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Nurses' Attitudes Toward Meaningful Use Technologies:
An Integrative Review

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Nurses comprise the largest segment of the healthcare workforce. As such, their perceptions of any new technology are important to understand, as it may ultimately mean the difference between acceptance and rejection of a product. The three-stage meaningful use program is intended to help improve and standardize data capture and advance clinical processes to improve patient and population outcomes in the US. With more than 471 000 healthcare providers having already received meaningful use incentive payments totaling more than $20 billion as of June 2015, it is critical to understand how these technologies are being viewed and utilized in practice. Understanding nurses' attitudes toward healthcare technology may help drive acceptance, as well as maximize the inherent potential of the new technologies toward improving patient care. Thus, the purpose of this integrative review is to highlight what is known about nurses' attitudes toward meaningful use technologies.

KEY WORDS: Bar Code Medication Administration, Electronic Health Record, Electronic Medical Record, Technology acceptance

Changes in technology are a constant in nursing. Every technological innovation from the creation of the disposable catheter in 1944 to the first heart transplant in 1967, through the human genome project on the 2000s,[1] has had an impact on nursing care, with current advances in technology having the potential to alter completely the way nursing will be practiced in the future.[2] Technology is often presented as having a positive impact on the quality and efficiency of nursing care. Information technology, for example, can enhance the nursing process by improving the collection, interpretation, management, and dissemination of important patient information, as well as automate processes to reduce nursing workload.[3,4] However, studies utilizing models and tools such as the Nurses' Attitudes Toward Computerization questionnaire, the Information Technology Attitude Scales for Health, and the Technology Acceptance Model suggest that nurses' attitudes toward healthcare technologies may vary significantly.[5–7]

One of the largest nurses' union in the US, National Nurses United, recently launched a campaign to alert the public to what it describes as the dangers of "unproven medical technologies" such as the clinical decision support (CDS) systems built into many electronic health records (EHRs).[8,9] Healthcare technology has at times been implicated as dehumanizing, or the antitheses of caring.[10,11] In contrast, the theory of technological competency as caring in nursing suggests that technology should be seen as a way to enhance caring in nursing, by helping to understand the patient as a whole and complete individual, not as a replacement for the human skills of caring.[12,13]

The rapid growth of technology in healthcare shows no signs of slowing down, as the Health Information Technology for Economic and Clinical Health (HITECH) Act, part of the 2009 American Recovery and Reinvestment Act, has budgeted more than $20 billion toward improving health information technology.[5,14] Facilities or individuals are eligible for incentive payments from this budget by complying with standards that demonstrate "meaningful use." Meaningful use covers implementation and use of electronic medical records (EMRs) and associated technologies to help improve healthcare quality, safety, and care coordination, as well as health information privacy and security across the US.[15–17] The three-stage program is intended to help improve and standardize data capture and advance clinical processes to ultimately improve patient and population outcomes.[18,19] With more than 471 000 healthcare providers having already received meaningful use incentive payments totaling more than $20 billion as of June 2015,[20] it is critical to understand how these technologies are being viewed and utilized in practice.

Healthcare leaders should understand nurses' attitudes toward healthcare technology in order to help drive acceptance and maximize the inherent potential of the new technologies toward improving patient care.[5,7,21] In the context of mandatory usage of meaningful use technologies (which many institutions require), measures such as perception and acceptance are more important than data usage statistics.[22] Therefore, the purpose of this integrative review is to highlight what is known about nurses' attitudes toward meaningful use technologies.

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METHODS

The five-stage methodology of Whittemore and Knafl[23] was used to conduct this integrative review. The five defined stages of problem identification, literature search, data evaluation, data analysis, and presentation are intended to ensure methodological rigor. This systematic process helps to minimize bias while allowing for multiple types (eg, experimental, nonexperimental, theoretical, empirical) of primary research to be independently evaluated. For purposes of clarity and exclusion criteria applicability, the review purpose was framed as the following research question: "What are nurses' attitudes toward meaningful use technologies?"

