

## Title

Issues affecting nurses' capability to use digital technology at work: An integrative review

## Abstract

**Background.** Digital capability, that is the ability to live, work, participate and thrive in a digital world, is imperative for nurses because increasingly nurses' work and patient outcomes are influenced by technology.

**Aim.** To evaluate and synthesise the evidence regarding the development of digital capability in nurses and the strategies that support effective integration of digital skills into the workplace.

**Design.** Whitemore and Knaf'l's methodology, following the preferred reporting items for systematic reviews (PRISMA) guidelines.

**Data sources.** CINAHL, Embase, PsychINFO, Medline (Ovid) and Pubmed databases were searched for articles published in English from 2008-2019. Search terms included; digital capabil\*, digital literacy, informatics, nursing informatics, health informatics, nurs\*, knowledge, knowledge integration, competency, continuing education, nursing skills, workplace, work environment.

**Review methods.** A total of 35 studies were retrieved for quality assessment by two reviewers using standardized critical appraisal instruments from the Joanna Briggs Institute (JBI-MAStARI and JBI-QARI). Minimum essential criteria and scores were agreed prior to appraisal.

**Results.** The 17 studies included comprised quantitative (n=7), qualitative (n=8) and mixed methods (n=2). Integration of digital capability in nurses' workplaces is dependent on user proficiency and competence (theme 1). Nurses use technology to access data at the point of care, specifically accessing evidence to guide care (theme 2a) as well as accessing the medical records (theme 2b). Nurses have several concerns related to the use of technology at point of care (theme 3), some of which can be resolved through investment for implementation (theme 4).

**Conclusions.** There are key attributes of digitally proficient nurses. Nurses with these attributes are more inclined to use digital technology in their work. Involvement of the nurses as end users in the development of digital systems to ensure they are fit for purpose, alongside investment in professional development opportunities for nurses to develop digital capability, should be prioritised.

**Keywords:** digital, technology, informatics, capability, literacy, integrative review

What does this paper contribute to the wider global clinical community? This paper provides summarised information that indicates that nurses recognise technology can enhance the quality of care they deliver as well as improving their efficiency. The literature describes the ways in which digital capability enhances the utilisation and adoption of technology in nursing practice. Further, it is apparent that digital capability can be developed through continuing professional development, especially at the point of care.

## Manuscript

### Introduction

In their working lives nurses will increasingly utilise technology to access data, manage e-records, and provide care via e-medicine and telehealth platforms (Skiba, 2017). While this presents opportunities to improve, enhance and positively transform care and clinical treatment, it is imperative that nurses and graduates have the knowledge, skills and resources they need to utilise technology at the bedside and in the community, especially as many initiatives related to technological adoption fail due to a lack of user uptake (Sassen, 2009). The ability to use technologies at the point of care requires a level of digital

capability. Digital capability has been defined as “those capabilities that fit someone for living, working, participating and thriving in a digital society” (Health Education England, 2016). Many nursing curricula around the world have attempted to integrate content to support the development of digital capability of students, however the adoption of recommended curriculum changes has been slow (Cummings, Shin, Mather, & Hovenga, 2016; Risling, 2017). Further, curriculum modifications do not necessarily reflect the needs of industry or the experience of students (Kennedy & Yaldren, 2017). The Digital Health Education Collaboration has undertaken a number of reviews of the evidence on digital education in health professions (Car et al., 2019). Further, a recent review by Foster and Sethares (2017) reported the strategies used to implement informatics into nursing curricula and described the facilitators and barriers to implementation of informatics into nursing curricula. However, there is a lack of understanding of the required digital capability of health professionals, including nurses and how digital capability is incorporated into nurses’ workplace/s. This integrative review explores nurses’ digital capability and the ways nurses and organisations are developing, incorporating and using technology when providing patient care.

## The Review

### Aims

The purpose of this integrative review was to synthesise and evaluate the evidence regarding the development of digital capability in nurses’ and the strategies that support effective integration of digital skills into the workplace. This evidence may be useful to better understand the educational needs of nurses, graduates and students, and may be used to inform preregistration curricula and continuing professional education (CPE) opportunities.

### Design

This review used the Whitemore and Knafl (2005) Integrative Review methodology and followed the preferred reporting items for systematic reviews (PRISMA) guidelines (see supplementary file 1). This approach allowed the analysis and synthesis of both empirical (qualitative and quantitative) and theoretical literature related to digital capability. In addition, as the concepts (digital capability, nurses and utilisation) were known and essentially form the categories, extracted data could be summarised and descriptively presented (Dixon-Woods, Agarwal, Jones, Young, & Sutton, 2005).

Following the chosen methodology, the first step in the review process involved clearly identifying the issue (ie the aim of the review) to allow a focused literature search to be undertaken (step 2). Data from relevant articles were then carefully evaluated (step 3) and analysed (step 4) using the Joanna Briggs Institute Methodological Appraisal tools (Joanna Briggs Institute, 2019). Finally, conclusions to inform practice, policy and education were developed (step 5) and presented in table format (Whitemore & Knafl, 2005). The Preferred Reporting Items For Systematic Reviews And Meta-Analysis (PRISMA) checklist was followed (Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009).

### Search methods

This review included articles related to the integration of digital capability in nurses’ workplaces. With the assistance of the Faculty of Health librarian and search strategy was developed. A concept grid was used to determine the likely subject headings and keywords. Appropriate combining search terms were explored. Truncation and wildcards relevant to each database were deployed and phrase searching was adopted as needed. The search terms include variations of the following keywords and phrases; digital capabil\*, digital literacy, informatics, nursing informatics, health informatics, nurs\*, knowledge, knowledge integration, competency, continuing education, nursing skills, workplace, work environment.

Articles that focused solely on current integration strategies used in undergraduate nursing curricula were excluded due to the presence of a recent review on this topic (Foster & Sethares, 2017). The articles included in this review were identified by searching the following databases; CINAHL, Embase, PsychINFO, Medline (Ovid) and Pubmed. A three-step search strategy was undertaken. An initial search of CINAHL was conducted and keywords contained within titles, abstracts and index terms of articles were noted. A second, more detailed search using the identified keywords and index terms was undertaken across each selected database. Third, reference lists of relevant articles were searched to identify additional studies. Given the relatively recent introduction of most of the technologies in nurses' workplaces and the rapid rate of technology redundancy, articles published from 2008-2019. Additional inclusion criteria were peer reviewed articles reporting original quantitative, qualitative or mixed methods research of nurses experiences of technology, published in English.

### Search outcome

The initial literature search was conducted in 2018 and repeated 2019 (last search date 2<sup>nd</sup> August 2019) and produced 640 articles using search strategies specific to each database. Following removal of duplicates (n=25), 615 potentially relevant studies remained. The titles and abstracts were screened for relevance with respect to the objectives of this review and 580 studies were excluded. The full-text of the remaining 35 studies were retrieved for detailed assessment against the inclusion criteria, and a further 15 studies were excluded leaving a total of 20 articles which underwent critical appraisal against the JBI appraisal instruments. Three articles (two quantitative and one qualitative) were excluded based on methodological quality, leaving 17 studies to be included in the review. There were minimal differences among reviewers regarding the assessment of these articles. Of the remaining 17 articles, seven were quantitative, eight were qualitative and two were mixed methods studies. The references of these articles were reviewed for studies not previously identified, and no additional papers were selected for critical appraisal. Figure 1 provides the PRISMA diagram which depicts search process for this review.

