8-10-2020

Increasing the Effectiveness of Clinical Practices with Health Informatics: Systematic Literature Review

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Abstract

Healthcare informatics involves different areas and activities like data collection, data analysis, and knowledge sharing among health care professionals. Healthcare Informatics scholars have been contending that the advancement in the discipline can enable healthcare professionals to provide better care to patients and the public. The current study goal is to identify the effectiveness of health informatics in improving clinical nursing practice from recent literature. We followed the systematic literature review by reviewing research papers published in the period between 2009 until 2019. The extracted data showed that there are four main themes of the nursing practices that are affected positively by the implementation of healthcare informatics. Namely, they are promoting quality of healthcare, improving electronic documentation of nursing practice, improving technological competencies and leadership practices, and improving clinical decision making. We discuss the findings and identify gaps to better direct future research in this area.

Keywords: Health Informatics, Informatics Effectiveness, Clinical Practices, Literature Review

Introduction

Healthcare informatics is the "science that consists of subjects such as data collection, data analysis, and knowledge sharing among health care professionals, so that they can provide better cares to patients and the public" (Ravi et al ., 2016).

Health informatics science is simply the study of resources and methods for the management of health information. It is also the acquiring, storing, retrieving and using of healthcare information to foster better collaboration among a patient's various healthcare providers (Coiera, 2015).

The significance of healthcare informatics science stems from its ability to improve the healthcare field by improving the quality and safety of patients care with electronic medical records, reducing the costs of medical errors, and with the use of patient portals it can encourage patient participation (Wan, 2006). In addition, it has the ability to share knowledge between healthcare providers. It provides the healthcare providers a way to know about their patient from other providers (Ravi et al., 2016).

Nurses are at the hub of information management of healthcare, and so, technology has permeated every aspect of healthcare; therefore, nurses have to be at the center of the technology in healthcare spot. Nursing informatics has been defined as the science and practice that integrates nursing, its information and knowledge with management of information and communication technology to promote the health of people, families and communities (McCormick and Saba., 2015). The American Nurses Association (ANA) has defined nursing informatics as "a specialty that integrates nursing science of multiple information and analytical sciences to identify, define, manage, and communicate data, information, knowledge and wisdom in the nursing practice" (Harrington, 2015).

There are a lot of forces that gives a rationale of nursing informatics. The institute of medicine (IOM) which have expressively written core competencies for all healthcare professional, including nurses, in order to be better and able to deal with information (Bakken et al., 2004). In addition, the Presidential Information Technology Advisory Committee (PITAC) has put four safety and quality reasons and ideas to have a standardized terminology between all parts and disciplines, which means that information and computers should be talking the language of healthcare (Force, 2004).

Nursing driving forces include that the National Center for Nursing Research (NCNR), which is an arm of the National Institute of Health (NIH), have created program goals for nurses and the competencies that nurses should have. These core competencies were adopted by the American Nurses Association (ANA), the National League for Nursing (NLN), and the American Association of Colleges of Nursing (AACN).

There are some other forces involved outside of clinicians and federal government, in particularly, the agency for healthcare research and quality (HRQ) that launched an initiative to improve patient quality and safety, one of the biggest initiatives that has been part of that need to interface with informatics is the barcoding of medication administration (Harrington, 2015).

Some of the benefits of informatics is that, in the past when everything was on paper, things were kind of buried, to find a patient record individually, maybe something you could manage, but finding trends in the patient care may be more difficult to see, and if you are looking for trends within a community, those might be nearly impossible to connect the dots because it would take a lot of manual pieces of paper, and somebody sitting down with a piece of grid paper and drawing some lines between things to try to find these patterns. With the advent of computer and

information sciences, working with nursing and other healthcare informatics, it is possible to find these patterns easier (Aitken et al., 2018).