Problem Identification Stage

The phenomenon of nurses' attitudes was purposely chosen to give a broad conceptual view of the problem. Attitudes refer to "a complex combination of things we tend to call personality, beliefs, values, behaviors, and motivations" and "include feelings, thoughts and actions."[24(p44)] For the purpose of this review, meaningful use technologies are used to refer to EMRs, EHRs, electronic medical administration records (eMARs), barcode medication administration (BCMA), and nursing CDS. These specific technologies were chosen because they were judged by this author to have the greatest impact on nursing processes and workflows.

Literature Search Stage

Inclusion criteria for this review were identified as primary source material, such as books, dissertations, research articles, and concept analyses, and studies involving nurses' perceptions of technology. Sources were excluded from this review if the relevant technology was not one of the three identified meaningful use technologies, if the primary population group was not registered nurses, if the source was not primary (eg, editorials or discussion papers), if the study was not conducted in the US, and if the study did not answer the research question.

Structured searches were conducted within five electronic databases: CINAHL Complete, MEDLINE Complete, ScienceDirect, PsycINFO, and Proquest Dissertations and Theses Global. All sources published between January 2010 and July 2015 were included in the search. The selected period for studies beginning from 2010 was deliberately chosen as most likely to reflect meaningful use technologies, based on the meaningful use EHR incentive program, which allowed hospitals to receive incentive payments as early as 2011.[18] Varied search terms (Table 1) were used to broaden the depth and scope of the search. Using the identified terms as well as the limiters of English language and US studies (as the meaningful use program is limited to the US), 496 articles were retrieved. The retrieved sources were first screened for inclusion criteria by title. If the source could not be excluded by title alone, the abstract (or book summary) was read. If the abstract met the inclusion criteria, the full text of the source was obtained. This approach led to 26 studies. In addition, manual searching was performed on all reference lists and of all articles from January 2010 to present of *CIN: Computers, Informatics, Nursing*, the *American Journal of Nursing*, and *Nursing Management*, because these journals were noted to feature relevant content. After removal of duplicate studies and application of exclusion criteria, 17 relevant studies were identified. A diagram of the decision-making process for inclusion in the integrative review is provided in Figure 1.

Table 1. Search Strategy and Outcomes

Database	Search Results					Total
	ProQuest Dissertations and Theses Global	MEDLINE Complete	CINAHL Complete	ScienceDirect	PsycINFO	
Results found	129[a]	44	136	39[b]	148[b]	496
Relevant articles	8	3	12	0	2	25
Total after duplicates removed	8	3	12	0	0	23
Reason(s) for exclusion						
Focus not on nurses	2	4	6	0	1	13
Relevant technology not meaningful use	11	6	11	3	9	40
Not a US study	0	6	6	3	14	29
Did not answer research question	108	25	101	33	122	389

Search date July 25, 2015; limiters used: geography: US; language: English.

[a]Keywords (*EMR* OR *EHR* OR *Barcode* OR *Clinical Decision Support*) AND (*Attitude* OR *Perception* OR *Acceptance* OR *Perspective*) AND (*nurse* OR *nursing* OR *RN*) in abstract search. All other limiters identical.

[b]Search done using title, abstract, and keywords.

