

ELECTRONIC MEDICAL RECORD IMPLEMENTATION IN NURSING PRACTICE:  
A LITERATURE REVIEW OF THE FACTORS OF SUCCESS

by

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Bridget Anne Steiner

April 2009

DEDICATION

This work is dedicated to with love to my husband, Scott, and my daughter, Keely.

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## ABSTRACT

This is a review of the current literature to discern what factors need to be present in an electronic medical record (EMR) implementation in order for it to be successful for nurses. An extensive literature search was performed by using databases CINAHL, MEDLINE, and Health Reference Center for primary sources of research that specifically addressed EMR implementation and nursing. A coding scheme was developed and applied to each article for analysis. It was found that fit of the EMR with nurse functions, education, and positive nurse attitude were the three most common factors associated with successful EMR implementation for nurses. Lack of computer system quality, lack of fit of the EMR with nurse functions, and time requirements of its use were most commonly associated with lack of success.

## RESEARCH PROBLEM

### Introduction

The current environment of managed healthcare, in which most nurses work, is driven by the need to get the most productivity out of scarce resources (Kellum & Gillmer, 2000). Furthermore, in 2004, President Bush announced a federal initiative for all health care systems to transition from paper-based data management to electronic-based data management (Brailer, 2005). These trends are influencing health care organizations to transition from paper-based to electronic or computer-based documentation systems. How this technological revolution will affect the work of nurses over the next few decades is uncertain.

This literature review will identify the factors that promote successful electronic medication record (EMR) implementation in nursing practice. The goal is to discover and highlight the major issues of EMR implementation for nurses. This knowledge can help future nurses, nurse informaticists, nurse managers and nurse administrators anticipate and prepare for the challenges of EMR implementation.

### Purpose

The purpose of this literature review is to analyze the evidence that exists regarding what makes implementation of EMRs successful in terms of nursing practice. This review will focus on the transition process that nurses complete when incorporating EMRs into their practice, and what factors contribute to a successful, or unsuccessful, transition.

## Background

What is an Electronic Medical Record? Definitions of key terms will be addressed later. However, a brief explanation of the electronic medical record, or EMR, is warranted at this time. An electronic medical record is, according to the latest definition from the National Alliance of Health Information Technology (NAHIT), “an electronic record of health-related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within one health care organization” (2008, p. 6). An EMR characteristically contains lists of patient problems, medications, allergies, as well as health maintenance data, progress notes, various test results, and ordering functions (Bates, Ebell, Gotlieb, Zapp, & Mullins, 2003).

Historical Perspective of Electronic Medical Records. The Department of Family Medicine at the University of South Carolina was one of the first known organizations to develop and use an EMR in 1972. It was a system created and maintained by the Department, not an outside vendor, and consisted of mini-computers maintained by on-site programmers. In the 1990s, it became apparent that a better, more economical system of EMRs could be purchased from a computer software company. In April of 1991, the Department of Family Medicine transitioned to a new system from an outside vendor (Ornstein, Oates, & Fox, 1992).

By the early nineties, the idea of widespread EMR implementation was on the horizon. Organizations, while not yet utilizing a full-fledged EMR, had begun to use

computer programs to manage data on test results and patient demographics (Sane, 1990). Health care information technology planners realized that the next logical step for health information systems was a completely integrated EMR (Dunbar, 1990).

Recent Developments. As health care organizations progress into the twenty-first century, the interest and implementation of EMRs has grown significantly (Carroll, Bradford, Foster, Cato, & Jones, 2007). Anecdotes on the benefits of EMRs, from several health care organizations that have implemented them, include increased patient safety by reducing medical errors, time efficiency, and decision support tools (Deese & Stein, 2004). EMRs can help promote teamwork across disciplines by enhancing the visibility of each disciplines' work. The EMR also has the capacity to track outcomes specific to nursing by capturing and compiling nursing data (Beaty, 2007). However, extensive EMR implementation is has not yet occurred due to the vast financial and organizational requirements (Ash & Bates, 2005). Experiences with implementation have been varied as some organizations have adopted them without the proper preparation (Murphy, 2007).

In his 2004 State of the Union address, President Bush announced his goal of computerized health records to be available for most Americans by 2014. He created the position of National Coordinator of Health Information Technology within the Department of Health and Human Services. He cited safety, reducing costs, and increased quality of patient care as reasons for this initiative. This initiative not only calls for widespread EMR adoption, but the ability of electronic health records to be shared easily between health care systems, and the creation of standards for national interoperability (Brailer, 2005).

President Obama plans to continue promoting and providing incentives for EMR adoption in his new administration. The Health Information Technology for Economic and Clinical Health Act (Section 3011, 42, USC ---- 2009), part of the American Recovery and Reinvestment Act passed in February of 2009, included over \$20 billion dollars of federal aid allotted to develop health care information technology infrastructure. This includes \$17.2 billion in incentives for providers to adopt electronic health records, primarily through Medicare and Medicaid reimbursement (Health Information and Management Systems Society, 2009).

#### Significance of EMR Implementation to Nursing

Potential Benefits. EMRs can save health care organizations money. In a study done by Wang et al. (2003), the estimation of money saved by the organization per provider over a five year period was \$86,400. This was directly attributed to using the EMR. Tripp, Narus, Magill & Huff (2008) found that accessing longitudinal data stored in the EMR allows clinicians to surmise patient trends. Hollingworth et al. (2007) found that using EMRs for prescribing does not disrupt clinical workflow, and enhances safety and quality of care for the patient.

EMR Implementation is a Change Process. EMR implementation is a course of action that requires much time and attention (Karnas & Robies, 2007). The psychological impact of change should not be minimized. Change in the workplace creates stress, uncertainty, and role confusion (Schoolfield & Orduna, 1994). Lack of user acceptance

and staff attitudes have been cited as factors that hinder EMR implementation (Ash & Bates, 2005; Ball & Lillis, 2000; Beaty, 2007; Clemmer, 2004).

Why is Successful EMR Implementation Important to Nurses? Nurses are the largest group of users of health care information technology, and therefore would be greatly impacted by EMR implementation. It is hypothesized that an EMR that is well-implemented can maximally enhance the nursing workflow and allow nurses to improve quality of care by updating nursing procedures and adding decision support tools (Deese & Stein, 2004). However, there is little research available regarding how EMR use does affect the work of nurses once implemented (Kossman & Scheidenhelm, 2008)

Many questions still remain as to the best way to implement an EMR for optimal results, for both health care systems and patients. The types of EMR software and the manner in which they are deployed remain highly diverse (Davidson & Heineke, 2007). This is an opportunity for nurses to evaluate the factors that make EMR implementation successful in nursing practice, and to voice this knowledge as health care organizations plan future EMR adoption.

### Research Question

Adoption of EMRs requires change. Organizational transition to a new system is challenging and complicated (Schoolfield & Orduna, 1994). Nurse documentation, time management, patient care delivery, and work flow are all affected (Smith, 2004). The question to be answered by this review is: what factors need to be present during an EMR implementation to ensure a successful transition and adoption by nurses?

### Conceptual/Theoretical Framework

The researcher has chosen Rozzano C. Locsin's model of "technological competency as caring in nursing" (2005) to guide this study because this model specifically integrates who nurses are, as professionals, with the modern technology they encounter in their workplaces. The electronic medical record is quickly becoming the latest technology for nurses to master. Understanding how nursing and technology intersect is important to give nurses a frame of reference for the incorporation of electronic medical records into their practice. Locsin (2006) states:

The ultimate purpose of technological competency in nursing is to acknowledge that wholeness of persons is a focus of nursing and that various technological means can and should be used in nursing in order for nursing to realize the wholeness of person more fully (p. 381).