### Quality appraisal

The titles and abstracts of articles identified using the search strategy were initially reviewed. The full text articles of studies deemed relevant were obtained to determine if they met the inclusion criteria. Quality appraisal of the final selected articles was undertaken by two reviewers independently using standardised instruments from the Joanna Briggs Institute (JBI). Quantitative studies were appraised (author initials to be inserted here after the review) using the JBI Meta-analysis of Statistical Assessment and Review Instrument (JBI- MASTARI), while qualitative studies were appraised (author initials to be inserted here after the review) using the Joanna Briggs Institute Qualitative Assessment and Review Instrument (JBI-QARI) (Aromataris & Munn, 2017). Mixed methods studies were assessed (author initials to be inserted here after the review) using both JBI-MAStARI and JBI-QARI (Aromataris & Munn, 2017). Any disagreements that arose between reviewers regarding assessment of the articles were resolved through discussion, and with a third reviewer.

The JBI Meta-analysis of Statistical Assessment and Review Instrument (MAStARI) comprises nine questions which address sampling, control of confounders, justification of measurements and approaches to statistical analysis. The JBI-MAStARI tool requires reviewers to allocate findings of 'yes', 'no', 'unclear' or 'not applicable'. In this review it was agreed prior to critical appraisal that six of the criteria were considered to be essential, and that articles would be included if at least five of six essential questions were answered 'yes' and there was agreement between the reviewers.

The JBI-QARI appraisal instrument comprises of ten questions which address congruency between the philosophical basis of the study, study methodology, description of the context, the influence of the researcher, how data is represented and how results interpreted. Like the JBI-MAStARI tool, the JBI-QARI appraisal tool requires reviewers to allocate findings of 'yes', 'no', 'unclear' or 'not applicable'. In this review it was agreed prior to critical appraisal that papers would be included if eight of the ten appraisal questions were answered 'yes', there was evidence of the study being ethically sound, and there was agreement between the reviewers.

#### Data synthesis

To ensure rigor in this stage of the review two of the authors undertook independent analyses of the included studies. The process involved each author independently and carefully considering each source to determine its contribution to meeting the research aim, that is they described either the development of digital capability in nurses' or the strategies that support effective integration of digital skills into the workplace. Patterns and themes (similar words, phrases or constructs that were reported in the studies result) and that were consistent across the sources were identified.

Following this independent process the two authors conferred and subsequently synthesised the data into a final understanding of the phenomenon as it is described in the set of disparate publications. There were no discrepancies, although by agreement one theme was split into two sub themes.

#### Results

All included papers met the minimum criteria set by the reviewers to ensure scientific rigor. For all the included quantitative studies and the quantitative aspect of the mix methods studies, at least five of six applicable questions were answered in the affirmative on the critical appraisal checklist (Table 1). For the qualitative studies and qualitative aspect of the mixed methods studies, each met eight of the nine criteria on the critical appraisal checklist (Table 2).

The 17 included studies (table 3) were published over an eight-year period (2010-2018) and sample sizes ranged from eight to 35 579 (qualitative studies 6 - 93, quantitative studies 32 - 35579). The most common method of qualitative data collection was semi structure interview with individual nurses followed by focus groups and observation. Quantitative studies tended to use questionnaires developed specifically for the specific study (n=6), although validated data collection tools such as the Canadian Nurse Informatics Competency Assessment Scale (C-NICAS), the Information Technology Attitude Scales for Health (ITASH) and the Unified Theory of Acceptance and Use of Technology (UTAUT) questionnaire were all used. Qualitative studies were more likely to explore the impact of the adoption, implementation, integration and acceptance of digital technology. This impact was related to nurses as users, and patients and their families as recipients of care. Quantitative studies were more likely to explore nurses knowledge of and attitudes towards digital technology at the point of care, as well as their self perceived competence. The ten countries represented in the studies were; the United States of America (n=5), Canada (n=2), Australia (n=2), China (n=1), Taiwan (n=2), Korea (n=1), the Netherlands (n=1), Finland (n=1), Nigeria (n=1) and Brazil (n=1). Various types of technology were considered. Most of the included studies focused on Electronic Health Records (EHR)/ Electronic Medical Records (EMR), mobile electronic devices and bedside fixed data entry and retrieval devices.

Data was unable to be pooled due to the differences in tools used (quantitative studies) and the qualitative approaches adopted (including data collection and analysis techniques used). As indicated in the table there was wide variation in sample types (from new nurses to managers and informaticists) as well as in the sites from which they were recruited which included acute and chronic care, adult and paediatric environment, inpatient and outpatient settings, and metropolitan and rural contexts.

The final themes were derived based on the consistent quantitative outcomes or major qualitative themes that each paper reported, namely: 1) User proficiency and competence, 2) Point of care access to data, 3) Nurses concerns and 4) Investment for implementation. Theme 2 was further divided into; a) Point of care access to the evidence and b) Point of care access to the electronic health record (EHR). With reference to the primary sources, the consistently important elements were combined to summarize the integration of digital capability in nurses workplaces as demonstrated in table 4.

#### User proficiency and competence

This theme captured the factors related to the proficiency of nurses with respect to informatics in clinical practice and the factors associated with the development of competence. Many of the studies utilised descriptive methods to report the characteristics of nurses that are associated with competence. Nurses self-report their informatics competence as below “average” (Hwang & Park, 2011) or only slightly above “competent” (Kleib & Nagle, 2018). However, the younger the nurse, the more proficient they believe they are, with both Hwang & Park (2011) and Kleib & Nagle (2018) reporting a negative correlation between increasing age and informatics competency. This finding was also echoed in qualitative findings by Holtz and Krein (2011) and Shin, Cummings, and Ford (2018), where younger nurses reported issues similar to those expressed as follows “We have a lot of older nurses that aren’t that strong in computers and stuff, and those seem to be the ones that have the most questions” and older nurses concurred in ways similar to this “You know, the younger people have grown up with computers—I don’t even have a computer at home” (Holtz & Krein, 2011, p. 256). To some extent it was identified that this can be overcome by education where nurses with a higher qualification (such as a Master’s degree or Doctoral qualification) or an additional, non-nursing qualification (Kleib & Nagle, 2018) self-reported higher informatics competence than nurses with a Bachelor only qualification (Kleib, Sales, Lima, Andrea-Baylon, & Beath, 2010; Wei-Lan, Li-Qun, & Hong-Yu, 2013). Nurses with an additional qualification in information technology are also more proficient and competent in the use of technology within their role (Kleib & Nagle, 2018). In addition to age and qualification, results revealed that nursing experience also influences informatics competence. Increased clinical experience was associated with an increased likelihood to utilise technology at point of care (Hwang & Park, 2011; Kleib et al., 2010; Wei-Lan et al., 2013).

To improve nurse digital capability, informatics education is increasingly becoming available during undergraduate education and through continuing professional education (CPE). This is creating opportunity for the development of competence in nurses who are already well qualified or experienced, however consistent with other findings related to age, older nurses are less likely to pursue CPE opportunities (Kleib et al., 2010). Where formal education is undertaken, it results in increased competence (Hwang & Park, 2011; Kleib et al., 2010) however those nurses whose work is predominately at the bedside are less likely to undertake CPE (Kleib et al., 2010).