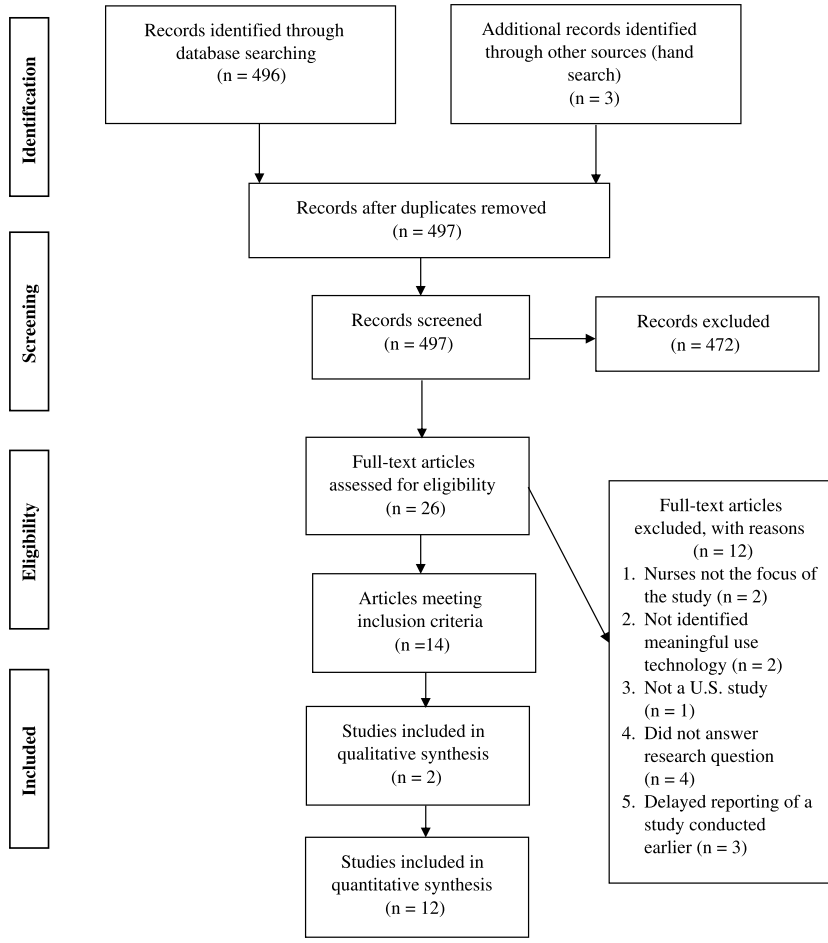

FIGURE 1. PRISMA diagram of search strategy and outcome.[42]

Of the studies included, seven were doctoral dissertations, and the remainder research articles. Twelve studies were quantitative research, two were qualitative research, and three were of mixed-methods design. Of the nine full text articles that were excluded, two did not have nurses as the focus of the study, one examined attitudes toward technology that was not identified as meaningful use by this review, one study was not conducted in the US, and four were excluded because they did not answer the research question. Three additional sources[25–27] were later removed in the analysis stage because the studies referenced were performed several years before the meaningful use program was introduced. Thus, 14 studies are included in this review (Table 2).

Data Evaluation Stage

All quantitative studies were reviewed using Bowling's[40] checklist for assessment of rigorous research criteria (Table 3). All qualitative studies were reviews using Pearson's[41] qualitative findings critical appraisal scale (Table 4). The three mixed-methods studies were reviewed using the quantitative criteria because the focus of all three studies was on the quantitative results. Each of the studies was noted to have limitations when the appropriate criteria were applied. However, with the exception of Adams,[28] all the studies were judged to be adequate for inclusion. Upon further review of Adams' study, considering that "quality criteria apply mainly to experimental designs,"[40(p122)] despite the low sample size (N = 13) and several methodological concerns, the study was judged of sufficient rigor to be included. Thus, none of the 14 selected studies were excluded.

Data Analysis Stage

Data analysis for the studies was performed by summarizing the studies in a data extraction matrix (Table 3). This matrix summarized research methodology, as well as study purpose and thematic findings, in table format. A descriptive summary is presented in the following section.

PRESENTATION/DISCUSSION

This review contained quantitative, qualitative, and mixed-methods research studies from which the following major themes were identified:

