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Use of Health Information Systems for Evidence-based Practice Implementation: Literature review

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Purpose: Use of health information systems is a requisite to activate evidence-based practice (EBP) and there have been diverse attempts at implementation, but EBP remains a challenge. Little attention was paid to that different uses of health information systems would bring a difference in EBP implementation. This study aimed to explore the practical applications of health information systems for EBP implementation at the point of care. **Methods:** Studies published between 1995 and 2010 were retrieved using databases of Medline, CINAHL, and EMBASE. The search terms used were 'nursing, evidence-based practice, information system' and 'nursing, evidence, a decision support system. Of 296 studies retrieved, twenty seven studies meeting the inclusion criteria were analyzed. **Results:** Use of health information systems designed for EBP implementation were divided to two categories: health information systems that provide electronic links to numerous evidence resources (9 studies) and health information systems that provide structured electronic formats embedding evidence systematically filtered and preprocessed from evidence resources (18 studies). The former was rarely useful for EBP implementation in clinical situations where organizational and individual barriers were common. These barriers made it difficult to handle plentiful evidence provided from evidence resources In contrast, the latter was useful for immediate use of evidence for EBP implementation. Electronic formats were embedding evident contents for assessments, diagnoses, care plans, outcome evaluation, and alerts. **Conclusion:** A strong culture for EBP implementation is required and it is necessary to improve use of health information systems for EBP implementation at the frontline nurse level.

Key Words: Evidence-based nursing, Evidence-based practice, Health information systems, Reviews

INTRODUCTION

Evidence-based practice (EBP) is to integrate knowledge arising from the best research evidence, one's clinical expertise, and patient preferences within the context of available resources into decision making about health care of individual patients. EBP is eventually to improve patient safety and quality of health care [1,2]. However, utilization of research evidence is a challenge [3]. Research on health care phenomena starts from ideas to improve quality of health care and findings of research are integrated into clinical practice. Clinical practice also generates the need for research to address problems arising in clinical spots and subsequently improve practice performance. When the gap between research and practice narrows through a continuous connection between research activity and clinical practice, implementation of EBP becomes easier. Recently, implementation of EBP in healthcare organizations has been emphasized due to a rapid growth of health information technology [4-6]. Today's information technology (IT) makes it possible for new knowledge accumulated from research studies to be immediately preserved and shared electronically. IT also provides links to Internet websites containing useful healthcare information so that nurses can get access to new knowledge anytime, anywhere. Furthermore, IT infrastructure involving library service allows nurses to readily access to research evidence [7]. Thus, implementation of health information systems has been highlighted as an essential strategy to support and enable EBP in the practice arena [6,8,9]. However, despite the expectation of EBP implementation by use of health information systems, finding prevailing evidence and applying it to an EBP process in real time are still a challenge [3,10-12].

Many studies reported inconsistent findings about EBP implementation by use of health information systems, such as improvement and no change of clinical practice by EBP implementation. To understand why EBP im-

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plementation remains a challenge, studies investigated factors that contributed to EBP failure. Common barriers to EBP implementation are listed in Figure 1 [5,7,12-15]. These barriers are both organizational and individual issues in nature and explain the reasons about why nurses experience difficulties in implementing EBP.

1. Steps for an EBP Process

It is necessary to understand the steps of an EBP process in conjunction with the barriers to EBP implementation. The key steps to implement EBP have been suggested in previous studies [2,4,9,15]. The steps identified commonly included: (1) forming well-designed clinical questions in response to a recognized information need; (2) searching for literature to obtain evidence that addresses that need; (3) appraising the retrieved evidence in terms of usefulness, relevance, accuracy, reliability, validity, and applicability; (4) applying the evidence to a client situation and, if necessary, changing practice; (5) evaluating the effects of any decisions and actions taken; and (6) building a credible dissemination of the evidence and using it.

