

Barriers for Hospital-Based Nurse Practitioners Utilizing Clinical Decision Support Systems

A Systematic Review

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There is a national focus on the adoption of healthcare technology to improve the delivery of safe, efficient, and high-quality patient care. Nurse practitioners fulfill an emerging strategic role in the hospital setting. A comprehensive literature review focused on the question: What are the barriers for nurse practitioners utilizing clinical decision support in the hospital setting? Nine studies conducted from 2011 to 2017 were the basis for this review, which identified 13 barriers for nurse practitioners utilizing clinical decision support in the hospital. Having the right information, including up-to-date evidence-based practice guidelines, accurate clinical pathways, and current clinical algorithms, was the most common barrier. Providing reliable clinical decision support is crucial as nurse practitioners become more dependent on hospital technology systems in the delivery of safe patient care. Eliminating barriers to the use of clinical decision support is important for informaticists and nurse practitioners because both groups concentrate on acceptance of decision support systems in the hospital to meet the goal of safe and high-quality patient care.

KEY WORDS: Barriers, Clinical decision support, Hospital, Nurse practitioner

Currently, there is a nationwide focus on the adoption of healthcare technology to improve the delivery and quality of safe and efficient patient care.¹⁻³ There has also been a surge in the presence of nurse practitioners in the hospital setting to help alleviate the physician shortage.⁴ Both clinical decision support (CDS) and the role of the nurse practitioner improve the quality of clinical care delivery in the hospital.^{1-3,5} However, CDS utilization targets physicians, with little mention of nurse practitioners.^{2,3} The purpose of this systematic review is

focus on the question: What are the barriers for nurse practitioners utilizing CDS systems in the hospital setting? Greenes³ has identified a barrier as anything that impedes acceptance of CDS systems. Eliminating the barriers to CDS is important to informaticists and nurse practitioners because both groups concentrate on acceptance of decision support systems in the hospital to meet the goal of safe and quality patient care.

BACKGROUND

Clinical decision support is “a process for enhancing health-related decisions and actions with pertinent, organized clinical knowledge and patient information to improve health and healthcare delivery.”^{3(p690)} Clinical decision support is not merely the use of technology; it is using technology to find meaningful information to make clinical decisions and provide the best possible patient care. Osheroff⁶ has provided the necessary framework to successfully design and implement CDS systems. The framework, also known as the CDS Five Rights, is the right information to the right people in the right format and the right channel at the right time.^{1,3,6,7} The CDS *right information* includes clinical knowledge, evidence-based practice guidelines, clinical pathways, and clinical algorithms.^{1,3,6-8} The CDS *right people* considers the people who need information for clinical decision making and consists of physicians, nurse practitioners, nurses, pharmacists, clinical staff, and patients.^{1,3,6,7} The CDS *right format* describes decision support interventions, such as alerts, data, prompts, order sets, and informational buttons.^{1,3,6,7} The design and implementation of decision support through the CDS *right channels* incorporates the Internet, electronic health records, patient portals, workstations, and mobile technology systems.^{1,3,6,7} Finally, the CDS *right time* pinpoints the timing of CDS in the workflow along with the right time to guide key decisions or actions.^{1,3,6,7} Use of the CDS Five Rights framework can assist in determining optimal CDS system utilization, as well as identifying barriers to use.

Preventing medical errors and patient harm continues to be a major driving force in healthcare, and nurse practitioners can influence CDS utilization in the hospital for safe patient care.³ The characteristics embedded in the definition of CDS and the

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CDS Five Rights are integral to reducing medical errors and improving care delivery.^{2,3,6} The attention to medical errors can be traced back to the Institute of Medicine's seminal report *To Err Is Human*, which raised public awareness concerning the current state of healthcare and the need for improved safety.² Implementing technology and CDS systems to monitor for and identify errors before they affect the patient can prevent injury and harm. As the topic of patient harm receives more attention, the spotlight extends beyond the medical community, as evidenced by political enthusiasm, social motivations, and a global focus on patient safety.¹⁻³

Nurse practitioners play an emerging strategic role in the hospital setting. According to the American Association for Nurse Practitioners,⁴ more than 222 000 nurse practitioners are licensed in the United States, and 49.9% of nurse practitioners hold hospital privileges. Although only 7.7% of acute care nurse practitioners and 1.7% of neonatal nurse practitioners work in the hospital arena,⁴ nurse practitioners are assuming increased responsibilities in the inpatient hospital setting, and many groups have called for nurse practitioners to play a greater role and grant full practice authority.⁴ The conclusions of a systematic review by Stanik-Hutt et al⁵ were that nurse practitioners deliver high-quality, safe, and effective care, and that hospital-based nurse practitioners use hospital technology along with CDS systems to deliver high-quality, safe care during all phases of the patient's hospital stay.¹⁻⁵