Table 2. Research Design and Description of Studies Reviewed

Author(s), Year, Title	Purpose	Study Design	Sample Size, n	Data Analysis	Findings	Themes
Adams[28]: "Nurses Knowledge, Skills, and Attitude Toward Electronic Health Records (EHR)"	To assess the effect of simulation training on a generic EHR	Nonexperimental Pretest for Attitudes toward Computers in Healthcare assessment scale version 3	13 (Convenience sampling)	Quantitative descriptive	Simulated EHR training may help nurses who have not previously used EHR	Education regarding EMR use an important predictor of acceptance
Bennett[29]: "The Relationship Between Barcode Medication Administration Satisfaction and the Use of Workarounds Among RNs"	Understand relationship between BCMA satisfaction and workaround usage	Cross-sectional survey Workaround Usage and Satisfaction with Barcoding Instrument for Nurses	89 (Response rate 33.6%)	Analysis of variance (ANOVA) Correlational (Pearson *r*) Independent *t* test	Nurses with more than 25-y experience and those with less computer experience more likely to use workarounds	RNs who were more satisfied were less likely to use workarounds
Carayon et al[22]: "ICU Nurses' Acceptance of Electronic Health Records"	Assess ICU nurses' acceptance of EHR technology	Longitudinal quantitative descriptive Cross-sectional surveys at 3 and 12 mo postimplementation	3 mo, 121 (Response rate 51%) 12 mo, 161 (Response rate 72%)	Multivariate	Acceptance and perceptions of usability and usefulness of EHR and eMAR increased with time	Nursing input into design and improvement lead to increased acceptance and positive perception
Crawley[30]: "Nurses' Perceptions of the Electronic Health Record"	Explore nurses' perceptions of EMR in ambulatory care	Transcendental phenomenological Semistructured 13-question interviews	16 (20 intended but saturation reached at 16)	Phenomenology	Resistance to change barrier to implantation. Training best way to support adoption.	Improved quality of care from paper records due to legibility/access
Culler et al[31]: "Nurses' Perceptions and Experiences With the Implementation of a Medication Administration System"	To describe a qualitative evaluation of eMAR implementation	Qualitative longitudinal Interviews at 6 and 18 mo postimplementation	14 (Response rate 58.3%) 13 (Response rate 92.86% at 18 mo)	Grounded theory	Increased productivity reported by 50% of respondents. Decreased login times resulted in increased acceptance	Implementation barriers have less to do with functionality than processes and workflow issues
DesRoches et al[32]: "Health Information Technology in the Workplace: Findings From a 2010 National Survey of Registered Nurses"	Examine RN perceptions of health information technology (HIT) on quality of care and daily work	Exploratory descriptive Survey 116 close-ended questions and one open-ended question	532 (Response rate 56%)	χ^2 ANOVA Regression analysis	Younger nurses viewed HIT as improving care quality and efficiency RNs in outpatient practice found HIT more time-consuming. Number of technologies affects views of care	CDS usage not widespread or actualized Older nurses less positive on use of technologies
Fiato[33]: "Enhancing Electronic Medical Records (EMR) Implementation: Peer Support Interventions Influencing Nurses' Acceptance and Use"	To identify what types of implementation interventions influence perceived usefulness and perceived ease of use of EMR	Survey adapted from Technology Acceptance Model version 3	150 (No specific response rate designated)	Descriptive Correlational (Pearson *r*) ANOVA Multivariate ANOVA (MANOVA)	Peer support had a significant effect on perceived usefulness and ease of use. Computer anxiety did not affect that relationship	Younger nurses (aged <30 y) found EMR more useful and user friendly. Peer support was affect decision to accept and use EMR

(continues)