Locsin understands that the modern health care world is permeated with technology that nurses are expected to use with competence on a daily basis. Instead of viewing technology as an entity that divides nurses from the patients, technology can be used to know them more fully. The model recognizes caring in nursing, human beings as persons, and technological competence as three spheres that interface, and through which nurses come to know their patients (Locsin, 2005). As applied to the use of electronic medical records (EMRs), nurses can show they care about the patient by using the EMR to better synthesize important health information about the patient. This greater knowledge of the

person as a whole human being improves the nursing process and, ultimately, patient care.

This is important to keep in mind for nurses impacted by their health care organization adopting an EMR. Caring, which is central to the philosophy of nursing (Locsin, 2005) need not be lost in becoming technologically proficient at this new skill. The organization and efficiency of the electronic medical record can be used to the nurse's advantage to know patients more completely.

Nursing and Technology. Locsin defined nursing as “knowing” persons. Knowing is an ongoing process of collecting and processing information about the person to determine who they are and what they are. Technology allows nurses to enter the world of the patient in ways that broaden knowledge of the patient. Therefore, competent use of technology enhances nursing (Locsin, 2005).

Caring and Technology. Caring, while traditionally perceived in ways such as holding the patient's hand, takes on new meaning in this model of practice. Using technology proficiently to help a patient is an act of caring as knowledge gained from its use can help to support the patient in their health care endeavors. This is important to understand as, many times, the use of technology and caring are perceived as mutually exclusive. This belief prevents nurses from using technology to their advantage to know patients fully. Technology use is viewed as just another task, and the patient becomes an object in the process of the task (Locsin, 2005).

To prevent patients from being objectified through the use of technology, or

nurses getting lost in the tasks of technology use, a broader frame of mind must be employed. Locsin (2005) states, “to fully care in this increasingly sophisticated world, nurses generally recognize that technologic proficiency is a desirable attribute and not a substitute for caring but an important variation of caring” (p. 123). This perspective helps nurses view the technology they encounter in their workplaces as a tool to know patients as human beings in the moment, and not just another task to be completed (Locsin, 2005).

Value for Nursing Research. Locsin’s theory (2005) gives an invaluable perspective on how nurses can relate to the ever-increasing technology in their work. It is important for nursing to define what technology means to the profession and how it will be used by the profession. Health care is a multi-profession world where the influences of other paradigms such as a business or medical model may take precedence over nursing models. Nurses, who know where they stand in terms of how technology should be used in their work, can better advocate for their position and influence change in their organization (Carroll et al., 2007).

### Definitions

The author is interested in the factors of successful EMR implementation in nursing practice. Using basic English language definitions, a factor is “one that actively contributes to the production of a result” (Merriam-Webster, factor, 2008). The word implementation means “carry out, accomplish; especially: to give practical effect to and ensure of actual fulfillment by concrete measures” (Merriam-Webster, implementation, 2008). Success is a “favorable or desired outcome” (Merriam-Webster, success, 2008).

NAHIT recently made an effort to gather consensus opinion among industry and government information technology leaders to define key health information technology terms. As stated previously, an EMR is “an electronic record of health-related information on an individual that can be created, gathered, managed, and consulted by authorized clinicians and staff within one health care organization” (NAHIT, 2008, p. 6). This term is often used interchangeably in the literature with the term electronic health record (EHR), and this was important to take into consideration for the literature search process.

However, recent agreement is that EMR and EHR are not one and the same. An EHR is defined by NAHIT as “an electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be created, managed, and consulted by authorized clinicians and staff, across more than one health care organization” (2008, p. 6). Therefore, the difference in the two according to NAHIT has to do with the degree of interoperability and accessibility of the record, and it not simply arbitrary preference of the word “medical” or “health.”

### Assumptions

The author expects to find that the factors influencing EMR implementation in nursing practice will be similar across various settings, yet each organization will have unique challenges based on its unique characteristics. The degree to which organizations plan and organize their EMR deployment will directly impact its success in nursing practice. Factors enabling or hindering success will be able to be identified and categorized from the literature. This collection of knowledge can be used by nurse

administrators, nurse informaticists, advanced practice nurses, and staff nurses in future EMR implementations as a guide to ease the transition and enable success.

Consistent with Locsin's (2005) assumption, the researcher thinks that the purpose of technology is to enhance nurses' understanding of patients as a whole and to improve nurses' practice. In addition, the researcher believes that technology is not meant to make nurses' work harder or to interfere with what nurses strive to do, care for the patients in the best way possible. If the effects of the EMR are not beneficial at this time, nurses need to know what action is necessary to make these new systems work to their advantage.

### Limitations

There are limitations to this study. There is a time frame of approximately one calendar year in which to gather and synthesize information into a coherent form. The results may not be as comprehensive or in-depth as a study done over more time. Nursing informatics is also a relatively new topic in the profession (Carroll, et al., 2007). This may limit the ability to compare findings with other similar research. Lastly, the researcher will be conducting the literature review through the Montana State University library system. This system is adequately comprehensive but may not have every article published that pertains to this topic. For example, works that have not been published in a peer-reviewed journal may have relevant information, but are not able to be found by electronic databases.

## SEARCH METHODS

### Literature Search

#### Inclusion/Exclusion Criteria

Establishing selection criteria was the first step in the literature search. The dates of publication were limited to the past five years, starting in 2003 going through 2008. The basis of this decision was to keep the literature as relevant as possible in a rapidly evolving field.

Next, articles only from peer-reviewed journals were used. This is to maintain a high level of quality of the works. Only primary sources of research were selected. Although integrative literature reviews can contain non-research, theoretical articles (Whittemore & Knafl, 2005), works such as “opinion articles, case reports, anecdotes, and clinical descriptions” (Polit & Beck, 2008, p. 137) should not be included in literature reviews. They serve to give perspective on an issue, but are not good sources to build an evidence base (Polit & Beck, 2008).

The articles needed to be written in English, but the research did not necessarily need to be done in the United States or by an American researcher. As EMR implementation is a global phenomenon (World Health Organization, 2006), nurses across the world may have relevant experiences from which American nurses can learn. There were several research studies done internationally. Although differences in culture could create confounding factors regarding what factors ensure successful EMR

implementation for nurses, the decision was made to include these studies as long as they were published in accepted peer-reviewed journals.

There were numerous articles about EMR implementation. However, many did not address nursing issues in regard to EMR implementation. Some articles talked about nurses in passing, or referred to “staff” in their discussion of EMR implementation. If the article did not specifically discuss what makes EMR implementation successful or unsuccessful for nurses, it was not selected because it would not support the aims of this review. In summary, research articles written in the last five years, issued in peer-reviewed publications, which specifically address the factors that influence successful EMR adoption by nurses, were chosen.

### Search Methods

Databases. The literature was searched using several different approaches. The first approach was to use common databases of nursing, medical, and allied health literature to gather information. The databases used for this review were the Cumulative Index of Nursing and Allied Health Literature (CINAHL), MEDLINE (PubMed), and the Health Reference Center Database.

Search Terms. The search terms were drawn from the research question and conceptual framework. The keywords *electronic medical record, electronic health record, nursing, implementation, success, change, technological competency, caring,* and *Locsin* were all used in various combinations to search CINAHL, MEDLINE and Health Reference Center. Titles, abstracts, and text were reviewed to assess fit with inclusion

criteria. Articles that were duplicated in successive searches were excluded.

Supplemental Search Methods. In addition, the journals of *CIN: Computers, Informatics, Nursing*, and the *Journal of the American Medical Informatics Association* were hand searched. As these were two of the most widely referenced journals in the EMR database searches, it seemed wise to make sure nothing was missed from these two sources. Lastly, ancestry searches were done on all the articles collected from the previous two methods, to identify any pertinent studies not found in the databases or journal searches. In all, a total of twenty-nine articles were selected.

