48.3%). The participants perceived more frequent (including very frequently and frequently) problems with PDA use for injectable medications (58.5%) and non-injectable medications (66.6%) than in blood transfusions (43.2%) and blood collection (36.9%).

Nurses' Perceptions of Personal Digital Assistant Use

Table 2 shows the means and SDs of items on the nurses' perceptions of PDA use and the frequency of agree, neutral, and disagree responses. A number of PDAs sufficient for the nurses on duty to use (item 3) had the highest mean, and additional input required due to poor interfacing between the PDA and the EMR (item 8) had the lowest mean. The 13 items (items 1, 2, 5, 6, 8, 9, 11, 12, 19, 20, 21, 22, and 25) in Table 2 showed a negative response in over 46% of the participants, which showed low means of less than 2.70 points. The six items (items 3, 4, 10, 15, 23, and 24) received over 50% positive responses. About half of the participants reported that they scanned the barcodes of the patients' wristbands (item 10). Five items (items 13, 14, 16, 17, and 18) had the most neutral responses, ranging from 35% to 45% of the participants.

Table 2. Nurses' Perceptions of PDA Use

	Mean (SD)	Strongly Disagree/ Disagree	Neutral	Strongly Agree/ Agree
		n (%)		
1. Frequent technical errors or failures[a]	2.51 (0.956)	34 (14.4)	80 (33.9)	122 (51.7)
2. Frequently disconnected from Wi-Fi[a]	2.63 (1.135)	52 (22.0)	66 (28.0)	118 (50.0)
3. No. PDAs sufficient for nurses on duty to use	3.88 (1.175)	37 (15.7)	40 (16.9)	159 (67.4)
4. Barcode scanning entered immediately	3.33 (1.127)	55 (23.2)	62 (26.3)	119 (50.5)
5. No additional input required due to good interfacing between the PDA and the EMR	2.18 (1.182)	161 (68.2)	33 (14.0)	42 (17.8)
6. Presenting medication prescription changes in the EMR in real time	2.33 (1.019)	134 (56.8)	75 (31.8)	27 (11.4)
7. New mistakes associated with PDA use[a]	2.81 (1.073)	59 (25.0)	80 (33.9)	97 (41.1)
8. Additional input required due to poor interfacing between the PDA and the EMR[a]	1.90 (0.960)	15 (6.3)	38 (16.1)	183 (77.6)
9. Difficulty of manual data entry[a]	2.57 (1.126)	44 (18.7)	75 (31.8)	117 (49.5)
10. Often not scanning the identification barcode on the patient's wristband[a]	3.44 (1.196)	119 (50.5)	62 (26.3)	55 (23.2)
11. Difficult to scan barcodes on injectable medications[a]	2.20 (1.064)	29 (12.3)	51 (21.6)	156 (66.1)
12. Difficult to scan barcodes on non-injectable medications[a]	2.18 (1.041)	25 (10.6)	59 (25.0)	152 (64.4)
13. Difficult to scan barcodes on blood transfusion packs[a]	2.84 (1.048)	57 (24.1)	95 (40.3)	84 (35.6)
14. Difficult to scan barcodes on blood collection tubes[a]	2.93 (1.087)	71 (30.1)	83 (35.2)	82 (34.7)
15. Helpful for reducing or preventing medication accidents	3.80 (1.104)	29 (12.3)	52 (22.0)	155 (65.6)
16. Allowing partial modification of prescriptions in the PDA to be the same as in the EMR	2.89 (1.056)	76 (32.2)	100 (42.4)	60 (25.4)
17. The helpdesk promptly handles requests for help with PDA use	2.97 (0.998)	65 (27.6)	107 (45.3)	64 (27.1)
18. The administrative and nursing departments are supportive of PDA use	2.91 (1.035)	80 (33.9)	90 (38.1)	66 (27.9)
19. Making it easy to do tasks related to PDA use	2.62 (1.118)	109 (46.2)	73 (30.9)	54 (22.8)
20. Tasks related to PDA use finished quickly	2.36 (1.092)	133 (56.4)	66 (28.0)	37 (15.7)
21. Making it effective to do tasks related to PDA use	2.61 (1.134)	113 (47.8)	72 (30.5)	51 (21.6)
22. Useful	2.66 (1.191)	110 (46.6)	64 (27.1)	62 (26.3)
23. Easy to learn	3.72 (1.002)	24 (10.1)	71 (30.1)	141 (59.8)
24. Easy to use	3.45 (1.049)	44 (17.8)	76 (32.2)	118 (50.0)
25. Satisfied with PDA use	2.62 (1.114)	112 (47.5)	75 (31.8)	49 (20.7)

[a]Reversely scored.