METHODS

The Indiana University Ruth Lilly Medical Library was accessed and an electronic database search of Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, Cochrane Methodology Register, CINAHL Complete, Database of Abstracts of Reviews of Effects (DARE), Educational Resource Information Center (ERIC), Google Scholar, Health Source: Nursing/Academic Edition, Health Technology Assessments, and MEDLINE with Full Text (EBSCO) was conducted in January 2017 to identify relevant literature to answer the research question: What are the barriers for nurse practitioners utilizing CDS systems in the hospital setting? Search terms were generated from the research question using the Problem, Intervention, Comparison, Outcome (PICO) format. MeSH terms and keywords focused on nurse practitioners, the hospital setting, and CDS systems as the core content area of interest. The citation manager EndNote X8 Windows (Clarivate Analytics, Philadelphia, PA) was used to manage references. Only studies published in the English language from 2011 to 2017 were considered for this review.

Inclusion Criteria

Inclusion criteria concentrated on study participants, setting, and CDS as the core content area (Figure 1). Participant criteria

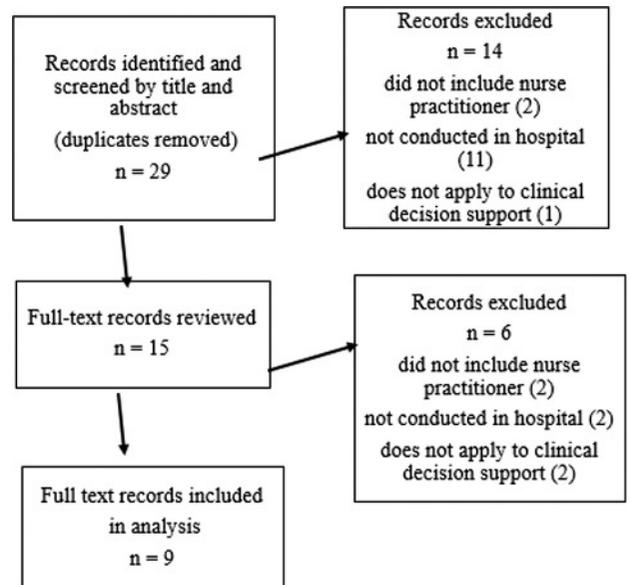


FIGURE 1. Database search results.

focused on nurse practitioners, midlevels, advanced practice nurses, advanced practice RNs, or advanced practice professionals. Studies with blended or heterogeneous sampling were included, as long as study participants included nurse practitioners, midlevels, advanced practice nurses, advanced practice RNs, or advanced practice professionals. A study of nurse practitioner students was also included. Studies involving only physicians or only pharmacists were excluded.

The criteria for the study setting centered on inpatient facilities, including hospitals and the acute care setting; some were heterogeneous and included both the inpatient and outpatient setting and were included in the review. Studies were excluded if they were in the outpatient, ambulatory, home health, or clinic setting. Finally, studies were omitted if the core content area of interest was not CDS.

Study Selection

After duplicates were removed, the study selection screening process started with a title and abstract review and then proceeded to full-text record review. A flow diagram of the study selection process is presented in Figure 1. First, the title and abstract were screened to identify studies that met inclusion criteria. Next, full-text articles were obtained and reviewed, and studies were selected based on inclusion and exclusion criteria as described above. Two full-text articles were not obtained and consequently excluded. Once the article met the inclusion criteria, studies were reread, and barriers were pinpointed. An annotated bibliography was created to organize the findings. In total, nine studies met all inclusion criteria and were used for this systematic review.

FINDINGS

The numbers and types of studies used for this systematic review were as follows: four qualitative studies,^{9–12} four quantitative studies,^{13–16} and one qualitative metasynthesis.¹⁷ Two of the nine studies were considered weak because of the sampling.^{13,14} The nine studies identified a total of 13 barriers for nurse practitioners utilizing CDS in the hospital (Table 1). Each study is briefly described in the following paragraphs, along with the barriers identified.

Ariosto's⁹ retrospective quantitative analysis examined CDS alerts related to opiate allergies in an inpatient hospital academic medical center.⁹ This blended sample included 15.4% of nurse practitioners.⁹ The researchers described four barriers to utilizing CDS alerts. First, the high number of insignificant and inappropriate alerts led to nuisance alerting and high override rates.⁹ The second barrier to fully utilizing CDS was the incorrect system setup of allergy alerts in the electronic health record.⁹ The decision support algorithm used to explain opiate allergies was improperly defined.⁹ Another barrier described was inappropriate data intake and inaccurate patient information in the electronic health record.⁹