It also improves the communication between the providers, and now the information isn't simply on a written piece of document, and this information can flow electronically between agencies and providers, to be able to get that information quicker and to find patterns a little sooner (Hind et al., 2017).

Easy, quick storage and retrieval of records, and saving of time and money are other benefits of healthcare informatics. It is more efficient if you are looking for patient's data or community data, as it is easier to retrieve information and it is a savings money as well because if things are coded appropriately, then it is possible to identify those areas where charges may not have been documented correctly and the healthcare setting may lose money because of poor coding (Robertson et al., 2016).

Other benefits of healthcare information include enhancing practice and allowing nursing sciences to develop, improving the quality of documentation, quality control and research, and building evidence-based foundation for nursing knowledge (Subbe et al., 2019).

Despite the huge advances in the field of healthcare informatics, there is a restricted amount of studies that provide unreliable evidences supporting the assumption that healthcare informatics improve the clinical nursing practice in developing countries.

Wu, Wang, and Ji (2017) have reported that integrating information and communication technology has significantly improved nurses practice in Mainland China, Hong Kong and Taiwan. In another study performed by Al-Hawamdih and Ahmad (2018) that aimed at examining nursing informatics competencies and its relation to the quality of information processing had reported that there were several predictors which explained the variation of information processing among the studied nurses. These factors included nurse's informatics competencies, their clinical specialties and the number of years in service.

In another study that was carried out by Al-Rawajfeh and Tubaishat (2017), the study sought to identify the obstacles and facilitators of using e-records by Jordanian healthcare workers from nurses' perspectives. The study reported that incentives to purchase electronic healthcare records and the availability of technical support were the most reported facilitators of using healthcare e-records. On the other hand, lack of financial resources, lack of IT staff and disruption of clinical care were the most reported obstacles.

A though rough review of the literature about the use of healthcare informatics in the nursing field indicated that most of the research papers are still in the preliminary stage which discuss the issues of integration, facilitators, barriers, competencies, knowledge and perceptions of the healthcare workers. There were no studies that discussed the effectiveness of healthcare informatics in improving clinical nursing practice in developing countries.

Research question

To guide the current systematic review, the following research question was formulated:

"**What is the effectiveness of healthcare informatics in improving clinical nursing practice in developing countries?**"

To answer the previously stated research question, the researcher conducted a systematic literature review to identify the impact of using healthcare informatics on improving the clinical nursing practice in developing countries. In the methodology, the systematic review process consisted of three phases: planning the review, conducting the review and data extraction and synthesis.

Methodology

Theoretical basis

Systematic review is a method of identifying and synthesizing research evidence that fits pre-specified criteria in order to answer a specific question (Higgins and Green., 2011). The purpose of systematic review is to call existing research on specific question by synthesizing results of several studies. They should be conducted with the same rigor that is expected from the primary search (Okoli and Schabram., 2010).

A systematic review uses transparent procedures to find and synthesize the results of relevant research (Littell, 2005). Procedures are explicitly defined in advance in order to ensure that the exercises are transparent and can be replicated. Studies included in the review are screened for quality (Campbell and Phelps., 2012).

The overarching aim of a systematic review should be to summarize and help people understand the evidence (Gough, Oliver and Thomas., 2017). A number of factors may motivate authors to undertake a systematic review (Kirk et al., 2015). For example, reviews can be conducted in an effort to resolve conflicting evidences to explore variation of practice or to confirm the appropriateness of current practice. Systematic reviews may demonstrate when knowledge is lacking and can be used to guide the research (Boland, Cherry, and Dickson., 2017).

By synthesizing the results of multiple studies, a systematic review provides a more comprehensive picture than a single study (Moher et al., 2015). When connected well, systematic review should give the best possible estimate of any true effect. As of all research though, the value of a systematic review depends on what was found and the theory of reporting (Eden, Levit, Berg, and Morton., 2011).