### Findings

CINAHL. The search term *electronic medical record* yielded 229 results. To narrow the results, the terms *EMR* and *nursing* were used together. This produced 30 results, from which two articles were selected because they met inclusion criteria. The terms *EMR* and *implementation* used together produced 61 results. 17 were duplicates of *EMR* and *nursing*. One article was selected because it met inclusion criteria. The keywords *EMR* plus *technological competency* yielded no results. *EMR* and *caring* produced one result, but it was not chosen because it was an opinion article. There were no duplicates here. *EMR* and *change* yielded 17 results, and *EMR* and *success* produced five results, none of which were selected because they did not meet inclusion criteria. There were six and three duplicates here, respectively.

The search term *electronic health record* produced 150 results. To pare down results, *EHR* and *nursing* were used together to obtain 17 articles. Two were selected

because they met inclusion criteria. There were no duplicates.

*EHR* and *implementation* produced 50 results with eight duplicates, but none were conscripted because they did not meet inclusion criteria. *EHR* plus *technological competency* yielded no results. *EHR* plus *caring* produced three results with one duplicate, none of which met inclusion criteria.

*EHR* plus *change* produced 16 results with eight duplicates, and *EHR* and *success* provided ten results with six duplicates. None were selected for review because they did not meet inclusion criteria.

MEDLINE. The term *EMR* in the MEDLINE database produced 1,717 results. Again, this was too large a number so *nursing* was added as a term. This produced 153 results, and 11 articles were chosen because they met inclusion criteria. There were 18 duplicates. *EMR* and *implementation* yielded 336 works, so the term *nursing* was added to taper results. This produced 38 articles with 22 duplicates. None were selected because they did not meet criteria.

The use of *technological competency* with *EMR* obtained no results. *EMR* and *caring* obtained 12 results with two duplicates, none of which met inclusion criteria. *EMR* and *change* produced 97 results with 12 duplicates, and none of the studies met inclusion criteria. *EMR* and *success* created 66 results with eight duplicates, and none were chosen as they did not meet criteria.

The same process was performed again using *EHR* as a keyword. There were 1,302 results. *EHR* and *nursing* produced a more manageable result of 126 with 47

duplicates, and three articles were conscripted because they met inclusion criteria. *EHR* and *implementation* obtained 282 results, so the keyword *nursing* was added to this search and results were 30. No articles were selected as all were duplicates. *EHR* with *technological competency* identified no results. *EHR* and *caring* resulted in 10 hits, none of which met criteria. There were five duplicates. *EHR* with *change* and *success*, respectively, obtained 93 and 57 results with 14 and 18 duplicates. No articles were selected because they did not meet criteria.

Health Reference Center. *EMR* as a search term yielded 173 results. *EMR* plus *nursing* produced 13 results, but no articles were chosen because they did not meet criteria. *EMR* and *nurse* obtained five results, and one article was selected because it met the inclusion criteria. The remainder of the search was done exactly the same as the previous two databases, and no additional articles were conscripted because they did not meet criteria.

Hand Searches. Six articles were chosen from a hand search of *CIN: Computers, Informatics, Nursing* from 2003 until the present because they met the inclusion criteria. None were selected from the *Journal of the American Medical Informatics Association* because they did not meet criteria.

Ancestry Searches. Reference lists of all the articles previously selected were scanned. Three articles were found to meet the criteria of this review.

Theoretical Framework. There is no record of anyone using Locsin's (2005)

technological competence as caring theory to guide EMR research or inquiry. The use of conceptual frameworks in this area of study is very limited. There were no articles found that specifically incorporated Locsin's (2005) theory, electronic medical records, and nursing.

## DATA ANALYSIS METHODS

### Plan for Data Evaluation

#### Quality of the Literature

Each study was critiqued for quality. This required first categorizing the articles into quantitative research or qualitative research. Guidelines created by Polit & Beck (2008) were used to evaluate the quantitative and qualitative research and to give each study a quality score (see Appendix A). Each “yes” answer to the guideline questions received one point. The points were totaled for each article resulting in the quality score. An evaluation matrix (see Appendix B) was used to organize this information (Polit & Beck, 2008). The quality score was then used in the final data analysis to determine the strength and weaknesses of the findings from each study.

#### Data Reduction

Study Design. The studies were then subdivided into groups according to the type of design, such as quantitative correlational or qualitative descriptive, et cetera. This was documented in the evaluation matrix as well (see Appendix B).

Coding Scheme. Once in groups, the studies were analyzed for coded independent variables and coded dependent variables (see Appendix C). These codes were derived from the literature and theoretical framework. Independent variables are the factors involved in EMR implementation, such as organizational support, nurse perspective, nurse input, degree of EMR training, and so forth. Coded dependent variables are the

evidence of success after EMR implementation and include nurse satisfaction, ease of use, enhanced patient care, reflection of nursing work in the EMR, and improved interdisciplinary collaboration. Additional codes emerged as the research was analyzed, and previously analyzed studies were re-checked for new codes. This data was organized in a results matrix (Appendix D).

Once all the pertinent information was organized, the results were ready for analysis. Patterns and themes were discerned. Similarities and differences were noted. Gaps in the research were identified. These findings are presented in the next chapter.

## FINDINGS

Data AnalysisOverview

Summary of the Literature. Twenty-nine studies were analyzed for research quality as well as the factors that need to be present for EMR implementation to be successful for nurses in regards to EMR implementation (see Appendices B and D). Eighteen of these studies were quantitative and 11 were qualitative. The most common quantitative design, found in seven studies, was a post-intervention survey. There were also four pre-post intervention studies (Choi, Woan-Heui, et al., 2006; Donati et al., 2008; Hurley et al., 2007; Smith, Smith, Krugman & Oman, 2005) and two work sampling studies (Korst, Eusebio-Angeja, Chamorro, Aydin & Gregory, 2003; Lee, Mills & Lu, 2008). Qualitative designs were more diverse and included two phenomenological studies (Andre, Ringdal, Loge, Rannestad & Kaasa, 2008; Kossman & Scheidenheim, 2008), three ethnographic studies (Bar-Lev & Harrison, 2006; Saleem, Patterson, Militello, Render, Orshansky & Asch, 2005; Vogelsmeier, Halbesleben, & Scott-Cawiezell, 2008) and one case study (Obstfelder & Moen, 2006). Of note, 14 of the 29 studies were conducted in countries other than the United States, with four studies from Taiwan (Lee, 2005; Lee, 2006; Lee, 2007; Lee, Mills, & Lu, 2008), three from Korea (Ahn, Park, You, Shin, Woo & Jo, 2006; Choi, Chung & Lee, 2006; Choi, Woan-Heui, et al., 2006), three from Norway (Andre, Ringdal, Loge, Rannestad & Kaasa, 2008; Obstfelder & Moen, 2006; Wibe, Edwin, Husby & Vedal, 2006), one from Israel (Bar-

Lev & Harrison, 2006), one from Italy (Donati et al., 2008), one from Germany (Mahler et al., 2007), and one from Sweden (Dahm & Wadensten, 2008).

Quality. Each study was assessed for research quality using the criteria set forth by Polit & Beck (2008) (see Appendix A). A quality score was determined by applying the criteria (see Appendix B). The highest quality scores, in order from highest to lowest, came from studies by Lee (2006), Saleem et al. (2005), Lee (2007), Sidlow and Katz-Sidlow (2006), Smith et al. (2005), Lee (2005), Kossman and Scheidenhelm (2008), Moody, Slocumb, Berg, and Jackson (2004), Andre et al. (2008), and Lee et al. (2008). The lowest quality scores, in order from lowest to highest, were from the studies by Ahn et al. (2006), Keenan and Yakel (2005), Choi, Eun, et al. (2006), Choi, Woan-Heui, et al., (2006), Wibe et al., (2006), Donati et al. (2008), and Sackett, Erdley and Jones (2006).