#### Point of care access to data

The access to data needed at the point of care was prevalent in the literature, with both access to the evidence and the electronic medical record frequently discussed as reasons why nurses require digital capability.

##### Access to evidence

Having access to data and evidence in electronic form facilitates clinical decision making by virtue of the ease and efficiency of access to information at the point of care. This is true for nurse managers seeking data to make decisions at an organisational level (Jensen, Guedes, & Leite, 2016) as well as nurses using local policies and procedures or published evidence (Kent et al., 2015) to guide their clinical practice.

Coupled with proficiency in using basic electronic forms of communication, this evidence can rapidly be shared within nursing teams, benefiting the patient, the nurse and the organisation (Koivunen, Niemi, & Hupli, 2015). However there is concern that nurses, particularly new graduates, may not know how to identify “good” information and evidence and interpret it for use in the clinical environment (Shin et al., 2018).

#### Access to the EHR

Healthcare organisations are increasingly moving to a paperless or paper-light record management associated with a patient’s episode of care. The EHR (also known as the electronic medical record or hospital information system) is perceived by nurses to improve patient care (Wei-Lan et al., 2013). Specific examples cited in the literature include facilitating a patient centred, coordinated approach to care (Asan, Flynn, Azam, & Scanlon, 2017), nursing diagnosis and care planning (Kent et al., 2015; Wei-Lan et al., 2013) including during emergencies (Asan et al., 2017), medication safety (Dowding, Turley, & Garrido, 2015; Kent et al., 2015). A quote published by Dowding succinctly captures this element of EHR utility.

“To me it is pretty accurate because it tells you if you are not giving the right medication to the right patient ... It identifies the patient. It identifies the drugs ... I think it has made it a lot safer especially with the scanning of the meds” (p. 355).

Further, the EHR facilitates nurses providing education to patients and their families (Asan et al., 2017; Dowding et al., 2015). Similarly, allowing patients and families to have access to the electronic record improves their involvement in care, although sufficient education is required to ensure that they have an understanding of the information and data (Asan et al., 2017).

Access to and use of EHRs was identified as assisting in the reduction of errors (Wei-Lan et al., 2013), decreasing workload and improving time management for nurses (Wei-Lan et al., 2013), especially where internal messaging is an element of the patient record system (Koivunen et al., 2015). The use of the EHR improved communication within the nursing team and between health professionals during the shift (Dowding et al., 2015; Koivunen et al., 2015; Wei-Lan et al., 2013) and between shifts (Staggers, Clark, Blaz, & Kapsandoy, 2011).

#### Nurses concerns

The impact of technology on patient outcomes is a driver for uptake. Where nurses believe systems will enhance patient care they are more willing to adopt the technology into their care (de Veer, Fleuren, Bekkema, & Francke, 2011). However, nurses have concerns that the use of technology can be time consuming and can therefore leave them time poor when it comes to providing direct patient care. This is particularly the case when ensuring timely documentation while using the EHR (Dowding et al., 2015; Staggers, Elias, Makar, & Alexander, 2018) and in higher acuity areas (Holtz & Krein, 2011). Nurses are also concerned about ensuring confidentiality and privacy of patient information (Koivunen et al., 2015) as demonstrated by this quote:

“The other thing is ... you have visitors coming in the room and ... who’s to say they want Aunt Sue to know all that information when she’s visiting. You know we have to get permission to give any information out so, yes it’s kind of right there for anybody” (Asan et al., 2017, p.261).

Another concern is related to the potential for plagiarism and copyright breaches when using information (Jensen et al., 2016).

In addition to concerns related to utilisation of technology in patient care, nurses described frustration and stress associated with functionality of the technology. Where the technology was not fit for

purpose, but its use was mandated, such as a handover sheet, nurses reported reverting to printing hard copy documents to manually include additional information. This helped to overcome the inflexibility and rigidity of the computerised tool (Staggers et al., 2011). Usability and reliability issues also reverse any gains that can be achieved at point of care and further threaten patient safety (Staggers et al., 2018). Technical issues, access to devices, duplication of information and poor implementation of systems all contribute to nurse stress and frustration (Chang, Lee, Liu, & Mills, 2016; Liu, Lee, & Mills, 2015; Shin et al., 2018; Staggers et al., 2011; Staggers et al., 2018).

#### Investment for implementation

Several of the reviewed studies provided guidance and direction that could overcome some of the issues that nurses identified with the use of technology in patient care. The first of these is the importance of stable systems to prevent disruptions to services (Asan et al., 2017; Koivunen et al., 2015; Staggers et al., 2011; Staggers et al., 2018; Wei-Lan et al., 2013) that drive nurses to seek workarounds or spend time problem solving (Chang et al., 2016; Liu et al., 2015) or preferring and reverting to lower tech solutions (Asan et al., 2017; Staggers et al., 2011). This quote presented by Chang et al. (2016) is illustrative of the issues nurses face and the solutions they use to address them.

“Our work is extremely busy, and the systems operation and data retrieval are too slow! Waiting for the screen to load takes too long. Sometimes, typing/recording data does not require that much time! However, we are forced to wait for the screen to load before we are able to enter data. In the end, we had to adjust our work procedures; that is, we would do other things while we were waiting for a screen change. Previously, with the paper-based health records, we could just pick up the paper chart and begin writing” (p. 184).

Nurse leaders and champions should be involved in the development and evaluation of point of care digital tools and systems, to ensure that their design responds to the problems nurses face, and that there is widespread acceptance of and adaptation to implementation (Chang et al., 2016; Kent et al., 2015; Liu et al., 2015; Staggers et al., 2011; Staggers et al., 2018).

To build digital capability in nurses organisations should allow time for exploration of the technology’s utility (Kent et al., 2015), its adoption (de Veer et al., 2011) and then adaptation to the change in practice (Chang et al., 2016). However it is overwhelmingly apparent that developing nurses’ digital capability requires initial and ongoing training opportunities (Asan et al., 2017; Chang et al., 2016; de Veer et al., 2011; Koivunen et al., 2015; Liu et al., 2015; Shin et al., 2018; Staggers et al., 2018; Wei-Lan et al., 2013) to build on the pre-existing capability that nurses bring with them to the workplace. Education and training opportunities should be provided at orientation (Shin et al., 2018), factored into the nurses duties (Wei-Lan et al., 2013) and should include general computer knowledge, as well as specifics relating to hardware and software (Wei-Lan et al., 2013).

#### Discussion

“Every nurse, an e-nurse, able to use data, information, knowledge and technology to maximum effect for patients, carers and service users” was first proposed by the Royal College of Nursing in 2016 (Clever Together: National Information Board’s Building a Digital Ready Workforce (BDRW) Programme, 2018, p3) and is a reasonable expectation given the explosion of technology in our everyday world and in healthcare (Skiba, 2017). In order to be an e-nurse, a degree of digital capability is required. The purpose of this integrative review was to synthesise and evaluate the evidence regarding the development of digital capability in nurses’ and the strategies that support effective integration of digital skills into the workplace. This review explored the development and integration of digital capability into nurses’ work. Despite the rapid uptake and the swift evolution of innovation, there is a

relative dearth of research on how nurses can develop digital capability and integrate this capability into their work. It is apparent from our review of the literature that while there are a number of factors that facilitate the use of technology in patient care, there are also a number of gaps in the literature about ongoing issues with technology integration, which we address in the following discussion.