As mentioned earlier, studies that investigated the effectiveness of healthcare informatics in improving nursing clinical practice in developing countries provided unreliable evidences supporting the reported positive contribution of healthcare informatics in improving nursing practice in developed countries. Therefore, a systematic review of those studies will provide a better understanding of the healthcare informatics effectiveness issue.

Reasons for adopting systematic literature review

Systematic literature review should be performed based on a previously set and defined search protocol or strategy. The search strategy should allow the assessment of the carried-out search (Staples and Niazi., 2007). Many reasons were behind performing a systematic literature review, the most significant were:

1. Summarizing the present empirical evidences regarding the effectiveness of healthcare informatics in improving the clinical nursing practice in developing countries (Okoli and Schabram., 2010).

2. Identifying the gap in the present research studies in order to highlight and uncover the areas that require further investigation (Okoli, 2015).

3. Providing a clear framework that guides the new research studies (Bettany-Saltikov, 2015).

Important features of systematic literature review

systematic literature review is different from the conventionally performed literature review; there are many features that create this distinction:

1. In systematic review, there is a development of a search protocol that includes setting a research question and a clear methodology that will be adopted to perform the literature review (Akobeng, 2005).

2. The adopted pre-defined search strategy will be seeking to extract the maximum number of related research studies (Jalali and Wohlin., 2012).

3. Both the search strategy and the findings are documented for referencing and citation issues (Greenhalgh and Peacock., 2005)

4. In systematic literature review, it is a must to specify inclusion and exclusion criteria that are used to select the related studies (Hartley, 2000).

5. Systematic reviews restrict the data that are needed to be extracted and assessed from the included studies (Okoli, 2015).

6. A systematic review is a pre-requisite of the quantitative meta-analysis that integrates related studies from different resources on the same topic (Piper, 2013).

The process of systematic literature review

Conducting a systematic literature review includes different activities. There are three major steps when carrying out a systematic review (Wright, Brand, Dunn, and Spindler., 2007):
- Planning the review.
- Implementation of the review.
- Reporting the review

These steps are shortly explained in the upcoming sub-sections:

Planning the review:

Planning is the first step of conducting a systematic literature review. It contains setting a plan of the next steps. In this step, the researcher formulates the research question that will be answered through carrying out the systematic literature review (Butler, Hall, and Copnell., 2016).

After the analysis of the rationale of the systematic review, the databases and other secondary sources are searched for any previous systematic reviews that address the suggested research question. Then, the researcher develops a search strategy specifying the steps followed during the systematic review (Okoli, 2015).

The systematic review protocol includes the following (O'Connor et al., 2014):
- Gathering background information related to the topic of the systematic literature review.
- Identifying and formulating the research question.
- Listing the databases and other data sources that are going to be searched.
- Specifying the inclusion and exclusion criteria.

- Preparing checklists that will be used to assess the quality of the studies resulted from searching the databases and other resources.
- Specifying the techniques that will be used to extract data from the studies.
- Setting a timeline that determines the start and end points of the systematic literature review.

Implementing a systematic review

After preparing the reviewed protocol, the researcher identifies the sources and databases that will be used to perform the systematic reviews.

- **Search process:** in this step, the researcher determines a search strategy that will follow to carry out the systematic review. The search strategy includes exploring both electronic scientific databases and other related sources that might include studies related to the topic of interest. The researcher documents the whole search process, so that it can be transparent, replicable and might be analyzed again (Moher et al., 2015).
- **Study selection:** in this step, the researcher selects the most suitable and related studies. The studies are selected based on the previously set inclusion and exclusion criteria. The inclusion and exclusion criteria are set based on the formulated research question (Okoli, 2015). Further, the inclusion and exclusion criteria are applied to restrict the studies to the most related studies meeting these criteria.
- **Study quality assessment:** the researcher will assess the quality of the relevant studies after they are subjected to the inclusion and exclusion criteria. Assessing the quality of the studies is based on three different factors: Bias, internal and external validity. Quality assessment of the studies is measured through using a tool, mostly a checklist that includes reference factors and standards that will be subjected to evaluation for each study (Henderson et al., 2010).
- **Data extraction:** the aim of this step is to develop forms to extract data. These forms will be used to record data gathered from the relevant studies accurately. It is significant in this step to avoid duplication. If data are extracted from unpublished or running studies, the researcher must report and clarify the limitations related to these data. Extracting data from the relevant studies includes two stages: primary analysis and secondary analysis (Butler et al., 2016).
- **Data synthesis:** synthesizing data includes to collect and summarize the findings of the included primary studies. Shortly, the extracted amount of data is synthesized for reporting (Moher et al., 2015). Data synthesis provides an answer of the formulated research question.