#### Literature Related to EMR Implementation Success for Nurses.

Overview. Of the 29 studies that were reviewed, only three of the implementations were predominantly devoid of success (Andre et al., 2008; Obstfelder & Moen, 2006; Vogelsmeier et al., 2008). Sixteen studies had mixed results with a combination of successes and barriers. Ten studies had outcomes that were predominantly positive even with the presence of negative factors in the EMR implementation.

Factors Predicting Successful Outcomes. Of the sixteen factors identified in the

coding scheme, there were seven that were frequently cited. The factors found most often in the literature, associated with EMR success, in their order of frequency were: 1) fit of EMR program with nurse functions (eleven studies, 38%) 2) presence of education and/or training, perspective and/or attitude of nurses is positive, (nine studies, 31%), 3) time requirement for EMR documentation viewed positively and presence of computer experience (eight studies, 28%), 4) support for personal needs (seven studies, 24%), and 5) inclusion of nurses in the implementation planning process (six studies, 21%).

Factors Predicting Unsuccessful Outcomes. In addition, the lack of certain EMR implementation factors was associated with barriers to success in these studies. The most frequent were: 1) lack of computer system availability and/or quality (13 studies, 45%), 2) lack of fit of EMR program with nurse functions (10 studies, 34%), 3) time requirement for EMR documentation viewed negatively (nine studies, 31%), and 4) perspective/attitude of nurses was negative and lack of education and training (five studies, 17%) (See Table 1).

Most Common Successes. Successful outcomes of EMR implementation for nurses, most commonly found in the literature, were: 1) workflows that support nursing work (15 studies, 52%), 2) nurse satisfaction (14 studies, 48%), 3) increased quality of documentation and ease of use and/or nurse proficiency (12 studies, 41%), 4) enhanced patient care and safety (eight studies, 28%), and 5) enhanced interdisciplinary communication (six studies, 21%). Outcomes that were most frequently cited as unsuccessful were the absence of: 1) workflows that support nursing work (14 studies,

48%), 2) nurse satisfaction (12 studies, 41%), and 3) ease of use and/or nurse proficiency (eight studies, 28%) (See Table 1).

Table 1. Summary of Factors of EMR Implementation Success

Factors predicting successful outcomes	Factors predicting unsuccessful outcomes	Successful outcomes	Non-successful outcomes
Fit of EMR program with nurse functions 11 studies 38%	Lack of computer system availability and/or quality 13 studies 45%	Workflows that support nursing work 15 studies 52%	Lack of workflows that support nursing work 14 studies 48%
Education and/or training, perspective and/or attitude of nurses is positive 9 studies 31%	Lack of fit of EMR program with nurse functions 10 studies 34%	Increased quality of documentation, nurse satisfaction 14 studies 48%	Lack of nurse satisfaction 12 studies 41%
Time requirement for EMR documentation viewed positively, presence of computer experience 8 studies 28%	Time requirement for EMR documentation viewed negatively 9 studies 31%	Ease of use and/or nurse proficiency 12 studies 41%	Lack of ease of use and/or nurse proficiency 8 studies 28%
Support for personal needs 7 studies 24%	Attitude is negative, lack of education 5 studies 17%	Enhanced patient care and safety 8 studies 28%	
Inclusion of nurses in the implementation planning process 6 studies 21%		Enhanced interdisciplinary communication 6 studies 21%	

Association of Certain EMR Implementation Factors with Successes. Successful EMR implementation was observed, in many studies, to occur in the presence of specific factors. The factor “fit of EMR program with nurse functions” and the success of “workflows that support nursing work” had the highest frequency of association (eight studies, 28%). This was followed by a nine-way tie of fit of EMR with ease of use and/or nurse proficiency, fit of EMR with nurse satisfaction, time requirement of EMR documentation with increased quality of documentation, education and/or training with ease of use and/or nurse proficiency, education and/or training with nurse satisfaction, computer experience with ease of use and/or nurse proficiency, computer experience with nurse satisfaction, perspective and/or attitudes of nurses with workflows that support nursing work, and perspective and/or attitudes of nurses with nurse satisfaction (six studies each, 21%).

Association of Negative Factors and Lack of Success. The absence of certain EMR implementation factors was associated with a lack of success. The most common association was between the absence of computer system availability and/or quality with lack of nurse satisfaction (10 studies, 34%). This was followed by absence of fit of EMR with nurse functions and lack of nurse satisfaction (nine studies, 31%), absence of computer system availability and/or quality with lack of workflows that support nursing work (eight studies, 28%), absence of computer system availability and/or quality with lack of ease of use and/or nurse proficiency (six studies, 21%), absence of fit of EMR with lack of workflows that support nursing work and lack of ease of use and/or nurse

proficiency (six studies, 21%), and undesirable time requirement for EMR documentation with lack of workflows that support nursing work (six studies, 21%). Poor computer infrastructure and a lack of EMR fit with nurse functions were most often associated with a lack of success.

### Themes

EMR Fit. Several themes emerged as the literature was evaluated for factors of success (see Table 2). One chief theme was the importance of EMR fit with nurse functions and the functions of the workplace overall. Several studies (Bar-Lev & Harrison, 2006; Lee, 2006; Saleem et al., 2005; Vogelsmeier et al., 2008) demonstrated that if the EMR did not support the workflow of clinicians, the EMR would not be used properly or efficiently. In fact, the term “workaround” was used in a few studies, referring to informal workflows developed by staff to deal with the barriers of the current EMR system (Vogelsmeier et al., 2008). In two of the studies, (Bar-Lev & Harrison, 2006; Saleem et al., 2005), EMR designers and support staff worked with clinicians to either reconfigure the EMR for better use, or find strategies for incorporating the EMR requirements into their workflows. These clinicians included nurses and physicians in the Bar-Lev and Harrison (2006) study, and nurses, nurse practitioners, physicians, residents, and physicians assistants in the Saleem et al. (2005) study. These interventions subsequently led to a successful integration of EMRs into practice. Interestingly, Lee (2006) and Saleem et al. (2005) had the two highest quality research scores of this

review.

Computer System Availability and Quality. Poor computer system availability and quality was a major source of frustration and a barrier to success in several studies (Moody et al., 2004; Obstfelder & Moen, 2006; Smith et. al., 2005; Wager, Zoller, Soper, Smith, Waller & Clark, 2008; Wibe, Edwin, Husby, and Vedal, 2006). If technology infrastructure is inadequate, use of the EMR is less than optimal (Obstfelder and Moen, 2006). Smith et al. (2005) found that, even if charting quality improves, and documentation time on the EMR does not increase, nurses will still be dissatisfied if the overall system is slow and cumbersome to use.

Time. The theme of the EMRs and nurse documentation time was the prevalent theme in several studies. Korst et al. (2003) found that the EMR does not increase nurse charting time. The authors see this as a success. This was in contrast with findings by several authors (Hurley, Bane, Fotakis & Duffy, 2007; Kossman & Scheidenhelm , 2008; and Lee et al., 2008) in which nurse documentation time was increased. Nurses in the Hurley et al. (2007) study were not necessarily opposed to increased charting time if it improved documentation quality. The increase in time spent charting medications was attributed to a more detailed documentation process. The latter was seen as a success of EMR implementation. However, nurses in the Kossman and Scheidenhelm (2008) study found increased documentation time imposed by the EMR burdensome, due to slow computers, unavailability of computers, and system downtime. Nurses felt that this resulted in less time with patients, a definite lack of success in terms of patient care.

Choi, Woan-Heui, et al. (2006) found that the EMR saved documentation time in some areas, such as in the ICU where clinical data was downloaded directly from patient monitors into the EMR. Yet, overall shift documentation time for RNs increased if the computers were slow. Any time saved was seen as a success as it let nurses spend more time at the bedside. However, Donati et al. (2008) found that, even when the EMR saved nurses time on documentation, this was not necessarily translated into more time with patients.