The delivery of initial and ongoing education to nurses helps to support nurses to integrate and maintain digital capability skills in their practice. This finding is echoed throughout literature (Hwang & Park, 2011; Kleib et al., 2010; Staggers, Elias, Makar, & Alexander, 2018) and emphasises that high quality, accessible and timely education for nurses should be a priority for nurse educators and nursing management. Education focused on digital literacy seems to be particularly important for experienced and mature nurses, where emerging research demonstrates age to be a factor in digital capability among nurses. Our findings revealed that older, more experienced nurses seem to be less digitally capable compared to their younger counterparts (Holtz & Krein, 2011; Hwang & Park, 2011; Kleib & Nagle, 2018; Shin, Cummings, & Ford 2018). Bridging this generational gap with respect to digital literacy may be possible by encouraging older, more experienced nursing staff to undertake post-registration degrees, where they have more of an opportunity to be exposed to and develop digital literacy skills (Brown, Morgan, Mason, Pope & Bosco, 2020; Kleib & Nagle, 2018). Alternatively, whilst also appreciating older more experienced nurses may not attend, the provision of mandatory continuing professional development as informal learning could bridge this gap (Hwang & Park, 2011; Kleib et al., 2010; Mather & Cummings, 2017).

In addition to education, our findings showed that accessible, reliable, stable systems are essential for the successful integration of technology into nurses' work (Asan et al., 2017; Koivunen et al., 2015; Staggers et al., 2011; Staggers et al., 2018; Wei-Lan et al., 2013). Technical issues are common when new technology is implemented into healthcare settings and access to timely technical support is important (de Veer et al., 2011), regardless of how robust and well developed the technology may be. Our findings highlight how technical issues contribute to nurses' feelings of frustration and perpetuate negative attitudes and resistance among nurses in the uptake of technology (Chang, Lee, Liu, & Mills, 2016; Staggers et al., 2018). Further to this, both design and technical issues continue to impact on care delivery (Staggers et al., 2018) and could lead to patient dissatisfaction with care and delayed medical treatment.

A robust IT support system is a major investment (Ward, Vartak, Schwichtenberg & Wakefield, 2011), particularly through the implementation phase of integrating new technology to practice and associated training requirements. A reduction in these costs is anticipated as the technology becomes more readily available (Sharma et al., 2018). Our findings showed that managing technical issues also increases nurses' workload and takes nurses away from direct patient care. In addition to this, developing necessary digital skills, navigating and becoming familiar with new technology was perceived by nurses as time-consuming and increasing their workload. This finding is consistent with other studies, which showed that implementing new technology in healthcare demands more time of staff (Aguilera, Dickey & Guzman, 2020; Knippa & Senecal, 2017) and nurses have also reported that the use of technology can be time consuming making them time-poor (Chang, Lee, Liu, & Mills, 2016; Dowding et al., 2015; Holtz & Krein, 2011; Staggers et al., 2018). These increase demands faced by nurses during the implementation phase of integrating technology needs to be met with additional resources (ie more staff working on the floor) (Chang, Lee, Liu, & Mills, 2016) and post-implementation comprehensive cost benefit analyses should be undertaken before further changes to existing technologies are made.

While the implementation phase of integrating new technology in nurses' workplaces presents challenges, studies have shown that patient care and satisfaction with care are improved through technology (Asan, Flynn, Azam, & Scanlon, 2017; Dowding, Turley, & Garrido, 2015; Kent et al., 2015;



Wei-Lan et al., 2013). In an era of person-centred care this is an important consideration. Findings from our review showed that technology such as EHR can help to support active partnerships between nurses and patients and encourage patients to be more involved in their care. The EHR can be used to facilitate conversations between nurses and patients, and as a means to provide education to patients and their families (Asan et al., 2017; Dowding et al., 2015). Patients and families also have the ability to easily access their medical records, but this needs to be met with an increase in education offered by nurses and health care professionals to ensure they understand the information that is offered (Asan et al., 2017). The use of the EHR can also improve communication within the nursing team and between health professionals (Dowding et al., 2015; Koivunen et al., 2015; Wei-Lan et al., 2013; Staggers, Clark, Blaz, & Kapsandoy, 2011). What remains unclear from the literature we reviewed, is the extent to which the EHR are simply replacing paper versus whether the technology behind the EHR also incorporates elements of artificial intelligence (the use of algorithms) to support nurses care provision.

The exponential growth in the use of technology for patient care will continue and nurses should be ready and able to embrace a digital healthcare environment. In order for this to be a realistic expectation nurses must be involved in the development of systems, platforms and devices that are used at point of care and provided with the time and resources to implement them. An interesting feature of our review was the focus on competence with computer systems (including hardware and software) and communication technology, at the expense of emerging technologies such as wearables and self-monitoring devices. More research is needed to understand nurse knowledge of and attitudes towards new generation technology in the workplace.

Building digital capability in nurses will require a wide range of strategies to be put in place and investment from a number of stakeholders, including the nurses themselves, employers, policy makers and governing bodies. On the basis of the synthesis of literature regarding the integration of digital capability in nurses' workplaces Table 5 makes suggestions for practice, policy and education that may enhance nurses ability to use existing and emerging clinical care technology. However, these results should be interpreted with caution as there was a lack of homogeneity in the approaches to research exploring digital literacy and there were a number of methodological weaknesses of the descriptive studies. These include non-randomisation of participants and the fact that the outcomes of the people who withdrew were not described. Similarly, there were consistent methodological weaknesses in the qualitative studies with the lack of a statement locating the researcher culturally or theoretically evident in all studies. Further, the search terms used in this review do not encompass all terms used historically in the nursing informatics literature. We acknowledge there is a body of literature that exists prior to the introduction of the term "digital" to describe the concept of using software and / or hardware by nurses within healthcare environments. Additionally, the searched terms were generic and may have not been sufficiently sensitive to detect literature making specific reference to some technology actively used in the patient care such as personal monitoring devices and health applications.

## Conclusion

It is clear from the integrative review of the literature that there are a number of perceived key attributes of digitally proficient nurses. When these attributes are prevalent, nurses are more inclined to use the digital platforms to access medical records and point of care information. However, not all platforms and systems are designed with the nurse end user in mind, creating problems at the point of access. Therefore, the involvement of nurses in the development of digital systems should be prioritised and it is strongly recommended that there is investment in providing professional development opportunities for nurses to ensure they have and continue to build their digital capability.