Benson and colleagues¹⁰ conducted a quantitative study involving a nurse practitioner–led rapid response team in a 350-bed teaching hospital. The study design was a pre- and post-implementation survey comparison focusing on CDS database queries to identify sepsis.¹⁰ The researchers identified two barriers to CDS, including the lack of available clinical patient information (anion gap laboratory value) in the electronic health record and the CDS algorithm not supporting current evidence-based practice as outlined in the Surviving Sepsis Guidelines.¹⁰

A randomized controlled trial by Eldredge et al¹¹ involved 23 providers in an urban area, including seven nurse practitioners,

which focused on CDS utilization at the point of care. A pre- and post-trial survey was developed for data collection.¹¹ The outcome of this small clinical trial found two barriers to adoption: lack of training with the CDS tool and lack of time to use the tool at the point of care.¹¹

Oh and colleagues¹² conducted a randomized controlled trial to study CDS text-based electronic alerts focusing on acute kidney injury. The research occurred in the hospital setting, and the blended sampling (98 participants) included nine midlevel practitioners.¹² The researchers identified four barriers, including alert fatigue; delayed alerting resulting in lack of timeliness; lack of ability to target alerts to specific groups, for example, patients taking nephrotoxic drugs; and finally, the inability to create alert algorithms with different sensitivities to predict acute kidney injury.¹²

A metasynthesis by Miller and colleagues¹⁷ of nine qualitative studies included nurse practitioners providing direct patient care in inpatient and outpatient settings. The authors examined the difficulty of integrating CDS into clinical work.¹⁷ The metasynthesis identified five themes or barriers: usability and user interface challenges, lack of integration between the electronic health record and the CDS system, immature CDS algorithms, lack of interoperability, and patient safety.¹⁷

The qualitative observational design research by Cato et al¹³ studied 775 nurse practitioner students using mobile technology decision support to screen patients for tobacco use. The study setting included both acute care hospital and ambulatory care in New York City.¹³ Embedded in the nurse practitioner student documentation software was the CDS reminder.¹³ The researchers identified time, training, and lack of knowledge of current evidence-based guidelines as three barriers to using the mobile decision support reminder tool.¹³ A weakness of this study is that the sample was focused on nurse practitioner students.

De Wit and colleagues¹⁴ conducted a qualitative, pharmacy-led study to examine drug-related and medication-error CDS alerts. The study took place in a Dutch hospital setting with a blended sample that included nurse practitioners.¹⁴ They found five barriers to CDS-generated alerts: alert fatigue, incorrect CDS content, CDS inefficiencies, reliance on manual input of patient details, and inappropriate timing of the CDS alert notifications.¹⁴ A limitation of this study is that the researchers did not include the sampling details, and the number of nurse practitioners involved in the study is unknown.

Knoble and Bhusal¹⁵ conducted qualitative research studying CDS electronic algorithms by means of mobile technology. The sample targeted nurse practitioners in a heterogeneous setting that included hospitals in Nepal.¹⁵ The authors identified four barriers, including software flaws in the CDS algorithms, an application error, hardware technical challenges including inadequate touch technology, and unreliable battery life, which obstructed use of the CDS system.¹⁵

Table 1. List of 13 Barriers for Hospital-Based Nurse Practitioners Utilizing CDS in the Hospital

Barrier
CDS alerts/nuisance alerts ^{9,12,14,17}
Incorrect format ^{9,14}
CDS systems algorithm: improperly defined/not current with evidence-based practice ^{9,10,14,15,17}
Inaccurate patient information/lack of clinical patient information ^{9,10,16}
Inappropriate timing of CDS ^{11–14}
Lack of training ^{11,13}
Lack of knowledge ^{13,16}
CDS inefficiencies ¹⁴
Reliance on manual input ¹⁴
Incorrect CDS content ¹⁴
Hardware issues ¹⁵
Usability ¹⁷
Lack of interoperability ¹⁷

Smith and colleagues¹⁶ published a retrospective qualitative analysis of an effort to minimize gastrointestinal events caused by nonsteroidal anti-inflammatory drugs using a risk assessment CDS calculator. They specifically focused on nurse practitioners and used the Healthcare Cost and Utilization Project inpatient database.¹⁶ Incomplete patient information in the electronic health record and nurse practitioner lack of knowledge about the availability of the risk assessment calculator were two barriers recognized by the researchers.¹⁶

DISCUSSION

This literature review identified 13 unique barriers for nurse practitioners utilizing CDS systems in the hospital. The results are summarized in Table 1. The literature is limited, and few studies exist that solely focus on hospital-based nurse practitioners utilizing CDS systems in the hospital setting. This is remarkable and an important finding given the emerging role of the nurse practitioner in the hospital.^{4,5} At the time of writing, studies concentrating on electronic health records and CDS systems focus primarily on physician use.^{2,3} When nurse practitioners are included in CDS studies in the hospital, a blended sample of physicians and nurse practitioners is often utilized. More research aimed at nurse practitioners utilizing CDS in the hospital setting is essential. Comparison studies are needed to determine whether knowledge, skills, attitudes, and behaviors associated with CDS systems are similar or different between physicians and nurse practitioners.