Education and Nurse Inclusion. Keenan and Yakel (2005) and McLane (2005) both found that extensive education and inclusion of nurses in the planning process promoted EMR success. Assessing pre-implementation attitudes allowed implementation leaders to identify the concerns of the staff and tailor education to the staff's needs. Including nurses in the EMR design process promotes user acceptance and, therefore, a better chance of implementation success (McLane, 2005).

Table 2. Themes

Theme	Studies with Theme
Fit of EMR with nurse functions	Bar-Lev & Harrison, 2006; Lee, 2006; Saleem et al., 2005; Vogelsmeier et al., 2008
Computer system availability and quality	Moody et al., 2004; Obstfelder & Moen, 2006; Smith et al., 2005; Wager et al, 2008; Wibe et al., 2006
Time	Choi, W. et al., 2006; Donati et al., 2008; Hurley et al., 2007; Kossman & Scheidenhelm 2008; Korst et al., 2003; Lee et al., 2008
Education and nurse inclusion	Keenan & Yakel, 2005; McLane, 2005

### Discrepancies in the Literature

Interdisciplinary Communication. Lee (2007) found that an EMR implementation did not enhance interdisciplinary communication, as not all disciplines used the same charting system in this study. There was a subsequent lack of nurse satisfaction. Conversely, the implementation of an EMR sign-out function in a New York medical center was found to greatly improve interdisciplinary communication. It allowed nurses and residents to easily see each other's assessments at shift change, and resulted in enhanced nurse workflows and patient care (Sidlow & Katz-Sidlow, 2006).

Computer Experience. Stagers, Kobus and Brown (2007) found that increased computer experience promoted acceptance of EMRs. In contrast, Wager et al. (2008) found that EMR users with less experience were equally satisfied as experienced users with the EMR.

### Gaps in the Literature

Financial Issues. The discussion of financial matters, in regard to EMR implementation success for nurses, was missing from these studies. Whether the EMR saved the implementing institutions money, and if this had any impact on nurse wages, is not known.

Confidentiality. Some studies such as Lee (2006) showed that nurses were worried about patient confidentiality when using EMRs. No studies that also met the rest of the inclusion criteria specifically assessed if EMRs helped or hindered patient

confidentiality.

Ability to Summarize Clinical Data. Absent in these studies was information regarding the ability of nurses to use the EMR to summarize clinical data on patients. It is not known if this function of EMRs is widespread, and if nurses are able to use this to enhance patient care and nursing practice. As EMR proponents have used this potential EMR function as a reason to promote their adoption (Deese & Stein, 2004; Karnas & Robies, 2007), it is interesting that none of the articles that met the inclusion criteria for this study mentioned this aspect of the EMR.

### Results and Theoretical Framework

Locsin's (2005) theory that technological competency as caring in nursing guided this review. Although there were no articles that used this theory or its components explicitly to guide their research, themes such as the ability to use the EMR efficiently and enhanced patient care because of the EMR were found in the results of the literature as benchmarks of successful EMR implementation.

The coding scheme contained factors that could either help or hinder a nurse's technological competency of the EMR. It is interesting to note that of the top seven factors of success in EMR implementation for nurses, only one is solely under the control of the nurse alone, and that is their attitude. The other six – fit of EMR with nurse functions, education, support, time requirement, computer experience, and inclusion in the planning process – are factors that depend on the interaction between the nurse and the environment in which the EMR is being implemented.

Technological Competency. The results also contained types of successes that would indicate that a nurse achieved technological competency of the EMR, such as increased quality of documentation and ease of use and/or nurse proficiency (12 studies, 41%) and enhanced patient care and safety (eight studies, 28%). These results suggest that technological competency has a significant role in the success of EMR implementation for nurses, and this competency is a way in which nurses care for the patient.

#### Similar Study.

A study that was similar to this review, but done from a medical model perspective, was conducted by Van Der Meijden, Tange, Troost, and Hasman (2003). This was a literature review that compared studies from 1991 through 2001, analyzing the outcomes of employing computerized patient information systems, for the determinants of success.

Nineteen out of the 33 studies that were evaluated cited aspects such as ease of use, saving documentation time, and security as determinants of success. An increased completeness of the medical record and user satisfaction was also found in a majority of the studies to be a factor of success. Emphasis on communication and education was found to be imperative to success in the implementation process (Van Der Meijden et al., 2003).

The results from Van Der Meijden et al. (2003) correlate with the findings of this literature review. However, as this review evaluated physicians, nurses, and other health

care staff simultaneously, it is unclear as to what issues regarding determinants or barriers of success are specific to nurses (Van Der Meijden et al., 2003).

### Conclusion

To elucidate the factors significant to a successful EMR implementation, a coding scheme was devised and systematically applied to the literature. Results were verified by going back to each primary source and making sure that the study was correctly interpreted. Although there were 16 factor codes and 11 success codes, not all of them were prominent in the literature. However, several factors of success were prevalent in the studies, such as fit of the EMR program with nurse functions, and education and training. Workflows that support nursing work, nurse satisfaction, improved documentation, and ease of use were the ways in which nurses most commonly viewed an EMR implementation as a success.

Additionally, this same method was used to assess what factors were not present in an EMR implementation, and subsequent success or lack thereof. A computer system (software and hardware alike) that is difficult to work with emerged as a major impediment to EMR implementation success. Lack of proper training and support also contributed to sub-optimal outcomes.

Let it be noted that 16 of the studies had mixed outcomes. It was possible to have success in one area, for example enhanced interdisciplinary communication with the EMR, but to still have some problems with the computer hardware that posed problems to nursing workflow. Every study had its own unique circumstances, mix of variables,

and outcomes. Understanding the multifaceted nature of EMR implementation is essential to interpreting these studies.

## INTERPRETATION OF RESULTS

### Discussion

#### Theoretical Framework

Locsin's (2005) theory of technological competency as caring in nursing supports why nurses should be committed to successful EMR implementation and use. It is through proficient use of technology, as in this case the EMR, that nurses can more effectively care for patients (Locsin, 2005). An optimally functioning EMR, when used correctly, is a tool that can increase quality of patient care by providing the nurse with a more complete, efficient, timely, and safe medical record (Deese and Stein, 2004). For example, one nurse said about the clinical reminders built into the new EMR, "this online content reminds us of details that need particular attention as the patient's condition or care needs change" (Lee, 2007, p. 296.).

A poorly functioning EMR cannot better nursing care. Therefore, nurses must take the lead in addressing EMR implementation failures when they occur so that the best interests of patient care are protected. It is this ideal that nurses should keep in mind when embarking on the introduction of EMR technology, as it is a complex and consuming process. It is this ideal that fuels the desire to continue to learn about what factors are decisive in assuring EMR implementation success, so that these factors help nurses use technology competently.

## Methods

Literature Search. There were over fifty articles found in the search that described the experiences of nurses implementing EMRs. However, about one-half of these reports are anecdotal. The information they provided may be useful, yet it is not evidenced-based. Therefore, they could not be included in this literature review. Additionally, from what could be ascertained through searching the literature, there are no other literature reviews of the factors of success, from the perspective of nurses, in regard to EMR implementation.

Quality. A quality evaluation was performed on all studies included in this literature review. This was so the reader could put the findings of this literature review in perspective. However, a study with a low quality score does not necessarily have unsound results. The quality score was determined by what was included in the published report. Due to editing and other publication restrictions, all the elements of a study may not have been included. Keeping this in mind, the quality assessment gives an overview of the strengths and weaknesses of each study.

## Findings

Fit of EMR with Nurse Functions. It is clear from this literature review that the implemented EMR workflow must support and, ideally, make more efficient the work of nurses in order to be successful. In fact, not only was this identified as the most frequent factor contributing to success in this review, but the lack of EMR fit with nurse workflow

was the most cited reason for a lack of success. Bar-Lev and Harrison (2006) found that nurses and doctors had a real conflict between following the rigid workflow of the EMR or doing what they felt delivered safer and better care. Finding common ground between the desires of the designers and administration versus the practitioners is essential (Bar-Lev and Harrison, 2006).