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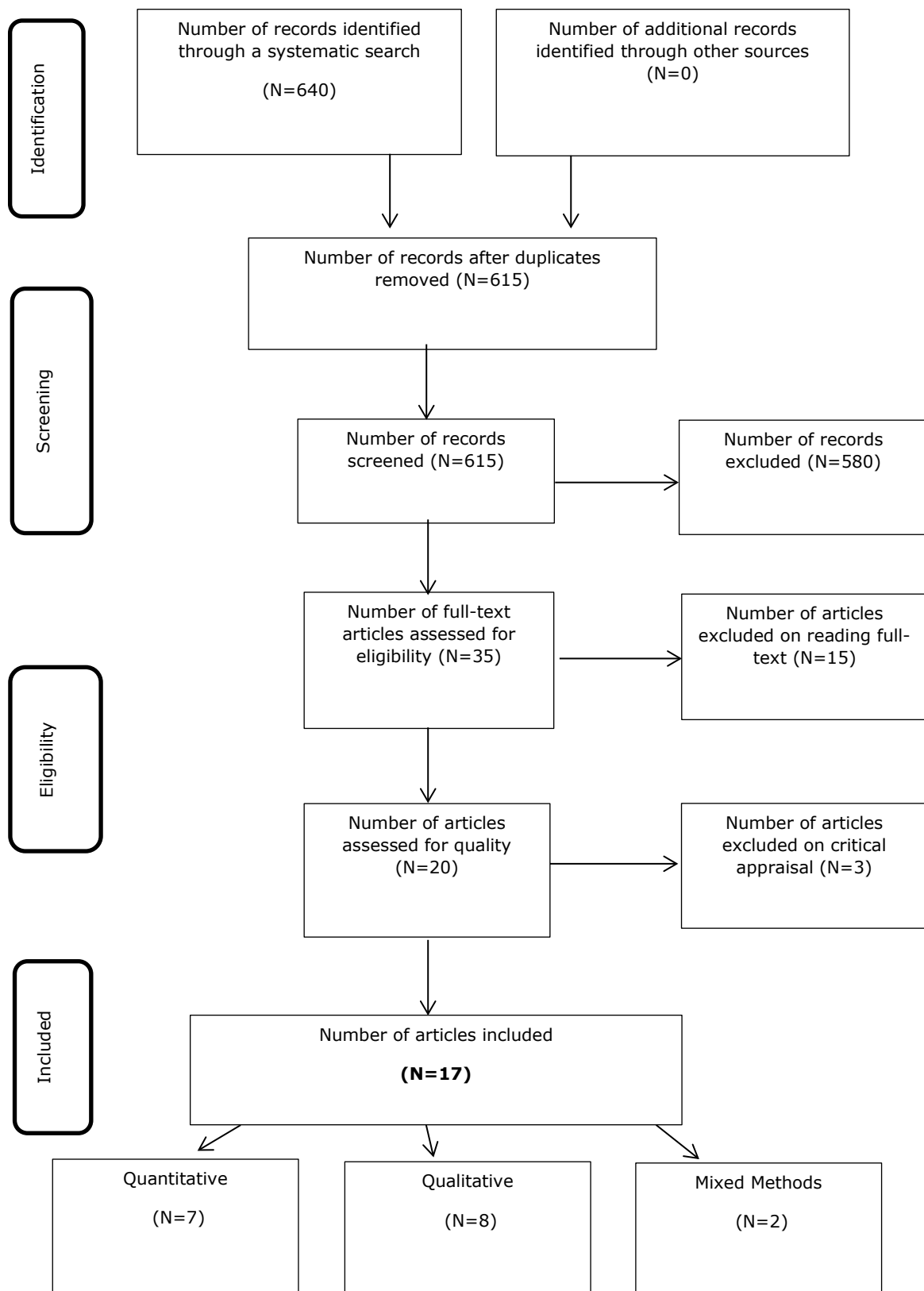
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Figure 1.



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

Figure 1. Search process for review

**Table 1: Critical Assessment using MASTARI (descriptive case studies) rankings**

**\* denotes mixed methods studies**

**# denotes third reviewer required**

**+ denotes excluded after review**

Study	Is the study based on a random or pseudo-random sample? <b>(desirable, but not an essential item)</b>	Q2 Are the criteria for inclusion in the sample clearly defined? <b>(essential criterion)</b>	Q3 Are confounding factors identified and strategies to deal with them stated? <b>(essential criterion)</b>	Q4 Are outcomes assessed using objective criteria? <b>(essential criterion)</b>	Q5 If comparisons are being made, is there sufficient description of groups	Q6 Is follow-up carried out over a sufficient period of time? <b>(Not essential, but noted as a limitation to the study)</b>	Q7 Are the outcomes of people who withdraw described and included in the analysis?	Q8 Are outcomes measured in a reliable way? <b>(essential criterion)</b>	Q9 Is appropriate statistical analysis used? <b>(essential criterion)</b>	Score
De Veer et al, 2011	✓	✓	N/A	✓	✓	N/A	N/A	✓	✓	6/9 (6/6 applicable)
Hwang, 2011 <sup>#</sup>	?	✓	N/A	✓	✓	N/A	N/A	✓	✓	5/9 (5/6 applicable)
Jensen et al, 2016	N/A	✓	✓	?	✓	N/A	N/A	✓	✓	5/9 (5/6 applicable)
Kleib et al, 2010	✓	✓	✓	✓	✓	N/A	N/A	✓	✓	7/9 (6/6 applicable)
Kleib et al, 2018	x	✓	N/A	✓	✓	N/A	N/A	✓	✓	5/9 (5/6 applicable)
Olajubu et al, 2015 <sup>#</sup>	✓	✓	N/A	✓	✓	N/A	N/A	✓	✓	6/9 (6/6 applicable)
Wei-Lan et al, 2013	x	✓	N/A	✓	✓	N/A	N/A	✓	✓	5/9 (5/6 applicable)
Holtz et al, 2011 <sup>*</sup>	x	✓	N/A	✓	✓	N/A	N/A	✓	✓	5/9 (5/6 applicable)
Koivunen et al, 2015 <sup>*</sup>	x	✓	N/A	✓	✓	N/A	N/A	✓	✓	5/9 (5/6 applicable)
Baskaran et al, 2015 <sup>+</sup>	X	✓	N/A	X	X	N/A	N/A	✓	✓	3/9 (3/6 applicable)
Miller et al, 2014 <sup>+</sup>	x	✓	X	X	✓	N/A	N/A	✓	N/A	3/9 (3/6 applicable)

Yes (✓)

No (X)

Unclear (?)

Not applicable (N/A)

**Table 2: Critical Assessment using QARI (qualitative assessment tool)**

**\* denotes mixed methods studies**  
**# denotes third reviewer required**  
**+ denotes excluded after review**

Study	Congruity between the stated philosophical perspective and the research methodology. (It was agreed that if the study demonstrated a sound qualitative approach, it would be included)	Congruity between the research methodology and the research question or objectives (It was agreed that study design congruent with the interpretative paradigm would suffice)	Congruity between the research methodology and the methods used to collect data (It was agreed that methods congruent with the interpretative paradigm would suffice)	Congruity between the research methodology and the representation and analysis of data (It was agreed that representation and analysis of the data congruent with the interpretative paradigm would suffice)	There is congruence between the research methodology and the interpretation of results (It was agreed that the of results must be congruent with the interpretative paradigm)	Locating the researcher culturally or theoretically (It was agreed that the context of the study would suffice to meet this criteria)	Influence of the researcher on the research, and vice-versa, is addressed	Representation of participants and their voices	Ethical approval by an appropriate body	Relationship of conclusions to analysis, or interpretation of data.	Score
Asan et al, 2017	✓	✓	✓	?	✓	✓	X	✓	✓	✓	8/10
Chang et al, 2016	✓	✓	✓	✓	✓	✓	x	x	✓	✓	8/10
Dowding et al, 2015	✓	✓	✓	✓	✓	✓	x	✓	✓	✓	9/10
Heidarizadeh et al, 2017 <sup>#</sup>	N/A	✓	✓	✓	✓	✓	X	?	✓	✓	7/10
Kent et al, 2015	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	9/10
Liu et al, 2015	N/A	✓	✓	✓	✓	✓	X	✓	✓	✓	8/10
Shin et al, 2018	✓	✓	✓	✓	✓	X	X	✓	✓	✓	8/10
Staggers et al, 2011	✓	✓	✓	✓	✓	✓	X	?	✓	✓	8/10