Differences in the Nurses' Perceptions of Personal Digital Assistant Use

Table 3 shows significant differences in the perceptions of PDA use regarding satisfaction with training on PDA use, the average number of times a PDA was used while on duty, interference with PDA use, and problems with PDA use for injectable medications. The post-hoc test showed differences between the subgroups. The subgroup satisfied with training on PDA use had the most positive perception of PDA use, followed by the neutral satisfaction subgroup and then the dissatisfied subgroup. The subgroups using a PDA three times or more had more positive perceptions of PDA use than the subgroup that never used a PDA. The subgroup that rarely experienced interference with PDA use showed

Table 3. Differences in the Nurses' Perceptions of PDA Use

		Perceptions of PDA Use			
		Mean (SD)	F	P	Scheffe Post-hoc Test
Satisfaction with training on PDA use	Satisfied (a)	3.25 (0.504)	31.495	<.001	a > b > c
	Neutral (b)	2.78 (0.458)			
	Not satisfied (c)	2.50 (0.512)			
Average no. times a PDA was used while on duty	No use (a)	2.36 (0.496)	5.472	<.001	c, d, e, f > a
	1–2 (b)	2.75 (0.513)			
	3–4 (c)	2.93 (0.421)			
	5–6 (d)	2.90 (0.574)			
	7–10 (e)	3.01 (0.536)			
	15 or more (f)	3.04 (0.583)			
Interference with PDA use	Frequently (a)	2.46 (0.504)	51.208	<.001	c > b > a
	Sometimes (b)	2.97 (0.404)			
	Rarely (c)	3.28 (0.454)			
Problems with PDA use for injectable medications	Very frequently (a)	2.79 (0.590)	5.108	.002	d > b
	Frequently (b)	2.68 (0.511)			
	Sometimes (c)	2.82 (0.520)			
	Rarely (d)	3.04 (0.475)			
Years of nursing practice	<1 (a)	3.19 (0.461)	2.406	.022	a > g[a]
	1 to < 2 (b)	2.87 (0.378)			
	2 to < 3 (c)	2.74 (0.534)			
	3 to < 5 (d)	2.79 (0.568)			
	5 to < 7 (e)	2.73 (0.567)			
	7 to < 13 (f)	2.80 (0.584)			
	13 to < 20 (g)	2.57 (0.346)			
	20–28 (h)	2.88 (0.640)			
Average no. patients per nurse	1–5 (a)	2.76 (0.539)	3.914	.002	b, c, f > e[a]
	6–10 (b)	3.04 (0.487)			
	11–15 (c)	2.77 (0.520)			
	16–20 (d)	2.72 (0.561)			
	21–25 (e)	2.01 (0.602)			
	30 or more (f)	2.85 (0.347)			
No. trainings on PDA use	None	2.78 (0.599)	2.902	.023	No difference between the subgroups
	1	2.75 (0.521)			
	2	2.81 (0.535)			
	3	3.07 (0.377)			
	4 or more	3.26 (0.739)			
Problems with PDA use for non-injectable medications	Very frequently	2.74 (0.546)	3.151	.026	No difference between the subgroups
	Frequently	2.73 (0.542)			
	Sometimes	2.98 (0.534)			
	Rarely	2.93 (0.455)			

[a]Not significant in the Scheffe test.

the most positive perception of PDA use. The subgroup experiencing rare problems with PDA use for injectable medications had a more positive perception of PDA use than the subgroup experiencing frequent problems with PDA use. There were significant differences in the perceptions of PDA use according to the years of nursing practice, the average number of patients per nurse, the number of training sessions on PDA use, and problems with PDA use for non-injectable medications. However, in the post-hoc analysis, there were no significant differences between the subgroups. There were also no differences in the nurses' perceptions of PDA use according to the other demographic and clinical characteristics of the nurses.