One way to make sure that EMR fit occurs is to involve nurses in the selection process of the EMR. By doing this, nurses will be able to select an EMR that meets their needs, have a sense of ownership in the project and this, in turn, can promote nurse satisfaction (Andre et al., 2008, Kossman & Scheidenhelm, 2008).

Computer System Availability and/or Quality. Computer infrastructure is another key factor this review identified as a factor contributing to success or lack thereof. As stated by a nurse in the study by Kossman and Scheidenhelm (2008), “It’s very slow, the computer is slow. When there is a glitch or a problem with it, it can really upset your whole day” (p. 74). Whether it is the quality of the computer itself, or the availability (or both), the EMR must have the technology to support its proper use. This is imperative because EMR usability has a tremendous impact on nurse satisfaction (Smith et al., 2005), a measure of success. Again, nurse input in planning the EMR deployment would be beneficial. Organizations need to do a thorough evaluation of their entire computer resources before they embark on EMR implementation.

Education and Attitudes. Not providing comprehensive education to nurses that are to use the EMR was associated with a lack of success in this review. In the study done

by Andre et al. (2008), “almost half of the respondents could not remember having participated in any training or teaching program in connection with implementing the system” (p. 186). Not surprisingly, this was one study with overall poor outcomes (Andre et al., 2008).

Conversely, thorough education was associated with nurse satisfaction. In the study done by McLane (2005), offering ample training sessions that worked easily into the nurses’ schedules, taught by the designers of the EMR, contributed to a very successful EMR implementation.

Additionally, not only do nurses have to learn how to use the EMR, but they may also need remediation on skills such as typing and computer navigation as well (Lee, 2007). Nurses that are not provided with adequate education may become overwhelmed and frustrated, generating a major impediment to success. Additionally, educators can play a key role in assisting future EMR users to become motivated and boost morale (Andre et al., 2008).

### Limitations

Confounding Variables. Implementing an EMR is a multi-factorial and complex process. While patterns and trends can be discerned, proving cause and effect is not possible. Also, differences in individual staff, the physical environment of the study, organizational culture, and country in which the study was done could have influenced the outcomes. It is impossible to say with absolute certainty what makes an EMR implementation successful or not for nurses. What can be taken away, however, are

general impressions that can be adapted and applied to future EMR implementations.

Bias. Some personal bias is inherent in any study, no matter how objective. The selection of studies for this review, and the way the articles were coded and interpreted, may have been influenced by personal biases of the author. To reduce bias as much as possible, the author bracketed to identify preconceived beliefs and opinions about the subject matter. By objectifying personal assumptions, and keeping these in mind through every step of the literature review, personal bias was reduced.

### Implications for Nursing

Education. Using technology competently is a way that nurses can deliver quality patient care (Locsin, 2005). As the trend toward computerization of health records continues, nurses will need to bring solid informatics skills to bring to their workplace. Such skills include data access and navigation, using e-mail, patient documentation, and knowledge of security protocols. These skills should be evaluated as part of undergraduate and graduate nursing curriculum. Skills training should be provided for those students who do not possess a basic level of proficiency. Nursing faculty also should be evaluated on their informatics skills and be required to incorporate informatics into their courses if appropriate (Ornes and Gassert, 2007).

Clinical Practice. As more and more health care organizations computerize their operations, nurses will be expected to use EMRs proficiently. Preparing ahead of time for the challenges of a major organizational change is one way in which nurses can be

leaders (Spross and Hanson, 2009). For example, doing a pre-implementation survey of nurses' computer experience and attitudes about the EMR (McLane, 2005), is one method of facilitating successful outcomes. McLane (2005) explains, "Understanding how the nursing staff feel about computers in the workplace and the role computers can play in practice enables the implementation team to structure communications, reframe misconceptions, and offer possible new perceptions" (p. 85). Staff education can then be developed and provided based on the survey results.

Setting up a feedback system, to ensure prompt response and support by project leaders when problems are encountered, is another strategy for successful implementation (Saleem et al., 2005). Involving nurses in the selection and design of the EMR is another simple way that leaders of health care organizations can increase the probability of a successful EMR implementation as it increases user acceptance (Lee, 2007). By employing these simple strategies, nurse and organizational leaders have a greater chance of achieving nurse satisfaction and nurse proficiency at EMR use.

Research. Health care organizations will continue to implement EMRs. Instead of documenting these processes anecdotally, nurse leaders should make the effort to design research studies to further determine the factors that contribute to successful EMR implementation. Further clarifying what works and what does not, in regard to EMR implementation, will help nurses, taking on this endeavor for the first time, plan for a successful outcome.

Additionally, Locsin's (2005) theory hypothesizes that the competent use of technology can help the nurse know the patient better. Further research needs to be done

to verify if the EMR is in fact helping nurses achieve this goal, versus simply creating more tasks for nurses to complete.

### Summary

Fit of the EMR with nurse functions, education, and positive nurse attitudes were found to be the top three most common factors associated with successful EMR implementation. Nurses equated EMR implementation success with workflows that support nursing work, nurse satisfaction, increased quality of documentation, ease of use, enhanced patient care and safety, and enhanced interdisciplinary communication.

Successful implementation of the EMR is the first step to its proficient use. Knowing the factors that contribute to the success of an EMR implementation, and employing them, can help nurses design a future EMR implementation that will be successful. Then, nurses can use this competency to deliver to the best, state-of-the-art care to patients.

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APPENDICES

APPENDIX A

EVALUATION MATRIX

Table 3. Evaluation Matrix

Study (Author & Year)	Design	Theoretical/ conceptual framework	Population	Sample and sampling method
Ahn et al., 2006	Quantitative descriptive correlational	none	Nurses at Seoul National University Hospital	N= 904 nurses, Convenience sample
Andre et al., 2008	Qualitative phenomenological	Phenomenological, hermeneutics	Healthcare workers on a palliative care unit at Frondheim University Hospital in Norway	N=1713 nurses Purposive sample
Bar-Lev, S. & Harrison, M. I., 2006	Qualitative Grounded theory Ethnographic	Giddens' theory of structuration	Health care workers at Shilo Medical Center, Israel	N=100 Uncertain number of nurses
Cherry et al., 2008	Qualitative descriptive	None	Directors of nursing and managers at long term care facilities	N=34 Convenience sample
Choi, Eun, et al., 2006	Quantitative post-intervention	None	Nurses at Seoul National University Bundang Hospital	N=503 convenience sample
Choi, Woan-Heui, et al., 2006	Quantitative, quasi experimental pre-post intervention	None	Nurses at Seoul National University Hospital	N=136 Sample method unclear
Donati et al., 2008	Quantitative pre-post intervention	None	ICU staff at a university hospital in Ancona, Italy	N=104 30 nurses Convenience sample
Dahm & Wadensten, 2008	Quantitative descriptive post intervention	None	RNs at two hospitals in Sweden	N=85 purposive sample
Gaumer et al., 2007	Quantitative descriptive	None	Graduates of Simmons College graduate nursing program	N=249 Convenience sample
Hurley et al., 2007	Quantitative with some qualitative elements Pre-post test	none	Nurses at an academic medical center in US	N=1,115
Keenan & Yakel, 2005	Quantitative with some qualitative elements	none	ICU nurses at academic medical center in US	Information not given
Korst et al., 2003	Quantitative work-sampling	none	Nurses on a labor and delivery unit at Cedars-Sinai Medical Center in Los Angeles	N=18 Random sampling
Kossman & Scheidenheim, 2008	Qualitative descriptive phenomenological	Doran's nursing role effectiveness model	Nurses on med/surg and ICU wards at two Midwestern hospitals	N=46 Convenience sample
Lee, 2005	Qualitative cross-sectional	none	Nurses at a Taiwan Medical center that have used computerized charting	N=202 Convenience sample
Lee, 2006	Qualitative descriptive exploratory	Lewin's change theory	RNs at 600 bed medical center in Taiwan that had used PDAs for 3 months	N=15 Purposive sample
Lee, 2007	Qualitative longitudinal	none	Nurses on surgical units at a 800-bed teaching hospital in Taiwan	N=22 Convenience sample