The answer of the research question might not be built on a single study. It could be built based on evidences provided by many research papers. The researcher has to specify and record all sources that are used to provide an answer to the research question (Uman, 2011).

Reporting the systematic literature review

The final step of a systematic review includes documenting the findings of the systematic review. The reporting of a systematic review must be accurate, precise, and following a scientific writing approach (Higgens and Green., 2011).

The current review was conducted in compliance with Preferred Items for Systematic Reviews and Meta-Analysis (PRISMA-NMA) extension statement for reporting of systematic reviews.

Search strategy

To identify studies related to the effectiveness of healthcare informatics in improving the clinical nursing practice in developing countries, the researcher conducted a comprehensive search of relevant databases to identify what databases are determined by the topic area. Three databases were chosen (The Cochrane Central Register for Controlled Trials (CENTRAL), PubMed, and Embase databases).

Based on the research question designed by the researcher, the search terms were determined, they are those terms that most likely to be found in the title and abstract (Health informatics, nursing, clinical practice).

Medical subject headings (MeSH) terms were used in the search process to ensure the coverage of all relevant studies to the topic area. The search keywords are composed by the terms representing the population, intervention and comparison in table (1).

Table (1): Search keywords

Health informatics	Nursing	Clinical practice
"medical informatics"[MeSH Terms] OR Health informatics[Text Word]	"nursing"[Subheading] OR "nursing"[MeSH Terms] OR Nursing[Text Word]	clinical[All Fields] AND practice[All Fields]

Inclusion criteria

The researcher applied the following inclusion criteria in order to include the search results in the systematic literature review. The research studies that were published in English language between

2009 and 2019 in peer reviewed journals. In addition, in order for a research study to be included, its reported outcome had to be relevant to the current study outcome, which is the effectiveness of healthcare informatics in improving nurses clinical practice.

Exclusion criteria

The studies not meeting one or more of the inclusion criteria were excluded from the current review. Research papers older than 2009 were excluded.

Data extraction and management

data extraction

The researcher adopted the "data collection form for intervention review – RCTs and non-RCTs" of the Cochrane collaboration. The form includes a part for the general information about the review. In the following parts, which are used to extract data, study eligibility is assessed through recording the study characteristics, type of study, participants, types of intervention, type of comparison, types of outcome measures, in addition to a decision of including or excluding of the study. If the study is excluded, a free-text space is provided to state the reasons for exclusion.

In case the study is included, the following parts (characteristics of the included studies, participants intervention groups, outcomes, risk of bias assessment, data and analysis, and other related information) are filled.

Data synthesis

Data synthesis incudes gathering and summarizing the findings of the selected primary trials. Due to the heterogeneity of the data of the primary studies, qualitative synthesis is performed on the extracted data.

Validation of the review protocol

The review protocol is considered as a guide for the actual implementation of the study, thus it is the most significant and critical component of a systematic literature review. Validating the review protocol is necessary to ensure the transparency and the high quality of the review.

Quality assessment of the included studies

The researcher performed a full quality appraisal of the included studies using the Consolidated Standards of Reporting Trials (CONSORT) checklist. The CONSORT checklist includes 25 ITEMS that assess the content of the research papers. It aims to improve the reporting of systematic reviews and meta-analysis (Alamri and Alharbi., 2018).