Advantages and Drawbacks of Personal Digital Assistant Use

Table 4 shows the advantages and drawbacks of using PDAs. The biggest advantage of PDA use perceived by the nurses was accurate patient identification (96.6%). The second most

Table 4. Advantages and Drawbacks of PDA Use (N = 233)

PDA Use (Number and % of the Nurses Who Responded)
Advantages
Accurate patient identification (225, 96.6%)
Medication accidents prevented and reduced (51, 21.9%)
Blood transfusion accidents prevented and reduced (11, 4.7%)
Acting-check input[a] automatically completed (11, 4.7%)
Drawbacks
Barcode scanning not working properly (97, 41.6%)
for non-injectable drugs such as pills, capsules, powdered medicine, liquid medicine, ointment, patch, and psychotropic drugs (38, 16.3%)
for normal saline for mixing with other drugs such as antibiotics (34, 14.6%)
for medications additionally prescribed (6, 2.6%)
for curved surfaces such as ampules, vials, and infusion bags (5, 2.1%)
for the names of attending physicians and interns (5, 2.1%)
for blood bags with wet surface (3, 1.3%)
for blood glucose values (2, 0.9%)
in a dark place (4, 1.7%)
Non-automatic, duplicate, or wrong acting-check input (62, 26.6%)
Frequent logouts (20, 8.6%)
Manually scanning a lot of medications (7, 3.0%)
Too intense red light and loud scanning sound from a barcode scanner, especially at night (5, 2.1%)
The hassle of disinfecting the PDA when used for infected and quarantined patients (2, 0.9%)
A big and heavy barcode scanner (3, 1.3%)
Frequently disconnected from Wi-Fi (11, 4.7%)

[a]Refers to documenting the time of implementing physician's orders such as medication administration in the EMR.

perceived advantage was the prevention and reduction of medication accidents (21.9%). The major drawback of PDA use was barcode scanning not working properly (41.6%). Barcode scanning did not work mainly for non-injectable medications (16.3%) and for normal saline used to mix with other drugs (14.6%). The second major drawback was non-automatic, duplicate, or wrong input of acting checks (26.6%).

DISCUSSION
Key Findings

This study examined the nurses' perceptions of PDA use for injectable medications, non-injectable medications, blood transfusions, and blood collection in two tertiary teaching hospitals. Overall, the nurses perceived more drawbacks than advantages in the use of PDAs, as shown by 13 items for which more than 50% of respondents responded negatively and six items for which more than 50% of respondents responded positively. Although more than half of the nurses perceived PDAs as easy to learn and use (items 23 and 24), less than half of the nurses were unsatisfied with PDA use (item 25). More than half of the nurses perceived PDA use as helpful for reducing or preventing medication and transfusion accidents (item 15). However, more than half of the nurses had negative perceptions of PDA use. The main reasons were because additional input for the PDA or the EMR was required due to poor interfacing between the PDAs and the EMR (items 5, 6, 8, and 9), barcode scanning not working well for injectable and non-injectable medications (items 11 and 12), and frequent wireless Internet disconnections (items 1 and 2). This was consistent with the finding that almost half of the nurses did not perceive PDA use as easy, quick, effective, and useful (items 19–22).

The written responses to the advantages and drawbacks of PDA use were consistent with the nurses' responses to the Likert-scale questionnaire on PDA use. Identifying the right patient and preventing or reducing accidents related to medication administration and blood transfusions were big advantages of PDA use. The automatic input of acting checks was also a merit of PDA use because it saved nurses' documentation time in the EMR. Automatic acting-check input means that when using the barcode scanner of the PDA, the medication administration time was automatically documented in the EMR. However, barcode scanning did not always work for three main reasons. The first reason was non-working barcodes. Barcodes on various forms of non-injectable drugs, barcodes on curved or wet surfaces, and barcodes of medical staff names were not scanned. The second reason was medication prescriptions that caused additional scanning. Normal saline used to mix with other drugs should be scanned separately. The nurses wanted a "bundle prescription" of normal saline and drugs for mixing so that they could scan them at once. The last reason was that the PDA was not interoperable with the EMR (or vice

versa). As an example, when additional prescriptions or prescription changes in the EMR were not presented in the PDA, the nurses had to modify medication prescriptions on the PDA to be the same as the prescription in the EMR. As another example, although mentioned by a small number of nurses, blood glucose values were not easily scanned by the PDA. Poorly working barcode scanning resulted in automatic acting checks that did not input into the EMR every time the PDAs were used. This caused the nurses to repeatedly scan and manually enter acting checks into the EMR. The nurses complained of difficulty in manually entering numbers or words into the PDA. Some of the nurses suggested the use of a stylus for manual input into the PDA. Frequent PDA logouts were an annoying drawback. The nurses had to enter their employee numbers one by one, which was time-consuming. They wanted to scan their employee numbers for easy login. The nurses reported that these barcode scanning problems caused delays in medication administration.