Lee et al., 2008	Quantitative work-sampling	none	Nurses at a Taiwan medical center	N=200 Purposive sample
Mahler et al., 2007	Quantitative time series	none	Nurses on four wards at University Medical Center Heidelberg, Germany	N=240 Random sample
McLane, 2005	Quantitative pre-intervention survey	none	Nurses and staff on bone marrow transplant unit in US	N=44 Convenience sample
Moody et al., 2004	Quantitative descriptive cross-sectional	none	Nursing staff at large magnet hospital in SW Florida	N=103 Convenience sample
Obstfelder and Moen, 2006	Qualitative case study	Actor-network theory	Nurses in Norwegian city community health service	N=9 Purposive sample
Sackett et al., 2006	Qualitative	none	Western New York RNs	N=41 Convenience sample
Saleem et al., 2005	Qualitative ethnographic	Ethnography	Nursing staff and providers at four VA medical centers	N=90 Convenience sample
Sidlow and Katz-Sidlow, 2006	Quantitative post-intervention survey		Nurses on a general medical unit	N=19 Convenience sample
Smith et al., 2005	Quantitative quasi-experimental pre-post test		Nurses on pulmonary and orthopedic units	N=46 convenience sample
Staggers et al., 2007	Quantitative post-intervention survey	Interdisciplinary human-computer interaction	Navy nurses at large military medical center in western US	N=20 Convenience sample
Vogelsmeier et al., 2008	Qualitative ethnographic		Nursing staff at five Midwestern nursing homes	N=88 Sampling method not stated
Wagner et al., 2008	Quantitative post-intervention survey		Physicians and nurses at Medical University of South Carolina	N=244 Convenience sample
Wibe et al., 2006	Quantitative post-intervention survey		Nurses and "key persons" at Ullevaal University Hospital in Oslo, Norway	N=22 Purposive sample

Study (Author & Year)	Instrumentation used	Major Strengths	Major Weaknesses	Quality Score*
Ahn et al., 2006	Questionnaire developed by author	Large sample size, valid tool, relevant topic	Very brief summary of research that leaves many questions for the reader	12/45
Andre et al., 2008	Interviews based on Center for Quality Management Concept Engineering Guide	Exposes important topic in nursing, personal experience	Need better detail of results, integration of results	37/51
Bar-Lev, S. & Harrison, M. I., 2006	Field observations plus interviews	Strong theoretical framework, clear problem and explanation of findings	Little description of data collection and analysis, efforts to reduce bias	29/51
Cherry et al., 2008	Interview guide	Relevant problem, detailed description of findings in table form, strong conclusion and implications	Odd layout of report, no use of quotes or excerpts, lit review not discussed in narrative	33/51
Choi, Eun, et al, 2006	Likert 5-point scale survey	Large sample, valid problem, survey relevant and findings meaningful	Very brief report with little description	20/45

Choi, Woan-Heui, et al., 2006	observation	Large sample, valid problem, provides base for future research	No literature review, hypothesis, conceptual framework, discussion of ethics, methodology decisions	20/45
Donati et al., 2008	Observation, questionnaire	Problem significant to nursing, basis for future research	No conceptual framework, methodology not detailed	21/45
Dahm & Wadensten, 2008	Survey created by author	Captures data of nurses regarding relevant problem, good directions for further research	Research questions not stated, no definitions of key concepts, validity of survey not clear	26/45
Gaumer et al., 2007	Survey created by author	Focus on advanced practice nursing, strong problem statement, good description of instrument and data collection	Sparse literature review, no stated research questions, no conceptual framework	30/45
Hurley et al., 2007	MAS-NAS scale Interview guide	Organized, meaningful evidence for nurses, problem is significant	No stated research questions, no literature review, no description of statistical tests used, method slurring	28/45
Keenan & Yakel, 2005	Survey Interviews Meetings Focus groups	Relevant problem, findings might help this particular institution, might help generate research ideas	Data not described in detail, no states research questions, no discussion of sampling and participants, low detail on methods, no implications for nursing research, method slurring	19/51
Korst et al., 2003	Observational matrix	Problem relevant to nursing, good research design, good discussion of findings	No clear research question, no conceptual framework, gaps in methodology, no discussion of ethics	30/45
Kossmann & Scheidenheim, 2008	Survey, observation, interviews	Strong problem, literature review and conceptual framework; thorough data description and discussion	Did not discuss use of IRB, rigor of methods	42/51
Lee, 2005	questionnaire	Relevant topic, problem clear, ethics discussed, thorough data analysis, description & discussion	Somewhat disorganized presentation, no clear research question, no conceptual framework	38/51
Lee, 2006	interviews	Very clear, concise, detailed methodology clearly explained, results organized	No definition of concepts, no triangulation	47/51
Lee, 2007	Interview guide	Relevant problem, insightful detail of findings. Method clearly explained, good design	No conceptual framework, evidence of enhancement of rigor	41/51
Lee et al., 2008	PDA data collection	Questions explicitly stated, data clearly presented, good discussion and implications	Confusing introduction, no detail about sample population, explanation of study rigor	32/45
Mahler et al., 2007	Instrument by Mahler	Relevant problem, good research design, proper statistical analysis, discussion of findings	No stated research questions, no lit. review, no conceptual framework, no operational definitions	28/45
McLane, 2005	Survey tool by Gardner and Lundsgaarde	Strong problem statement, data collection, description of population & findings	No stated research questions, no conceptual framework, findings not discussed in context of prior research	25/45
Moody et al., 2004	Attitude scale by Moody	Clear problem, research questions, design, data	No conceptual framework or power analysis of	33/45

		analysis & discussion	sample	
Obstfelder and Moen, 2006	interviews	Problem is clear, has conceptual framework, good insight and learning experience	No excerpts of interviews, lacking richness and vividness, no clear coding scheme	34/51
Sackett et al., 2006	Sackett, Erdly & Jones Healthcare Informatics Schemata, SWOT analysis	Useful for population at hand, significant to nurses, useful to other researchers	Lacking detail about research methods and procedures. No rich description, no lit. review	24/51
Saleem et al., 2005	Field notes	Clear problem, good lit. review, ethics discussion, clear design and data analysis	No triangulation or rigor enhancement	43/51
Sidlow and Katz-Sidlow, 2006	Survey	Clear problem, clear hypothesis, relevant to nursing, clearly described method and tool	No IRB, no conceptual framework, no definition of variables	34/45
Smith et al., 2005	Strong & Brodt Nurses' Attitude Toward Computerization survey, observation tool	Pertinent problem and questions, good design and analysis of results	No conceptual framework, discussion of ethics or generalizability	34/45
Staggers et al., 2007	Staggers Nursing Computer Experience questionnaire, QUIS tool	Clear problem, questions, and analysis of results	No literature review, detail lacking in some elements of design	31/45
Vogelsmeier et al., 2008	Field notes, process mapping, staff meeting notes	Relevant problem, time spent in field, triangulation, discussion and conclusions valid to nursing	No research questions, conceptual framework, no display of data in tables, not vivid	34/51
Wagner et al., 2008	QUIS online questionnaire	Clear problem, findings and discussion important to nursing	No conceptual framework, no research questions, no credentials of authors	28/45
Wibe et al., 2006	Survey, audit of nursing documentation	Pertinent data on nurse experience, analysis and discussion will contribute to further research	Problem statement not organized, no research questions, no lit. review, no discussion of tool or generalizability	21/45

\*The total possible number of quality points for a quantitative study

APPENDIX B  
CODING SCHEME

### Codes for Factors in EMR Implementation\*

1. Perspective and/or attitudes of management
2. Perspective and/or attitudes of nurses
3. Computer experience
4. Support for personal needs
5. Degree of planning by organization
6. Computer system availability and/or quality
7. Education and/or training
8. Financial support
9. Organizational culture
10. Commitment level to project
11. Inclusion of nurses in implementation planning process
12. Age
13. Job title
14. Communication and/or collaboration
15. Fit of EMR program with nurse functions
16. Time requirement for EMR documentation

### Codes for types of success after EMR implementation\*

- a. Workflows that support nursing work
- b. Charting that clearly shows nursing work
- c. Enhanced interdisciplinary communication
- d. Enhanced patient care and safety
- e. Ease of use and/or nurse proficiency
- f. Nurse satisfaction
- g. Stable, positive environment
- h. Increased quality of documentation
- i. Financial ease
- j. Ability to summarize clinical data
- k. Security and/or confidentiality

- The code for both the factors and successes was then given a + sign or a – sign to indicate the presence or absence of the factor or success.