Staggers et al, 2018	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	9/10
Holtz et al, 2011*	✓	✓	✓	✓	✓	✓	X	X	✓	✓	8/10
Koivunen et al, 2015*	✓	✓	✓	✓	✓	✓	X	✓	✓	✓	9/10

Yes (✓)    No (X)    Unclear (?)    Not applicable (N/A)

**Table 3: Included Studies**

Author(s) Country	Aim/Purpose	Setting or Context	Design & Sample	Measure/s	Analytical Methods	Results
(Asan et al. 2017) USA	To evaluate the use of a novel Health Information technology (HIT) in a pediatric ICU. Specifically, explored nurses' perceptions of the HIT and perceived effect on family engagement	Children's hospital PICU	Qual, PICU RNs (n=55)	Seven semi structured focus group interviews	Content analysis	Six major themes <ol style="list-style-type: none"> <li>familiarity and use routines,</li> <li>positive perceptions with the LCIM,</li> <li>negative perceptions with the LCIM,</li> <li>privacy,</li> <li>training, and</li> <li>suggestions for improvement.</li> </ol>
(Baskaran et al, 2015) India	To assess the knowledge and attitude of staff nurses to nursing informatics and determine the association between knowledge regarding nursing informatics with selected demographic variables.	Hospital	Quant, RNs (n=60)	Information Technology Attitude Scales for Health (ITASH)	Descriptive statistics, Chi-square tests	85% of respondents had no previous knowledge of nursing informatics. 53% and 45% of respondents had a negative or neutral attitude towards informatics (respectively). There was a significant
(Chang,et al. 2016) Taiwan	To examine the perspectives of nurses from paper to Electronic Health Records (EHR) and to explore the adoption process in different implementation processes	General medical and surgical wards of teaching hospital	Qual, female RNs, Total n=55 (stage 1 n=26, stage 2 n=29)	Four semi structured focus group interviews	Content analysis	Six major themes <ol style="list-style-type: none"> <li>liability, work stress, and anticipation for electronic health record</li> <li>slow network speed, user-unfriendly design for learning process</li> <li>insufficient information technology/organization support; on the second stage</li> <li>getting used to electronic health record and further system requirements</li> <li>benefits of electronic health record in time saving and documentation</li> </ol>

Author(s) Country	Aim/Purpose	Setting or Context	Design & Sample	Measure/s	Analytical Methods	Results
(De Veer et al 2011) The Netherlands	To gain a better understanding of the determinants influencing the success of the introduction of new technologies as perceived by nursing staff	Dutch hospitals, psychiatric organizations, care organizations for mentally disabled people, home care organizations, nursing homes or homes for the elderly	Mixed methods, nursing staff panel members; a permanent group of Nursing Assistants (NAs) and Registered Nurses (RNs) <i>n</i> =685	Open and close ended questionnaire developed for the study	Descriptive statistics, Chi-square tests "Coding"	6. unrealistic information technology competence expectation and future use.  25% of respondents rated the introduction technology as positive. The factors impeding actual use were related to the technology itself, eg malfunctioning, ease of use, relevance for patients, and risks to patients. Respondents stress importance of an adequate innovation strategy.
(Dowding et al. 2015) United States of America (USA)	To explore how nurses' use an integrated Electronic Health Record (EHR) in practice.	Two hospitals in northern California	Qual, multi-site case study, male & female RNs <i>n</i> =29	Non-participant observation & semi-structured interviews	Thematic Analysis	Key themes: Introducing the EHR improved: <ol style="list-style-type: none"> <li>1. communication,</li> <li>2. ease of access to information</li> <li>3. safety of medication administration processes.</li> </ol>
(Heidarizadeh et al, 2017) Iran	To explore nurses' perceptions of the challenges involved in the use of the electronic nursing documentation system based on the Technology Acceptance Model (V2)	Teaching hospital in Western Iran	Qual, Nurses with associate degree, bachelors degree and masters degree <i>n</i> =18	In-depth, semi structured interviews	Directed content analysis	Main categories: <ol style="list-style-type: none"> <li>1. Perceived usefulness <ol style="list-style-type: none"> <li>a. Subjective norms</li> <li>b. Experienced benefits</li> </ol> </li> <li>2. Perceived difficulty <ol style="list-style-type: none"> <li>a. Rationalisation</li> <li>b. Challenges in accepting change</li> </ol> </li> </ol>
(Holtz et al. 2011*) USA	To understand how hospital nurses perceived the implementation of a new electronic medical record (EMR) system	Midwestern regional hospital (rural area of Michigan)	Mixed methods. Registered Nurses (RNs) or Licensed Practical Nurses (LPNs) 113 participants.	Quant: UTAUT questionnaire (Venkatesh et al., 2003)	Descriptive statistics, Multiple regression analysis and a correlation matrix, T-tests  Thematic analysis	Quant: Social influence and performance expectancy were significant factors in system adoption. Effort expectancy did not have a significant influence on the intention to use the EMR Main themes (qual): <ol style="list-style-type: none"> <li>1. Social influence via superusers</li> </ol>

Author(s) Country	Aim/Purpose	Setting or Context	Design & Sample	Measure/s	Analytical Methods	Results
			Only ICU/CCU nurses were interviewed	Qual: Semi-structured interviews to capture concepts from the UTAUT, as well as general organizational and communication themes.		<ol style="list-style-type: none"> <li>2. Physicians not strong influencers</li> <li>3. EMR is a useful tool (except ICU/CCU participants)</li> <li>4. Nurses age influence perception of EMR use.</li> </ol>
(Hwang, 2011) Korea	To examine the factors affecting informatics competency to help develop strategies to improve nurses' informatics practice	Two tertiary teaching hospitals in Seoul, Korea	Quant: cross sectional survey Nurses n=350	Questionnaire designed for the study to collect data on nurses' informatics competency, basic computer skills, and attitudes toward computerization	Descriptive statistics, Student t tests and ANOVA tests, Pearson correlation coefficient, multiple regression analysis	69% of respondents considered their overall informatics competency below average. Scored highest on security and confidentiality, and lowest on telehealth. 59% rated their computer skills to be below average. Respondents had favourable attitudes toward computerization. Significant factors associated with informatics competency were basic computer skills and formal informatics education.
(Jensen et al 2016) Brazil	To identify informatics abilities essential to decision making in nursing management	All regions of Brazil	Quant: Survey study with specialist Brazilian Nurses in fields of health informatics and nursing management, n=32	Questionnaire developed based on the competencies Information Literacy (five categories; 40 abilities) and Information Management (nine categories; 69 abilities) of the TIGER – Technology Informatics Guiding Education Reform – initiative	Rasch analysis	In the information literacy competency, 18 abilities were considered essential and in Information Management, 38.