Assessing the quality of the studies is performed for evaluating the included research papers. It is a very challenging issue to determine to what extent the validity threats have been addressed by the author. Actually, the quality assessment was performed based on the study structure criteria. The evaluation of the included studies was carried out based on: Title, abstract, introduction, methods, results, discussion and findings (Boutron et al., 2017), as following:

1. Title: identifying the indexing of the included study as a randomized controlled trial. The author(s) of the study should include the word (randomized) within the title to point that the subjects of the study were randomized to their groups.

2. Abstract: the abstract must be structured in a way that summarizes the trial design, methodology, findings and withdrawn conclusions. Recommended items to include when reporting a randomized controlled trial in a journal abstract are: Author(s), design of the trial, methodology (subjects, interventional procedure, aim, outcome, randomization, masking), findings, conclusion, trial registration and funding.

3. Introduction:

- Background: if a scientific background is provided, in addition to providing a rationale of the study.

- Objectives: if the author(s) stated the objectives or hypotheses of the study.

4. Methods:

- Trial design: whether the author(s) described the trial design and included the allocation ration.

- Changes of trial design such as stating eligibility criteria, with justifications.

- Setting of the study: whether the author(s) stated the location(s) of data collection.

- Intervention(s): whether the author described the interventional procedure for both the control group and the interventional group.

- Outcomes: whether the author(s) pre-specified primary and secondary outcome measures, including assessment point and method.

- Changes of outcomes: stating any changes to the primary and secondary outcome measures with justifications.

- Sample size: stating the way of determining the sample size.
- Explaining any interim analyses and stopping guidelines, if applicable.
- Randomization of the participants: type, mechanism, and implementation.
- Blinding or masking.
- Similarity of interventions (if applicable).
- Statistical tests and methods.

5. Results:
- Participants' flow: random assignment, receiving intervention, and analyzed for primary outcome.
- Lost and excluded participants after randomization after the treatment with justifications.
- Defining the dates of recruiting and following up.
- Reasons(s) for stopping or ending the trial.
- Baseline data of the study participants in both groups (control and interventional).
- The number of the participants analyzed in each group.
- Outcomes and estimation: stating the primary and secondary outcomes of the control and the interventional groups, in addition to estimating the effect size and its accuracy (for instance 99% confidence interval).
- Binary outcomes: presenting both absolute and relative effect sizes.
- Ancillary analysis: providing results of any other conducted analyses.
- Harms: providing any significant harms or unintended effects in each study group.

6. Discussion:
- Providing limitations of the study and any possible bias or multiplicity of analyses.
- Generalizability: The external validity and applicability of the study results.
- Interpretation: interpretation is in line with the results and there is a balance of benefits and harms. In addition to consider any related evidences.

7. Additional information
- Trial registration: is the trial registered and the name of trial registry.
- If it is possible to access the full trial protocol.
- Source of funding

Conducting the review

The search strategy based on the validated review protocol is applied, starting with a pilot search and followed by the actual search.

- **Selection of databases and keywords**

To get a general idea about the quantity of the articles, the researcher performed a quick search on Google Scholar using the keywords: Health informatics, nursing and practice. Approximately 37.900 hits were found that included articles, patents and citations. Narrowing the search to the period of 2009 until 2019 yielded 97.600 hits.

Since Google Scholar searches across resources like articles, books, theses, abstracts, etc. to get more precise results, the researcher continued the search in various databases. The search was conducted in two phases: pilot search and actual search. The main objective of the pilot search was to identify the relevant and appropriate sources of articles.

- **Pilot search**

Since the aim of the pilot search is to find as many results as possible, no limitations were defined for the publication year while searching for the articles. In this stage, all articles related to the effectiveness of healthcare informatics in improving clinical nursing practice were included.