Comparison With Previous Studies

A recent previous study reported nurses' satisfaction with PDA use for the implementation of medical orders and nursing documentation. In a study by Shen et al,[1] the top reasons why nurses were satisfied with PDA use were the prevention of medical errors, improved patient safety, all sheets and charts available for documentation, ease of logging into any interface, and ease of learning how to use a PDA. However, the top reasons that nurses were not satisfied with PDA use were slow scanning of barcodes and bracelets, increased workload due to PDA use, and unstable Wi-Fi connections.[1] These findings, except for all sheets and charts available for documentation and ease of logging into any interface, were consistent with the findings of the present study. Our participants also reported increased workload due to PDA use, such as manually scanning many medications and the hassle of disinfecting the PDA for infected or quarantined patients.

Di Pietro et al[11] investigated the usability of PDAs with the functions of a drug handbook, a calculator, a nursing-sensitive outcomes assessment instrument, and nursing documentation. Nurses liked the portability and size of PDAs, ease of PDA use, easy access to relevant information for clinical decision-making, and the opportunity to document patient information at the point of care.[11] The point-of-care documentation eliminated charting duplication with an interface that allowed nurses to electronically send patients' information from their PDAs directly to the organization's electronic healthcare record.[11] This was similar to automatic acting-check input documented immediately after using the PDA. However, intermittent network accessibility was also a problem.[11]

In relation to the PDAs that were used as barcode scanners in this study, BCMA technology is similar to the PDAs used in this study. Barakat and Franklin[15] reported that using BCMA technology led to higher scanning rates of patient identification and medication verification before medication administration compared with a non-BCMA ward. A spaghetti diagram of a BCMA ward also showed a decreased walking pattern of nurses between patient beds and the medicine room of a nursing station than in a spaghetti diagram of a non-BCMA ward.[15] Most walking in a BCMA ward took place between patient beds. This indicated advantages to patient safety and nursing workflow. Our participants also reported the advantage of patient safety from PDA use. However, BCMA use did not affect the duration of medication administration rounds.[15] In fact, nurses in a BCMA ward administered more doses in a time frame similar to a non-BCMA ward and generally began medication administration rounds later.[15] Thus, medication administration appeared to be more timely in a non-BCMA than in a BCMA ward.[15] If nurses in a BCMA ward started medication administration rounds in a timely manner, the time of medication administration rounds in a BCMA ward would be reduced. Our participants reported delays in nursing workflow due to barcode scanners not working or no barcodes.

Truitt et al[6] reported a significant decrease in medication errors through the implementation of BCMA technology and electronic medication administration records. Specifically, electronic medication administration records improved communication between the physicians, nurses, and pharmacists and reduced transcription errors, and BCMA technology decreased administration errors.[6] Barcode medication administration technology prevented selecting the wrong patient and ensured that the correct medication and dose were administered.[16]

Strength and Limitations of This Study

The strength of this study was the use of both a quantitative questionnaire and written responses in a consistent manner. The quantitative survey allowed us to obtain information on what problems were encountered in PDA use and how many nurses perceived problems related to PDA use. The written responses provided the reasons for the questionnaire responses. They also provided suggestions to improve the problems related to PDA use. This made the findings of this study more reliable and consistent.

Although this study had strengths, it also had limitations. The findings of this study are not generalizable because a convenience sample of nurses using PDAs in the tertiary hospitals was used. The participants and hospitals using PDAs were not randomly selected, which creates a risk of bias. Another limitation of this study was that the focus was on the usability of the PDAs perceived by nurses and not on the patient needs and patient outcomes related to using PDAs.

The tertiary hospitals of this study are in transition to next-generation EMRs, which will be completed in December

2021. Thus, interfacing between the EMR and the PDAs is expected to be improved. Wi-Fi connection should be maintained for the seamless use of the PDAs. When the EMR upgrades are complete, a repeated study on PDA use needs to be conducted to evaluate nurse-centered improvement regarding PDA use in nursing practice. Furthermore, increasing the availability of barcode scanning for all medications applicable to PDA use and eliminating additional scanning for medication administration by redesigning the practice of current prescriptions should be considered. Further research needs to be designed to investigate patient outcomes related to PDA use, such as the reduction and prevention of errors in medication administration.

CONCLUSIONS

This study identified the usability issues of PDAs used mainly for medication administration from the experiences of nurses in clinical practice. Personal digital assistant use was originally designed to have interoperability with the EMR. However, the interoperability between the two systems did not work well enough to satisfy the nurses. Inappropriate availability of barcode scanning and prescription practices also increased the usability issues of PDAs. Based on the results of this study, the usability issues of PDAs should be addressed so that nurses can use PDAs for patient care without unnecessary effort and in a more efficient and effective way.

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