APPENDIX C

RESULTS MATRIX

Table 4. Results Matrix

Study Authors, Year	Factors Identified	Successes Identified	Similar studies	Contrasting studies	Comments
Ahn et al., 2006	12+, 13	f+			Positive attitudes correlate with age, nursing experience, and job title
Andre et al., 2008	2-, 3-, 4-, 7-/+ , 9-, 10-/+ , 11-, 14-	f-, e-, a-, g-			An implementation generally seen as unsuccessful by staff
Bar-Lev and Harrison, 2006	1-, 3+, 4+, 7+, 9-, 11+, 14+, 15 -/+	a-/+ , d-/+ , e-/+ , f-/+	Lee, T. 2006; Obstfelder and Moen, 2006; Saleem et. al., 2005; Vogelsmeier et. al., 2008		There will be tension between designers and users unless the EMR fits user needs
Cherry et al., 2008	2-, 3-, 4+, 5+, 7-/+ , 8-/+ , 9+	b+, f+, h+, i+			Cost is a significant barrier to implementation
Choi, Eun, et al., 2006	15+	a+, c+, e+, f+, h+	Wibe et. al., 2006		Nurses found EMR improved communication and quality of documentation
Choi, Woan-Heui, et al., 2006	16 -/+	a-/+ , b+, d+, h+, j+		Donati et. al., 2007	EMR increased time nurses could spend on patient education
Dahm and Wadensten, 2008	2+, 3+, 7+, 9+	a+, d+, e+, f+, h+			Perceived benefits such as enhanced workflow and patient care promotes nurse satisfaction
Donati et al., 2007	2+, 16+	a+, f+, h+		Choi et. al., 2006	Time saved on documentation does not necessarily translate into more time with patients
Gaumer et al., 2007	7-, 16+	d+			Not much data in this study
Hurley et al., 2007	3+, 15+, 16 -/+	a-/+ , c+, d+, f+, e+, h+	Kossman and Scheidenhelm, 2008; Lee et. al., 2008	Korst et. al., 2003	Nurses thought increased time of EMR charting ok if it improves overall quality
Keenan & Yakel, 2005	2+, 3+, 4+, 6-/+ , 7+, 10+, 11+	a-/+ , b+, e+, j+	McLane, 2005		Careful education and communication is key to implementation success
Korst et al., 2003	6+, 16+	a+, d+		Hurley et. al., 2007; Lee et. al., 2008	EMR implementation does not increase documentation time, and there are ways to make it convenient
Kossman and Scheidenhelm, 2008	2-/+ , 3+, 6-, 11+, 14-, 15-/+ , 16-/+	a+, c-/+ , d-/+ , f-, h+	Hurley et. al., 2007; Lee et. al., 2008	Korst et. al., 2003	Although the amount of time spent at computers was disliked, nurses liked EMR better than paper records

Lee, T., 2005	1-, 3+, 6-, 7-, 9-, 11-, 15-, 16-/+	a-, c-, d-, e+, f-/+			Computer availability is crucial to nurse satisfaction, as well as EMR design and education
Lee, T. 2006	1-, 2+, 6-, 7-, 9-, 11+, 15-, 16-	a-/+ , f+	Bar-Lev and Harrison, 2006; Lee, T. 2006; Saleem et. al., 2005; Vogelsmeier et. al., 2008		Nurses had to make special efforts to make the new charting system support their workflow
Lee, T., 2007	4-, 6-, 12-, 14-, 15-/+ , 16-	a-/+ , b-, f-, k-		Sidlow & Katz-Sidlow, 2006	Current system not based on nursing process, not connected to computer systems of other disciplines. Some features are efficient.
Lee et al., 2008	16-	a-, h+/-, e-	Hurley et. al., 2007; Kossman and Scheidenhelm, 2008	Korst et. al., 2003	Nurses spent more time documenting with EMR-unable to ascertain from information provided if this was perceived as good or bad
Mahler et al., 2007	11+, 15+	b+, e+, h+			A carefully designed system can effectively show and track nursing work
McLane, 2005	2-/+ , 3-, 4+, 7+, 9+, 11+, 14+, 15-/+	a+, f+, e+, k+	Keenan et. al., 2005		Extensive education and nurse involvement helped the implementation to be successful
Moody et al., 2004	2+, 3+, 4+, 6-/+ , 12-	a-, f-/+	Obstfelder and Moen, 2006; Smith et. al., 2005; Wager et. al., 2008; Wibe et. al., 2006		Quality of system set up affects user satisfaction
Obstfelder and Moen, 2006	3-, 6-/+ , 7-/+ , 15-/+	b-, f-, e-, h-	Moody et. al., 2004; Smith et. al., 2005; Wager et. al., 2008; Wibe et. al., 2006		Lack of detailed support, not fitting with nursing needs decreased success
Sackett et al., 2006	2+/-, 4+, 6+/-/+ , 7+/-, 8-	a +/-, c+, f-, e+/-			Different health systems have different experiences
Saleem et al., 2005	2-, 4+, 6-, 15-/+ , 16-	a-/+ , c-, e-/+ , f-/+	Bar-Lev & Harrison, 2006; Lee, T. 2006; 2006; Vogelsmeier et. al., 2008		EMR must fit workflow or providers will go to great lengths to work around it, therefore EMR use is not efficient
Sidlow and Katz-Sidlow, 2006	15+	a+, c+, d+		Lee, T., 2007	A specially crafted sign-out function can be very beneficial to interdisciplinary communication
Smith et al., 2005	2-, 6-, 16+	a-, e-, f-, h-/+	Moody et. al., 2004; Obstfelder and Moen, 2006; Wager et. al., 2008; Wibe et. al., 2006		Computer system quality and software quality was poor and this frustrated nurses
Staggers et al., 2007	3+, 6-, 7+, 15-/+	e+, f-/+		Wager et. al., 2008	Experience with computers promotes acceptance of EMRs
Vogelsmeier et al., 2008	6-, 15-	a-, e-, f-	Bar-Lev & Harrison, 2006; Lee, T. 2006; Saleem et. al., 2005		Staff will develop "workarounds" if EMR does not fit needs

Wager et al., 2008	2+, 3-, 6-, 7+, 15+, 16-/+	c+, e-, f+, h+	Moody et. al., 2004; Obstfelder and Moen, 2006; Smith et. al., 2005; Wibe et. al., 2006	Staggers et. al., 2007	Computer experience did not affect satisfaction in this study, poor system quality was a major source of dissatisfaction
Wibe et al., 2006	4+, 7+, 9+, 15-	e-/+, g+, h+	Moody et. al., 2004; Obstfelder and Moen, 2006; Smith et. al., 2005; Wager et. al., 2008		Lack of training and user- friendliness inhibited success, Charting quality improved