- **Search results**

The results of the pilot search are presented in table (2); the results shown in numbers are the total number of the articles that were found with the defined keywords used.

Keywords	Pubmed	Wiley Online Library	CENTRAL
Medical informatics AND nursing AND clinical practice	13	20	10
Healthcare informatics AND nursing AND clinical practice	6	24	63

The pilot search resulted in a total of 19 hits in PubMed, 44 hits in The Wiley Online Library, and 73 hits in CENTRAL. The search terms "Medical informatics AND nursing AND clinical practice" and "Healthcare informatics AND nursing AND clinical practice" were the highly keywords that yielded search results from the databases.

- **Actual search**

The actual search was conducted in PubMed, CENTRAL and The Wiley Online Library databases with the search keywords ""Medical informatics AND nursing AND clinical practice" and "Healthcare informatics AND nursing AND clinical practice" on January 2, 2020. The researcher applied the inclusion criteria and documented the search results.

Included studies were subjected to quality assessment in order to evaluate its quality through a group of set standards (discussed above)

Results

A total of 136 studies were identified. One hundred and twenty articles remained after duplicates were removed. After title and abstract screening, 14 articles were selected as relevant to our criteria. After full text screening, only 7 studies were eligible for systematic review (See Figure 1).

Thematic analysis procedure

Based on thematic analysis of the included studies, four themes were identified. These themes are as following:

1. Promoting quality and healthcare

   Darvish et al (2014) had reported that health informatics and technology plays a significant role in nursing practice. It had been reported that the key elements of nursing informatics implementation were considered as health care promotion, advanced systems, internet and network, because of the rapid development, to efficiently get use of IT in nursing outcome and quality of health care and to empower nurses; educational arrangement is recommended to hold specialized courses and workshops focusing on four target groups: studying, working, graduate, senior undergraduates and graduate doctoral.

   Wei-Lan, Li-Qun, and Hong-Yu (2013) had reported that despite the relatively brief training period, nursing informatics was adequately implemented among the Chinese nurses.

Respondents identified several key advantages of nursing informatics implementation, particularly its usefulness in aiding patient care for data management.
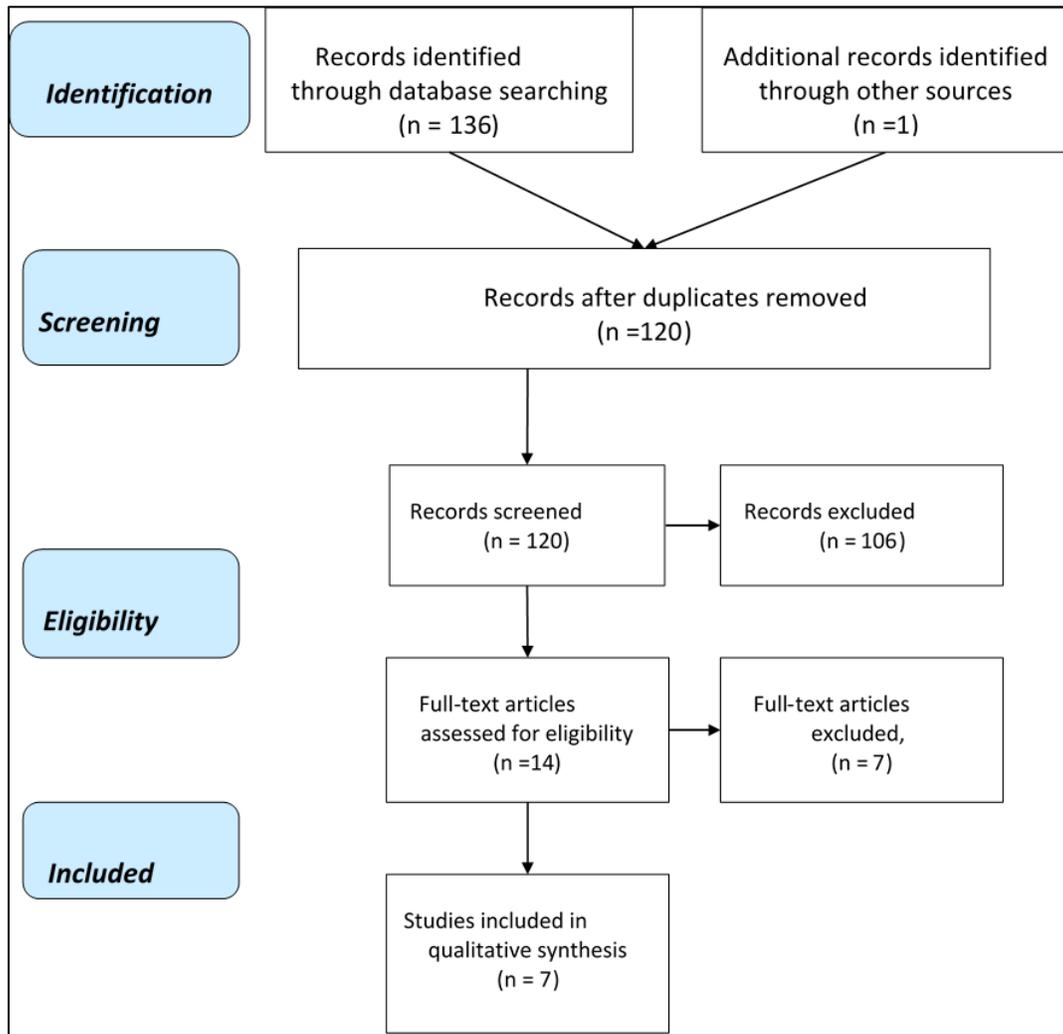