Developing well-designed clinical questions is necessary for identifying issues applicable to EBP. One method to do so would be to write the questions down on 'post-it' notes and then, categorize and prioritize them [4]. In order to search for literature to obtain evidence, published studies recommended accessing a variety of websites operated by governments, medical and nursing societies, medical librarians, teaching hospitals, evidence-based journals and the Cochrane Library. To evaluate retrieved evidence, individual nurses should critically analyze the information for applicability to a defined clinical situation, original clinical questions, and an individual client's needs. Nurses might use quality criteria to evaluate the retrieved evidence [4]. To apply the evidence to a client situation, a nurse should discuss the issues with healthcare providers, clients, and families, and then, provide the best intervention possible. To evaluate the effects of any decisions and actions taken, a nurse would determine how applying EBP affected patient's outcome and if additional interventions are needed. Nurses might use a tool to measure effectiveness of the intervention [15]. Lastly, if the intervention was effective, the evidence needs to be disseminated to front-line staff nurses. While dissemination of evidence, such as distribution of text-based, lengthy documents, is ineffective and can impede implementing EBP, active, rigorous, and well-planned strategies for dissemination bring an actual change incorporating new evidence into policies, procedures, and guidelines of clinical settings [5,15]. Gauging the level of staff understanding and verifying actual use of applied evidence are included as active strategies [4,15]. These EBP steps can be completed by individual nurses and/or healthcare provider teams [4,15].

Although these steps may appear to be a blueprint to realize EBP in nursing, they all are vulnerable to the barriers listed in Figure 1. If there is no strong support from an organization (e.g. lack of administrative support and lack of system-level infrastructure to encourage EBP) and individual nurses are not well prepared for EBP implementation (e.g. lack of time to search for literature and lack of training on research evidence utilization process), EBP in nursing will remain elusive. EBP implementation is a complex, multifaceted process involving individual and organizational issues [16]. As such, the EBP steps are not practical without eliminating the aforementioned barriers and nurturing a strong EBP culture.

Consequently, previous investigations of EBP imple-

Barriers to EBP implementation	Organization or individual issue
Insufficient time in searching, reading, and discussing literature Lack of training a process of research evidence utilization Lack of basic research knowledge such as appraisal and statistics Lack of motivation Lack of computer skills Pressure to conform to ritualistic practice Poor team work	Individual issues
Guidelines competing with patient priorities Lack of agreed priorities Lack of registered nurse authority to change practice Lack of administrative support Lack of incentives Lack of a system-level infrastructure Poor access to resources Technological problems such as overloading, downtime, and poor computing support	Organizational issues

Figure 1. Barriers to EBP implementation.

mentation's barriers overlooked the effect of different uses of health information systems designed to encourage EBP implementation. These studies did not clarify whether or not various uses of a health information system made a difference in EBP implementation, such as a difficulty and ease of EBP implementation. We need to examine past practices for EBP achievement in nursing through various uses of health information systems.

2. The Purpose of the Study

This study aimed to explore the practical applications of health information systems for EBP implementation at the point of care.

METHODS

Literature search was conducted with focusing on identifying different types of uses of health information systems designed for EBP implementation in the nursing field. Studies published between 1995 and 2010 were retrieved using databases of Medline, Cumulative Index of Nursing and Allied Health Literature (CINAHL), and Excerpta Medica dataBASE (EMBASE). The search terms used were 'nursing, evidence-based practice, information system' and 'nursing, evidence, a decision support system.' The inclusion criteria were studies that tried EBP implementation with evidence from tested and accredited health and nursing-related information and peer-reviewed research information. Studies were excluded in the case of no or insufficient mentions of nursing literature used as evidence resources. The search was conducted between May and June, 2011.

Of 296 studies retrieved, studies not accessed to a full text (163), studies describing algorithm of health information applications (57), and studies not mentioning nursing-related evidence resources (49) were excluded. Twenty seven of studies were finally included in analysis of this study.

RESULTS AND DISCUSSION

1. Use of Health Information Systems for EBP Implementation

Studies retrieved tried EBP implementation with a variety of evidence resources including printed resources such as research articles and books and accredited electronic websites such as government websites, the Cochrane Library, websites operated by nursing societies, websites operated by professional organizations, and bibliographic databases (e.g. Medline and CINAHL). Use of health information systems designed for EBP implementation were divided to largely two categories.

2. Encouragement of Evidence Utilization: Providing Links to Evidence Resources

Several studies listed websites available for EBP. As shown in Table 1, Internet websites and an electronic (or digital) library containing voluminous evidence information were linked to a health information system. Particularly, Bellika and Hartvigsen [17] included Internet websites to identify the most relevant clinical guidance for cancer patients. Barroso et al.[18] provided a link to an electronic library with a collection of qualitative studies for women with HIV infection to address the information needs of nurses who cared for them. Granger [4] and Williams et al. [15] provided Internet resources explaining the steps of EBP. Pochciol and Warren [7] emphasized the use of library services to enable EBP. Young and Stec [19] simply identified websites with a wealth of evidence-based information for pediatric home care clinicians.