Table 2. Research Design and Description of Studies Reviewed, Continued

Author(s), Year, Title	Purpose	Study Design	Sample Size, n	Data Analysis	Findings	Themes
Harmon et al[34]: "Then and Now: Nurses' Perceptions of the Electronic Health Record"	Assess and analyze RN perceptions of EMR preimplementation and postimplementation	Nonexperimental Correlational Assessment of Nurses' Attitudes Toward Computerization	230 (Response rate 10%)	Retrospective Correlational (Pearson *r*)	CDS important for improved safety Focus on communication once EMR was implemented	Overall positive response to EMR, but fears of loss of quality and increase in RN workload exist
Holtz and Krein[35]: "Understanding Nurse Perceptions of a Newly Implemented Electronic Medical Record System"	Explain and understand nurses' intention to use and adopt EMRs	Mixed methods: semistructured interviews and Unified Theory of Acceptance and Use of Technology survey	113 (Response rate 21%)	Descriptive Correlational (Pearson *r*)	Intention to use EMR affected by social influence and perceived self-efficacy	Expected increase in workload does not affect intention to use. Peer acceptance influences RNs
Jensen[36]: "Nurses' Perceptions of Nursing Care Documentation in the Electronic Health Record"	Identify current perceptions of EHR capture of nursing work and effect on RN satisfaction	Correlational survey Adaptation of Unified Theory of Acceptance and Use of Technology	393 (No specific response rate designated)	Correlational (Pearson *r*) χ^2 Logistic and multiple regression	EHR documentation was seen as relevant to nursing work and which corresponded to increased satisfaction	Performance expectancy (relevance) is related to satisfaction with EMR
Laramee et al[21]: "A Comparison of Nurse Attitudes before Implementation and 6 and 18 Months After Implementation of an Electronic Health Record"	Compare nurses' attitudes at 6 and 18 mo post-EHR implementation	Mixed methods: Modified Nurses Attitudes Toward Computerization Questionnaire Open-ended questions Longitudinal study at preimplementation, 6 mo, and 18 mo	Preintervention 312 (Response rate 18%) 6 mo, 410 (response rate 24%) 18 mo, 262 (Response rate 15%)	Descriptive χ^2 Phenomenology	Attitudes toward EHR less positive over time. Redundancy in documentation, time-consuming elements, and lack of focus on nursing-sensitive documentation all implicated	RN age and experience affect attitudes Challenge to implement EHR Workload increased but so did quality of documentation
Styron[37]: The Impact of Technology Attitudes and Skills of Rural Health Clinic Nurses on the Level of Adoption of Electronic Health Records in Mississippi"	To examine the current stage of EMR adoption, factors associated with integration, technology skills, and nurses' attitudes toward technology in Mississippi	Nonexperimental Questionnaire incorporating the Assessing Adoption of Effective Health Information Technology Questionnaire and items from PATCH Assessment Scale version 3	44 (Response rate not given)	Descriptive Correlational χ^2 ANOVA MANOVA	No differences between technology attitudes and age of nurses or years of experience Current stage of meaningful use did not affect technology attitudes	Nurses lack confidence in using technology Age and attitudes have a negative correlation but not found to be statistically significant
Ward et al[38]: "Nurses' Perceptions of How Clinical Information System Implementation Affects Workflow and Patient Care"	To examine the impact of EHR implementation on nurses' perceptions of workflow and patient care throughout the implementation process	Seven-Scale Information Systems Expectations and Experiences Survey Longitudinal before and after training and after implementation	Before training 354 (Response rate not given) After training 203 (Response rate not given Postimplementation 148 (Response rate not given)	Descriptive Factor analysis	Nurses without previous EMR experience were less optimistic postimplementation about learning and improving documentation Perceptions worsened for documentation time and patient care time	Less positive perceptions in nurses with more years of work experience Mistrust of CDS and fear of decreased communication. Communication viewed as increased

(continues)

Table 2. Research Design and Description of Studies Reviewed, Continued

Author(s), Year, Title	Purpose	Study Design	Sample Size, n	Data Analysis	Findings	Themes
Williams[39]: "Factors That Affect Bar Code Medication Administration Technology Acceptance"	Determine relationships between caring, role conflict, role ambiguity, organizational commitment, and BCMA technology on nurse acceptance	Mixed methods: Nonexperimental Adapted versions of four scales: Organizational Commitment Questionnaire Role Questionnaire Caring Behaviors Inventory–Short Form Perceived usefulness and perceived ease of use subscales	86 (Response rate 43%)	Correlational Content analysis	No relationship between nurses' perception, caring behaviors, and BCMA acceptance Higher organizational commitment levels correlated with ease of use perceptions and higher acceptance No correlation between age or educational and technology acceptance	Awareness of positive impact of technology helped drive acceptance Challenges arose from changes in practice and workflow

- nurses' attitudes toward meaningful use technology implementation
- nurses' attitudes toward postimplementation improvement attempts
- nurses' overall acceptance of meaningful use technologies