Figure 1

2. Electronic documentation of nursing practice

Saba et al (2018) developed a clinical care classification (CCC) system for the electronic documentation of patient care by nurses and allied health professionals. The developed panel focused on point-of-care solutions for the documentation of nursing practice in electronic

health record and/or healthcare information technology systems using the clinical care classification systems.

3. Improving technological competencies and leadership practices

Gartrell, Trinkoff, storr, Wilson (2015) had reported that using electronic personal health record among nurses in the nursing informatics community promotes the leadership practices and improves the staff technological competencies. The study findings were significant to inform policy efforts to encourage informatics and other professional nursing groups to become leaders and users of electronic personal health records, such use could help them endorsing and engaging patients to use electronic personal health records.

4. Decision making.

Hewner, Sullivan and Yu (2018) indicated that using healthcare information exchange to deliver appropriate and timely evidence-based clinical decision support in the form of care transition alerts and assessment of social determinants of health, in conjunction with data science methods, demonstrates the value of nursing care.

Whalen et al (2016) had analyzed the nursing clinical decision support requests and strategic plan in a large academic health system. It had been reported that a continuum of types of nursing clinical decision support needs emerged using the data-information-knowledge-wisdom conceptual framework: 1) facilitating data capture, 2) meeting information needs, 3) guiding knowledge-based decisions clinical interpretation by the nurse.

Khong et al (2015) explored the concepts that informed the registered nurses' decision to adopt the wound clinical decision support systems as an evidence-based technology in their nursing practice. The study identified eight emerging themes, namely, use of the wound clinical decision support system, beliefs in the wound clinical decision support system, unfluences of

the workplace culture, extent of benefits, professional control over nursing practices, use of knowledge, gut feelings, and emotions.

Conclusion

The current study aimed at identifying the effectiveness of health informatics in improving the clinical nursing practice. The extracted data showed that there are four main themes of the nursing practices that are affected positively by the implementation of healthcare informatics, namely, promoting quality of healthcare, improving electronic documentation of nursing practice, improving technological competencies and leadership practices, and improving clinical decision making.

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