The studies listed in Table 1 used health information systems as a bridge to provide links to a variety of websites containing accredited health-related information. The second step of an EBP process also recommended using many Internet resources to obtain evidence addressing an informational need. Unfortunately, the volumes of healthcare literature are unmanageably large, unwieldy, and highly diverse even though they are valid and accredited evidence [7]. In situations that do not control EBP barriers (Figure 1), it does not look possible that providing links to a variety of websites engages nurses to implement EBP or to follow the steps of EBP at the point of care. The health-related information on these websites mostly shows a display of copious amount of text-based documents [3]. This type of evidence dissemination is rarely useful for implementing EBP and changing practice because a display of text formats will not look specific and be meaningful to the target audience, such as nurses, in real time and in real practice [5,16,20]. Moreover, information from many of evidence resources can be redundant and inconsistent. Inconsistencies will pose threats to safety and quality of patient care [6]. As a matter of fact, studies reported that in spite of easy access to evidence resources, actual utilization of research evidence to daily practice was very low. Front-line nurses rarely searched for evidence related to practice even though computer terminals were readily

Table 1. Health Information Systems (HIS) Providing Electronic Links to Evidence Resources

Articles	Evidence resources	Use of HIS
Sitzia (2002) [5]	Internet resources including Cochrane Library, databases of clinical guidelines and best evidence	HIS provides electronic links to evidence resources
Spaeder (2002) [23]	Medline to address information needs generated during monitoring data automatically transmitted from patients *A structured query format was used	
Bellika & Hartvigsen (2005) [17]	Internet resources including national and institutional guidelines to find the most relevant medical guidance for cancer patients	
Barroso et al. (2006) [18]	Electronic library with qualitative studies for women with HIV infection to address information needs generated in caring for HIV women	
Tannery et al. (2007) [24]	Electronic library including original electronic journals, books, and drug information to address information needs at the point of care	
Granger (2008) [4]	Internet resources including government websites, Cochrane Library, websites provided by teaching hospitals, medical societies' websites, and CINAHL	
Pochciol & Warren (2009) [7]	Electronic library including bibliographic databases and accredited websites to address information needs at the point of care	
William et al. (2009) [15]	Electronic library including bibliographic databases and accredited websites to address information needs of home care nurses	
Young & Stec (2010) [19]	Internet resources including government websites, Cochrane Library, websites provided by teaching hospitals, medical societies' websites, medical librarians' websites, foundations and associations' websites, and lastly, websites from non-governmental/non-profit organizations to address information needs of pediatric home care nurses	

available to them. They mostly sought information from experienced colleagues such as clinical nurse specialists, senior nurses and physicians. In addition, they were satisfied with the verbal answers which exactly addressed their questions [3,21-25]. Nurses believed that their colleagues to be authoritative and trustworthy, and possessed more expert knowledge than themselves. Nurses thought this method of information gathering to be more convenient rather than searching for research articles and judging research evidence [2]. However, knowledge from experienced colleagues is often intuitive and subject to bias [26]. This 'blind spot' was overlooked during the efforts to provide links to websites for access to health-related literature. Although individual nurses might have every intention to search for research articles, they may not be able to do so in a busy unit. In particular, a nurse may have a difficulty with interpreting quantitative research findings and statistics. While nurses may intend to change daily practices based on recent evidence, they may not have the authority to do so. To become links that facilitate EBP implementation, coordinated efforts must first be made from an organization and individual staff nurses to address the EBP barriers listed in Figure 1.

As an alternative to providing links to numerous websites, there was a successful example attempted by the University of Iowa Nursing Informatics Research Team that transformed text-based protocols into reference information [6]. The reference information appeared as a number of essential recommendations artfully arranged on a screen. The reference also contained electronic links to the original full text research articles supporting the recommendations. For example, the reference information on how to assess pain in the elderly consisted of several recommendations including concrete examples of how to ask about pain, pain-related words frequently used by the elderly, and allowing sufficient time for the elderly to process information and to respond. The reference information trimmed from the original full text research articles was substantial for use at the point of care. First of all, it would function as a clinical solution for nurses under time constraints. This reference information is a type of the structured electronic format that will be discussed in the next section. In contrast, simply providing a display of plentiful evidence from electronic resources (i.e. providing original full text research articles) is of little use for nurses striving to implement EBP.