Implementation

General resistance to change is one of the primary factors that impede EHR adoption.[30,34,38] Other barriers to implementation often have less to do with functionality of the technology than with changes in nursing workflow or processes.[31,39] Process changes, although potentially appearing minor in implementation plans, are often what is most important to end-users (individuals who use a product once it has been fully developed) when the product is implemented.[31] Changes to workflow that affect job efficiency compromised the greatest barrier to acceptance.[31,39] Having nurse involvement from the inception and planning phases may help increase both acceptance and positive perceptions of the relevant technology.[22,39] Other suggested methods for improving the perceptions of meaningful use technologies during the implementation phase include simulated training sessions, peer support in the form of expert peer users, increasing organizational commitment, and a focus on clinical communication immediately after implementation.[28,30,33–35,38,39]

Postimplementation Improvement

A phenomenon known as the "Valley of Doom"[21(p527)] is used anecdotally to refer to feelings of despair or frustration after EMR implementation. This implies that satisfaction and acceptance are likely to decline immediately after implementation and rise after system improvements have been made. Nursing input into design and improvement of technologies was cited as a significant factor in improving perceptions of usability and usefulness over time.[22,31] In contrast, the one longitudinal study that showed a decrease in satisfaction 18 months after implementation indicated that nursing input was largely ignored,[21] leading to negative perceptions of an EHR. Changes suggested by nursing that resulted in improved perceptions included decreased login times, reduced redundancy, and increased focus on nursing sensitive documentation.[21,22,31,38] One study noted no significant difference in nurses' attitudes toward technology based on stage of meaningful use implementation.[37]

Acceptance

Perceived ease of use (usability), perceived usefulness, and performance expectancy (relevance) are important predictors of meaningful use technology acceptance.[22,29,35,36] An awareness of the positive impact of the technology on patient care also had an impact on acceptance.[22,33,34,39] Peer support, the encouragement and assistance of fellow nurses,

was noted as having a significant positive effect on the perceived ease of use, perceived usefulness, and intention to use technologies.[33,35] Nurses were more concerned with the perceptions of other nurses than of improved workflow or patient safety.[35] Thus, the support of nursing peers in the form of superusers and system trainers is likely to increase meaningful use technology acceptance.

Usability

The factor that most dominated the results when analyzing acceptance was usability. Usability, or ease of use, refers to the "efficiency and effectiveness of an application."[3(p123)] Excessive login time was commonly cited as negatively affecting usability.[21,22,31] Time required to complete tasks using the technology was another frequent negative perception.[21,30,34,36,38] Intuitively, the easier a technology is used, the more likely an individual is to use it. This a priori knowledge was found to be true in several studies.[21,22,31,34,36,38] The newer technologies of BCMA and CDS were not generally found to be as user-friendly as the EMR.[29,32,38,39] Thus, variation in nurses' acceptance was noted.

Barcode Technologies

Barcode medication administration acceptance was manifested in the studies as a lack of workaround (deviations in the work process to bypass a block in workflow[29]) usage. Both the total number of workarounds and the amount of different workaround types were inversely related to satisfaction with the technology.[29] Mixed results were seen when correlating the nurses' age or years of experience with increased use of workarounds.[29,39] Similar to obstacles to EMR implementation, obstacles to full BCMA acceptance tended to be more related to changes in nursing workflow and processes than with the barcode technology itself.[39] As a result, increased satisfaction with the barcoding process resulted in a reduced number of workarounds.[29] Nurses indicated that their satisfaction would be higher if they felt that the system were less prone to errors.[29,39]

Clinical Decision Support

Either the CDS was ignored as a meaningful use technology, or the functionality was overridden by the end-users in the selected studies. Mistrust of the technology, redundancy, and lack of task relevance were implicated as the main factors for the lack of acceptance.[32,38] One study indicated that nurses had less confidence in the CDS system after receiving training than prior to training.[38]

Age as a Factor

A negative correlation between age and technology acceptance was seen in 5 studies.[21,29,32,33,38] A sixth study showed a similar correlation, but the difference was not judged to be statistically significant.[37] The positive effect of peer influence on acceptance and perceptions, however, was not limited by the age of the nurse.[33,35]