Author(s) Country	Aim/Purpose	Setting or Context	Design & Sample	Measure/s	Analytical Methods	Results
(Kent et al. 2015) Australia	To understanding the issue of acceptance of technology by nurses, allowing for a full exploration of participants' reactions to the new technology being proposed	Two hospitals in Australia (One public & One Private)	Qual, male & female RNs and ENs n=52	Four semi structured focus group interviews	Analysed using the 12 theoretical domains framework (TDF) and component constructs developed by Michie et al.(2005) as a guide.	Perceived threat to participants clinical skill, and capability to capture clinical workflow. Potential to integrate care between departments; help management and support of nursing processes; and coordinate patient care. Responses differed across sites, influenced by experiences.
(Kleib et. al 2010) USA	To identify the proportion and characteristics of U.S. registered nurses reporting continuing education in informatics in 2000	All RNs in the USA or district of Columbia	Secondary data analysis of data obtained from the 2000 NSSRN cross sectional survey. RNs from USA or district of Columbia n= 35,579.	The NSSRN is a cross-sectional survey conducted every 4 years by the U.S. Department of Health and Human Services, Bureau of Health Professions.	Bivariate and logistic regression analyses	21% of respondents reported CPE in informatics in the year before the survey. The probability of continuing education in informatics increased with Internet access and decreased for nurses working outside hospitals or providing direct patient care.
(Kleib et.al 2018) Canada	To determine self-perceived information competencies and factors associated with competency among practicing nurses in Alberta	Clinical practice sites in Alberta	Exploratory descriptive cross-sectional survey. n=2844 RNs (98.5%) and Registered psychiatric nurses	Canadian Nurse Informatics Competency Assessment Scale (C-NICAS)	Descriptive statistics, one-way ANOVA with post hoc comparisons, and general linear model univariate analysis	Perceptions of competency were highest on foundational computer literacy skills and lowest on information and knowledge management competencies. Mean scores varied significantly in relation to age, qualification, experience, and work setting. The quality of informatics training and support offered by employers contributed most to variance. Previous informatics education, CPE and training, access to the internet and resources, use of health technology and informatics role also contributed to mean scores variance.

Author(s) Country	Aim/Purpose	Setting or Context	Design & Sample	Measure/s	Analytical Methods	Results
(Koivunen et al. 2015*) Finland	Describe nursing professionals' experiences of the use of electronic devices for communication with colleagues and other healthcare professional	Outpatient clinics in one healthcare district in Finland	A cross-sectional survey (electronic questionnaire with structured and open-ended questions.) <i>n</i> =122, Response rate was 21% ( <i>n</i> = 41 Registered Nurses, <i>n</i> = 56), public health nurses, <i>n</i> =9 charge nurses, <i>n</i> =9 practical nurses, <i>n</i> =6 OT or Physiotherapist)	Questionnaire developed for the study	Descriptive statistics and content analyses.	Respondents mostly use email for communication. Question-answer programmes and synchronous communication channels on the Internet were least used. Electronic devices were used for: <ol style="list-style-type: none"> <li>1. communicating practical nursing,</li> <li>2. improving personnel competences,</li> <li>3. organizing daily operations</li> <li>4. and administrative tasks.</li> </ol> Respondents believe devices may: <ol style="list-style-type: none"> <li>1. speed up the management of patient data,</li> <li>2. improve staff cooperation and competence and</li> <li>3. make more effective use of working time.</li> </ol> Identified obstacles were: <ol style="list-style-type: none"> <li>1. concern about information security,</li> <li>2. lack of technical skills,</li> <li>3. unworkable technology and</li> <li>4. decreasing social interaction.</li> </ol>
(Liu et al. 2015) Taiwan	To explore informatic nurses' experiences and alternatives to assist the growth and development of nursing informatics in practice.	National - eight hospitals	Qual, RNs <i>n</i> =8	In-depth, 1:1, face to face interviews	Content analysis	The main themes included <ol style="list-style-type: none"> <li>1. diversified roles and functions,</li> <li>2. vague job description,</li> <li>3. no decision-making authority,</li> <li>4. indispensable management support,</li> <li>5. searching resources for work fulfillment.</li> </ol>

Author(s) Country	Aim/Purpose	Setting or Context	Design & Sample	Measure/s	Analytical Methods	Results
(Miller et al, 2014) USA	To identify what, if any, gaps exist between the informatics knowledge and skills self-reported by new/novice nurses and the informatics knowledge and skills that new/novice nurses demonstrate in acute-care settings, as reported by nurse managers.	Acute-care settings, defined as any healthcare setting, excluding primary and long-term care, that used EHRs	Quant, new/novice nurses <i>n</i> =222 and nurse managers <i>n</i> =326	Questionnaire developed for the study. New/novice nurses answered questions about their knowledge and skill levels in 28 areas and nurse managers answered questions about the extent to which new/novice nurses in their facility demonstrate each of 28 knowledge and skills. The knowledge and skills were identified by reviewing existing literature discussing critical knowledge and skills in using an EHR. Both participant populations were asked to answer questions about EHR access as a nursing student, factors affecting EHR knowledge and skills, length of time to be comfortable using EHR, workload issues related to EHR, and type and hours of training received on EHR use.	Descriptive statistics	There was agreement between new/novice RNs and managers that seven of the 28 skill areas were "strengths" (word processing, email, online classrooms/education, presentation development, Internet usage and search engines, keyboarding, and nursing note documentation). There was agreement between new/novice nurses and nurse managers that eight skills areas were development areas (database use, webpage design, electronic publishing, computer languages, coding for billing purposes, electronic billing/payment, graphic development, and order entry).

Author(s) Country	Aim/Purpose	Setting or Context	Design & Sample	Measure/s	Analytical Methods	Results
(Olajubu et. al 2015) Nigeria	To examine nurses' knowledge and attitude to the use of nursing informatics and determine the extent to which nursing informatics is being utilized in practice	Primary, secondary and tertiary health care facilities (n=37) across six major towns in Osun State, Nigeria	Cross-sectional survey design Nurses n=350	Self administered questionnaire, which assessed attitude to nursing informatics, and accessibility to resources, knowledge and utilization of nursing informatics. Questions on attitude were adapted from Pre-test for Attitudes toward Computers in Healthcare (PATCH) Assessment Scale version 32	Descriptive statistics	61% of respondents demonstrated poor knowledge of nursing informatics. 62% of respondents in secondary & 66% in tertiary facilities had a positive attitude towards utilization of nursing informatics. 1 of the the 37 facilities had functioning computers and 54% of respondents never had access to computers at work. 50% of respondents in primary 75% in secondary & 66% in tertiary facilities do not utilize nursing informatics in providing services.
(Shin et al, 2018) Australia		Tertiary, acute, public hospital	Qual. N=6 clinical nurse educators significantly involved in supporting graduates	One focus group	Thematic analysis.	Main barriers: 1. Graduates inadequately prepared to use NI tools 2. Inefficient hospital systems 3. Discouraging ward culture 4. Lack of exposure to systems as a student
(Staggers et al. 2011) USA	To explore nurses' information management and use of electronic tools before and during nursing handoffs	One tertiary care facility & one cancer specialty hospital in Western USA	Qual, Handoffs n=93	Audiotaping handoffs, semi-structured interviews, observations, and fieldnotes	Descriptive coding	5 themes (from 33 categories): 1. "good nurse" expectations for handoffs, 2. paper forms are best, 3. information at a glance, 4. only pertinent information please, and 5. information tools that work