3. Encouragement of EBP Implementation: Providing Electronic Formats Embedding Evidence

Table 2 presents evidence embedded into electronic formats of health information systems. In these studies, evidence from selected evidence resources was reviewed, evaluated, filtered, and then embedded into required electronic formats, for the purpose of eventual use in practice. The electronic formats were embedding evidence in diverse ways including patient assessments, diagnosis recommendations, pre-built care plans, outcome evaluation recommendations, alerts and reminders, and creating a documentation format. Particularly, patient assessments were provided as forms to be filled out, whereas diagnoses, care plans, and outcome evaluations were mostly provided as structured reference information in drop-down boxes. Furthermore, many of the studies in Table 2 developed links between different electronic formats. It was mainly electronic links between patient assessment and care plan recommendations related to the assessment components [22,27,29-31,33,35,38,41,43]. The reminders or alerts based on documented values were electronically linked to reassessment to a plan of care or to an intervention [35-37,40,42].

Developing and using these electronic formats embedding evidence are actually to address most of the barriers to EBP implementation in Figure 1. Bulky evidence was filtered several times during the electronic formats were established and consequently, transformed into a final version containing evidence essential for specific practice. The final version of evidence is meaningful to target nurses for use in real time. The amount of evidence (i.e. assessment forms to be filled out and recommendations) arranged in the electronic formats was the level that nurses could deal with at the point of care. Thus, rather than that individual nurses had a hard time to search for relevant evidence literature and to choose the best from multiple evidence information at their busy time, they could effectively spend their time for applying the evidence systematically preprocessed for immediate use. In addition, use of evidence embedded in this type of electronic formats was mandatory and users were not allowed to continue to the next screen without following the recommended procedure. Thus, frontline nurses had no choice but to actively use evidence at the point of care.

A few studies gave weight to the method of embedding evidence into structured electronic formats for realization of EBP implementation. These studies reported nurses' preferences on the use of evidence in real time. Doran et al. [22] reported that frontline staff nurses preferred the use of structured formats at the point of care, such as an electronic intravenous medication guideline and ulcer risk assessment scale. Bellika and Hartvigsen [17] reported that searching for the most relevant information on websites was a time-consuming process that imposed a heavy burden on nurses. In addition to search activity, nurses had to judge what pieces of information were relevant. In the Tannery et al.'s study [24] which compared before and after access to an electronic library providing various evidence collections, most nurses still kept consulting their colleagues to solve their informational needs. In another study [23], nurses said that the Medline query system was too time intensive and there was a mismatch between their information needs and query system capabilities. Nurses mostly used the query to obtain simple drug information, rather than to obtain extended information such as patient assessments, care plans and outcomes evaluation. These studies indicated that access to evidence alone was insufficient to implement EBP. They emphasized that evidence should be disseminated in a synthesized and preprocessed form to enable frontline staff nurses to apply the evidence at the point of patient care [33,44,45].

Yet, such concerns are only the starting point for EBP implementation as evidence embedded in structured electronic formats does not cover all aspects of nursing care. First, embedded evidence is not specific to all patient populations. For example, evidence for physical assessment will not address both a neonate and adult patient because of inherently different components. The format would provide a comprehensive assessment with common content to be applied to all patients in a hospital. Thus, evidence in electronic formats should be improved to include specificity depending on specific patient population and their health status [44,45]. Second, all links between assessment, diagnosis, care plan, outcome evaluation, and other relevant recommendations should be provided in order to enable nurses to implement the nursing process based on EBP. In Table 2, a study [43] made such a full link between the nursing process steps. The links should naturally interface with the workflow of nurses at the point of care [46]. It will considerably reduce significant behavioral and system changes accompanied by EBP implementation. Lastly, evidence embedded in electronic formats should be updated at regular intervals with the most current evidence [44]. Despite the necessity of continuous updates, because evidence is embedded into structured formats of a health information system, utilization of evidence in clinical practice can be much easily achieved [6,33].