Computer Anxiety

Several studies examined computer anxiety as a variable in measuring acceptance. A lack of previous computer use or computer anxiety only seemed to affect nurses during the implantation period.[27,30,31,33,39] Elapsed time since implementation appears to be predictive of overall technology acceptance, regardless of computer anxiety or previous experience.[22]

Relationship of Findings to Other Reviews

A recent integrative review of nurses' acceptance of healthcare technology using the technology acceptance model as an explanatory framework[7] resulted in several of the same themes as those found in this review. Despite having no sources in common, themes such as organizational commitment, high-quality training, social influence, and perceived usefulness were common to both reviews. A 2010 review of factors affecting nurses' attitudes toward healthcare information technology found that increased computer experience is the main factor leading to positive attitudes, and usability issues are the main cause of negative attitudes.[5] The aforementioned study also reached a similar conclusion to this review, that nurse involvement in the implementation phase would likely lead to increased satisfaction.[5]

LIMITATIONS

There are several limitations inherent to this review. Some studies combining nurses with other healthcare professionals or exploring other aspects of meaningful use may have contained relevant information, which was not included in this review. Although every effort was made to find meaningful use–specific technologies, there was no indication in any study that the technology used was implemented specifically for the meaningful use program. Because this was a difficult variable to account for, the inclusion criterion date of 2010 and forward was important in order to make it more likely that technologies were implemented to comply with meaningful use.

A large number of dissertations (seven of 14 studies) comprised the synthesis matrix. Although these represented primary sources, a possible lack of academic rigor is possible because of the lack of a peer-review process. The included dissertations, with the exception of the 2015 Adams study, all scored favorably on Bowling's[40] critical appraisal checklist, thus limiting this concern.

Publication bias may exist with regard to the published journal articles; however, as the studies presented both positive and negative attitudes toward and acceptance of meaningful use technologies, this was judged to be of minimal concern.

Table 3. Quantitative Studies Critical Appraisal Checklist Matrix[40]

	Author(s) and Year	1 Aim and Objectives	2 Research Question	3 Variables Stated	4 Variables Clear	5 Design	6 Methods Appropriate	7 Tools Tested	8 Sample Described	9 Error	10 Ethics
1	[28]	Y	N	Y	Y	Y	N	Y	N	N	Y
2	[29]	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3	[22]	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
4	[32]	Y	N	Y	Y	Y	Y	N	Y	Y	N
5	[33]	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
6	[34]	Y	N	N	Y	Y	Y	Y	Y	Y	Y
7	[35]	Y	N	Y	Y	Y	Y	Y	N	N	Y
8	[36]	Y	Y	Y	Y	Y	Y	Y	N	N	Y
9	[5]	Y	N	Y	Y	Y	Y	Y	Y	N	Y
10	[37]	Y	N	Y	Y	Y	Y	Y	Y	N	Y
11	[38]	Y	N	Y	Y	Y	Y	Y	N	N	Y
12	[39]	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
Total yes		12	5	10	12	12	11	11	7	6	10
Total no		0	7	2	0	0	1	1	5	6	2

Finally, the number of selected studies (14 studies) and sample sizes of some quantitative studies may not have been sufficient to represent the full scope of information available. In particular, the studies of Adams,[28] Crawley,[30] and Culler et al[31] had sample sizes ranging from 13 to 16. It is the hope of this author that the rigor in which Bowling's[40] criteria were applied mitigates the effects of this limitation.

SUMMARY

In general, nurses' perceptions of meaningful use technologies in this study were positive. Negative perceptions of technology during the implementation phase tended to be more associated with changes in workflow and processes. From the perspective of education, preimplementation training was the suggested intervention to improve nursing perceptions. After implementation, a combination of improving usability, reducing redundancy, and increased familiarity with systems tended to increase positive perceptions of the implemented technologies. Acceptance was affected by several factors; however, peer support played the largest role in increasing nurses' acceptance. From a clinical practice perspective, this seems to indicate that identification and involvement of early adopters or peer champions might increase acceptance.