Author(s) Country	Aim/Purpose	Setting or Context	Design & Sample	Measure/s	Analytical Methods	Results
(Staggers et al. 2018) USA	To understand usability pain points faced by nurses regarding the use of health IT, identify their impact and importance, discuss responsibilities, and develop possible solutions to improve the health IT-user experience for nurses.	Experts in the areas of health IT design and national leaders who were nursing experts or those who interacted frequently with nurses were sought	Qual, <i>n</i> =27 ( <i>n</i> =9 nursing/NI, UX professional leaders <i>n</i> =4, nursing researchers <i>n</i> =7, and site leaders from a variety of settings across federal and non federal healthcare sectors <i>n</i> =7)	Semi-structured interviews	Content analysis	Four themes emerged: 1. user experience pain points 2. importance of the issues 3. the responsibility gap 4. acting on usability issues.
(Wei-Lan et al. 2013) China	To determine nursing informatics implementation in Qiqihar, China Specifically, to evaluate the relationship between NI and clinical competence, including NI's role in clinical decision making, nursing research, nursing outcomes, professional development, and the patient-nurse relationship	Three hospitals in Qiqihar, China; 1. General hospital, 2. Gynaecological/obstetric & infant hospital 3. Affiliated Hospital	Descriptive survey, <i>n</i> =150 RNs, ( <i>n</i> =50 from each hospital)	Four-part questionnaire developed for the study; Part 1: respondent characteristics. Part 2: NI mission, implementation, applications, patient care management and HIS. Part 3 advantages of NI for clinical practice. Part 4 disadvantages associated with NI implementation.	Descriptive statistics, logistic regression and chi-square analyses.	Nursing informatics was adequately implemented and nurses were knowledgeable about information systems. Respondents identified advantages particularly usefulness in patient care. Respondents identified hospital information system instability as an obstacle to implementation.

NOTE: \*Mixed methods studies

**Table 4 – Data Synthesis**

Themes	Source/s
<b>1) User proficiency and competence</b>	
a) Age is factor (younger tend to be more able and accepting/adaptable to new technology)	(Holtz & Krein, 2011; Hwang & Park, 2011; Kleib & Nagle, 2018; Kleib, Sales, Lima, Andrea-Baylon, & Beait, 2010; Shin, Cummings, & Ford, 2018; Wei-Lan, Li-Qun, & Hong-Yu, 2013)
b) Experience is a factor	(Holtz & Krein, 2011; Hwang & Park, 2011; Kleib et al., 2010; Wei-Lan et al., 2013)
c) Qualification is a factor and relies on adequate, early and ongoing informatics education	(Hwang & Park, 2011; Kleib & Nagle, 2018; Kleib et al., 2010; Olajubu, Irinoye, Ogunfowokan, & Olowokere, 2015; Shin et al., 2018; Wei-Lan et al., 2013)
d) Previous ICT education is a factor	(Kleib & Nagle, 2018)
<b>2) Point of care access to</b>	
a) Evidence (need help critiquing)	(Shin et al., 2018)
i) Clinical care eg Wound care	(Kent et al., 2015)
ii) Decision making eg policies and procedures	(Jensen, Guedes, & Leite, 2016)
iii) Can quickly share evidence	(Koivunen, Niemi, & Hupli, 2015)
b) EMR / EHR / HIS	
i) Improves quality of pt care and facilitates family involvement in care	(Asan, Flynn, Azam, & Scanlon, 2017; Dowding, Turley, & Garrido, 2015; Kent et al., 2015; Wei-Lan et al., 2013)
ii) Improves communication between health professionals	(Dowding et al., 2015; Koivunen et al., 2015; Staggers, Clark, Blaz, & Kapsandoy, 2011; Wei-Lan et al., 2013)
iii) Improves pt and family education	(Asan et al., 2017)
iv) Reduces errors	(Wei-Lan et al., 2013)
v) Decreases workload and improves time Mx	(Koivunen et al., 2015; Wei-Lan et al., 2013)
<b>3) Nurses concerns</b>	
a) Time away from the patient which increases workload	(Dowding et al., 2015; Holtz & Krein, 2011; Kent et al., 2015; Staggers, Elias, Makar, & Alexander, 2018)
b) Stress and frustration related to time, technical issues, duplication	(Chang, Lee, Liu, & Mills, 2016; Liu, Lee, & Mills, 2015; Staggers et al., 2011; Staggers et al., 2018)
c) Confidentiality and privacy of patient data	(Asan et al., 2017; Koivunen et al., 2015)
d) Copyright and plagiarism	(Jensen et al., 2016)
e) Can also cause pt and family concerns	(Asan et al., 2017)
<b>4) Investment for implementation</b>	

a) Nurse champions / leaders should be involved in development so that the system solves their problems and in evaluation. This involvement assists with adaption and acceptance.	(Chang et al., 2016; de Veer, Fleuren, Bekkema, & Francke, 2011; Kent et al., 2015; Liu et al., 2015; Staggers et al., 2011; Staggers et al., 2018)
b) Nurses need orientation, training and ongoing support	(Asan et al., 2017; Chang et al., 2016; de Veer et al., 2011; Koivunen et al., 2015; Liu et al., 2015; Shin et al., 2018; Staggers et al., 2018; Wei-Lan et al., 2013)
c) Nurses need time to adopt and adapt	(Chang et al., 2016; de Veer et al., 2011; Kent et al., 2015)
d) System should be stable / fast / accessible to prevent	(Shin et al., 2018)
i) disruption	(Asan et al., 2017; Koivunen et al., 2015; Staggers et al., 2011; Staggers et al., 2018; Wei-Lan et al., 2013),
ii) workarounds, problem solving, avoidance	(Chang et al., 2016; Liu et al., 2015)
iii) reverting to (preferring) paper	(Dowding et al., 2015; Staggers et al., 2011)

**Table 5: Implications for practice, policy and education**

Practice	Policy	Education
Allocation of time for nurses to explore and practice using digital platforms at the point of care delivery	Inclusion of nurse leaders, nurse informaticians and nurse clinicians in the development of digital platforms and systems	Incorporation of curriculum content that builds on student nurses pre-existing digital capability
Digital services (help and support) for nurses to troubleshoot and problem solve usability, technical and reliability issues	Development of guidelines regarding the confidentiality and privacy of patient and other sensitive information	Continuing professional development to maintain and build digital capability in nurses
Provision of point of care access to the evidence with education and support to identify appropriate clinical information	Thorough implementation strategy with engagement and appropriate timeline for the implementation of new technologies	Quarantined education time in orientation and in-service education
Widespread use of electronic medical records as a means to improve care quality and safety		Buddies, preceptors and mentors identified and allocated to support the development of digital capability in nurses
		Patient and family education regarding use and types of digital technologies used in their care delivery



# PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
<b>TITLE</b>			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
<b>ABSTRACT</b>			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1
<b>INTRODUCTION</b>			
Rationale	3	Describe the rationale for the review in the context of what is already known.	2
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	2
<b>METHODS</b>			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	NA
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	2
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	2
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	2
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	3-4
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	3-4
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	NA
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	NA
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	NA
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., $I^2$ ) for each meta-analysis.	4



# PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	4
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	NA
<b>RESULTS</b>			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	5-7
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Table 3
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	NA
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Table 3
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	NA
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	NA
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	NA
<b>DISCUSSION</b>			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	7
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	7
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	7-8
<b>FUNDING</b>			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	Acknowledged

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