This study focused on the use of health information sys-

Table 2. Health Information Systems (HIS) embedding Evidence

Articles	Evidence resources	Use of HIS: Preprocessed evidence embedded in electronic formats
Heermann et al. (1999) [27]	Research findings for ventilator management by arterial blood gas values	Ventilated patient assessment form Ventilator management recommendations
Reilly et al. (2000) [28]	Books; standards from professional organizations; and existing institutional-specific assessment tools for admission assessment and related advisories	Admission assessment form Referral advise based on the assessment
Jirapet (2001) [29]	Nursing textbooks; care plan guides; standards of practice; research findings; and (retrospective) data provided from experienced nurses for caring for mechanically ventilated neonates	Ventilated neonate assessment form Related diagnoses Related care plans Media including video, picture, and graph are inserted in a assessment format for exact assessment
Huang et al. (2003) [30]	Cancer pain guidelines and a pain assessment tool	Cancer pain assessment form Pain management recommendations
Im & Chee (2003) [31]	Email discussions of 19 nursing faculty members in oncology from 10 countries; research articles; national statistics data; and their clinical and research experiences for cancer pain	Cancer pain assessment form Pain management strategies
Sharpley & Holden (2004) [32]	Most commonly used tool for scoring the degree of illness of a patient in an intensive care unit.	Assessment form scoring the degree of patient's illness
Clarke et al. (2005) [33]	Clinical practice guidelines and literature review for pressure ulcer	Skin and pressure ulcer assessment forms Related care plans
Finkelstein et al. (2005) [34]	Research articles for respiratory symptoms of lung transplant recipients	Respiratory functions assessment form
Vogelzang et al. (2005) [35]	Research articles for normal range of blood glucose level in intensive care patients	Blood glucose assessment form Recommendation of insulin pump rate and next sample time based on the assessment Reminder for recommended actions
Brokel et al. (2006) [36]	Empirical studies; regulations; standards; and ad hoc expert editorial board for providing real-time alerts to abnormal events captured from data in a CIS (e.g., abnormal laboratory results, a positive screening response, a missed admission assessment)	Reminder for captured abnormal events
Kroth et al. (2006) [37]	Research articles for normal range of body temperature	Alert for low body temperature Advices for re-measurement of body temperature
Bakken et al. (2007) [38]	A literature review for fall-injury risk assessment	Fall-injury risk assessment form Pre-built care plans
	Clinical practice guidelines for screening of obesity, tobacco, and depression	Screening form including diagnoses, procedures, prescriptions, teaching and counseling, and referrals
Dong et al. (2007) [39]	National standard for patient triage in emergency department	Patient triage assessment form
Doran et al. (2007) [22]	Randomized controlled trials using clinical practice guidelines and other guidelines for patient outcome assessments and care plans	Real-time feedback based on patient outcome assessment Care plans related to feedback
Provost & Gray (2007) [40]	National standards; guidelines from professional organizations; research articles; and institutional policies and protocols for a perinatal documentation format	Perinatal documentation format Alert for essential documentation entries missed
Roukema et al. (2008) [41]	Research articles for serious bacterial infection (SBI) in children	SBI assessment form Diagnostic management advice
Lyerla (2008) [42]	Recommendations from professional organizations and research articles for a head-of-bed (HOB) elevation to decrease ventilator-driven pneumonia	Reminder for an appropriate HOB angle Contraindications against the HOB angle
Kim et al. (2007) [43]	Research articles; national guidelines; patient care documents; quality measures and indicators; and standards from professional organizations for the selected 22 nursing phenomena of concern in adult population (e.g., activity tolerance, infection)	Structured assessment forms Alerts for problems Pre-built care plans Structured outcomes evaluation

tems designed for utilization of nursing literature such as research findings in clinical practice. Patient data per se gathered for patient care are also evidence resources [6,26, 38,43], which is another aspect of EBP. Patient data contain a variety of information such as laboratory results, medications, patients' demographics, and nursing documentation records about patient care. The data provide important clues in grasping causes of problems rising in clinical spots. When the data are appropriately sorted and analyzed, the outputs are represented as significant information and knowledge to improve practice [6,43]. In the studies retrieved in this study, seeking EBP using patient data were very rare. Only one study [43] used patient care documentations as evidence resources. Further research is required to study health information systems that analyze and evaluate patient data as significant evidence for EBP implementation.

For implication for nursing practice, this study provided a comprehensive understanding of the state of EBP implementation depending on use of health information systems. It is hoped that this study can serve a foundation for development of smart health information systems to activate EBP implementation at the frontline staff nurse level.

4. Limitation of the Study

The findings of this study cannot be generalized because non-English studies regarding using health information systems for EBP implementation were not included in this study.

CONCLUSION

Use of health information systems is a requisite to activate EBP and while there have been various attempts to do so, true EBP implementation remains a challenge. This study reviewed the related literature to explore whether different types of uses of health information systems made a difference in actual implementation of EBP. The literature review presented two different types of uses of health information systems to implement EBP at the point of care: health information systems that provide electronic links to numerous evidence resources and health information systems that provide structured electronic formats embedding evidence systematically filtered from evidence resources. Use of structured electronic formats embedding preprocessed evidence for immediate use actively engaged nurses into EBP implementation. In contrast, providing electronic links to copious evidence resources was rarely useful for EBP implementation in clinical situations where organizational and individual barriers were not controlled. When a strong culture for EBP implementation exists, a provision of electronic links to evidence resources can definitely actualize EBP implementation.

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