The relatively newer meaningful use technologies of CDS and barcode medication technologies were not as easily accepted by nurses compared with acceptance of the EMR. This was manifested by workarounds and system overrides. Analysis suggests that as the technologies become commonplace and are used more often, and usability increases, nurses' acceptance of these technologies will increase.

Table 4. Qualitative Findings Critical Appraisal Scale[41(p62)]

	Criteria	Culler et al[31]	Crawley[30]
1	Congruity between the stated philosophical perspective and the research methodology	Unclear	Yes
2	Congruity between the research methodology and the research question or objectives	Yes	Yes
3	Congruity between the research methodology and the methods used to collect data	Yes	Yes
4	Congruity between the research methodology and the representation and analysis of data	Yes	Yes
5	Congruity between the research methodology and the interpretation of results	Yes	Yes
6	There is a statement locating the researcher culturally or theoretically.	No	No
7	The influence of the researcher on the research, and vice versa, is addressed.	No	Yes
8	Participants and their voices are adequately represented.	Yes	Yes
9	Ethical research according to current criteria or evidence of ethical approval by an appropriate body	Yes	Yes
10	Conclusions drawn in the research report appear to flow from the analysis or interpretation of the data.	Yes	Yes

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Table 3. Quantitative Studies Critical Appraisal Checklist Matrix[40], continued

11	12	13	14	15	16	17	18	19	20
Piloted	Analysis Adequate	Results Clear	R/T Hypothesis	Limitations	Conclusions	Generalize	Implications	Conflict	Accessible Data
N	N	Y	Y	Y	N	N	Y	N	N
Y	Y	Y	Y	Y	N	N	Y	N	N
Y	Y	Y	Y	Y	N	N	Y	N	N
N	Y	Y	Y	Y	N	Y	Y	N	N
Y	Y	Y	Y	Y	N	N	Y	N	N
N	Y	Y	Y	Y	N	N	Y	N	N
N	Y	Y	Y	Y	N	Y	Y	N	N
Y	Y	Y	Y	Y	N	N	Y	N	N
N	Y	Y	Y	Y	N	N	Y	N	N
Y	Y	Y	Y	Y	N	N	Y	N	N
Y	Y	Y	Y	Y	N	N	Y	N	N
Y	Y	Y	Y	Y	N	N	Y	N	N
7	11	12	12	12	0	2	12	0	0
5	1	0	0	0	12	10	0	12	12

Implications for Future Research

There is a significant gap in literature regarding the long-term follow-up of the attitudes toward the investigated technologies. Most of the longitudinal studies examined the changes in attitudes and perceptions up to 6 months after implementation.[21,22,31,38] Only one study[34] examined nurses' attitudes toward a technology after a longer period (5 years). This is likely due to the relatively short duration of the meaningful use program, but nonetheless, this knowledge gap exists. Acceptance of BCMA and CDS should be re-examined as the technologies become commonplace and integrated into existing nursing workflow. Several studies utilized frameworks such as the technology acceptance model[29,33] to explain or predict nurses' attitudes toward technologies, but no study identified a theoretical framework used to guide implementation. Locsin's[12,13] theory of technological competence as caring in nursing seems ideally suited for increasing nurses' perceptions of technology relevance and perceived usefulness.

CONCLUSION

Nurses compose the largest segment of the healthcare workforce.[21] As such, their perceptions of any new technology are important to understand because they may ultimately mean the difference between acceptance and rejection of a product. The results of this review reflect the importance of involving nurses in the planning, development, implementation, training, and continuing evaluation of meaningful use technologies. It is clear from this study that nurses' perceptions of meaningful use technologies are most influenced by peer support and the overall effect of the technology on existing processes and workflow. Meaningful use technologies are intended to improve healthcare quality, safety, and care coordination. Proactively engaging nurses as full stakeholders in implementing and improving these technologies is the surest way to increase acceptance and positive perceptions and thus ensure improvements in patient care.

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