The initial analysis of the literature revealed several barriers to using CDS systems. The list of barriers is expansive and covers everything from alerts, software flaws, hardware challenges, technical limitations, and workflow inefficiencies. Clinical workflow is a determining factor for efficient utilization of CDS.¹³ Eldredge et al¹¹ called attention to the cost of CDS systems and access to decision support tools at the point of care. Even so, a better understanding of decision support tools pertaining to mobile technology is necessary.¹³

Nonetheless, continued analysis uncovered similar and overlapping elements for several barriers. A common and recurring barrier involved improperly defined CDS algorithms and incorrect clinical content.^{9,10,14,15,17} Other consistent findings included incomplete patient information^{9,10,16} and timing of the CDS notification.¹¹⁻¹⁴

Further evaluation required a logical methodology to sort the findings. Mertz⁷ emphasized that decision support structures consist of the CDS Five Rights for complete, reliable, and relevant design of CDS systems. The CDS Five Rights framework was thus used to identify patterns or themes for the barriers, isolate the shortcomings of CDS, and categorize the 13 barriers into five groups (Table 2). There are four

Table 2. List of Barriers for Nurse Practitioners Utilizing CDS Systems: Categorized by CDS Five Rights

CDS Five Rights	Barrier Identified
Right information	<ul style="list-style-type: none"> • CDS systems algorithm: improperly defined/not current with evidence-based practice^{9,10,14,15,17} • Inaccurate patient information/lack of clinical patient information^{9,10,16} • Lack of knowledge^{13,16} • Incorrect CDS content¹⁴
Right people	<ul style="list-style-type: none"> • Lack of training^{11,13} • Usability¹⁷
Right format	<ul style="list-style-type: none"> • CDS alerts/nuisance alerts^{9,12,14,17} • Incorrect format^{9,14} • Reliance on manual input¹⁴
Right channel	<ul style="list-style-type: none"> • Hardware issues¹⁵ • Lack of interoperability¹⁷
Right times	<ul style="list-style-type: none"> • Inappropriate timing of CDS¹¹⁻¹⁴ • CDS inefficiencies¹⁴

barriers grouped into the CDS right information category. In the CDS right people category, two barriers are noted. The CDS right format category consists of three barriers. The CDS right channel comprises two barriers, and two barriers are associated with the CDS right times. The number of barriers in each CDS Five Rights category was used to rank the findings in the following order:

1. right information
2. right format
3. right times
4. right channels
5. right people

According to the CDS Five Rights framework, the greatest barrier identified for nurse practitioners using CDS in the hospital setting is the CDS right information (Table 2). Relevant clinical knowledge, up-to-date evidence-based practice guidelines, accurate clinical pathways, and current clinical algorithms are key elements that encourage nurse practitioners to accept and use CDS in the hospital setting. Clinical decision support is necessary in order to achieve the goals of evidence-based practice.^{1-3,7} Ariosto⁹ emphasized that CDS relies on accurate and complete data and information in the electronic health record. Mertz⁷ stated that CDS is “getting usable information to provide the best possible care.”^{7(p6)} Identifying and removing barriers increases utilization and acceptance of CDS, enhances safety, and improves the quality of patient care.

Limitations

Despite the effort to include all the appropriate research, it is possible that the search strategy inadvertently excluded relevant articles. The approach to study selection may have also introduced selection bias. The heterogeneity of the sample

populations and study settings consequently could introduce outcome limitations. Multiple inpatient settings, including an inpatient academic center, inpatient acute care hospital, inpatient community hospital, and an inpatient rapid response team, could introduce outcome limitations. Some studies had a small sample size; therefore, generalization may not be applicable.

CONCLUSION

This systematic review identified 13 barriers for nurse practitioners using CDS systems in the hospital setting. The most common barrier for nurse practitioners utilizing hospital CDS systems in the hospital is the *CDS right information* (Table 2), which includes up-to-date evidence-based practice guidelines, accurate clinical pathways, and current clinical algorithms. Providing reliable CDS is crucial as nurse practitioners and clinicians become more dependent on these technology systems in the delivery of safe patient care. Nurse practitioners are an untapped resource that can positively contribute to reducing barriers and improving acceptance of CDS systems. Future research relating to hospital-based nurse practitioners and their use of CDS systems is recommended.

As health information technology moves at lightning speed, CDS is vital. It is hoped that informaticists and hospital clinical technology action teams utilize the findings of this systematic review when planning, designing, and implementing CDS systems. Furthermore, a call to action is needed for more research regarding nurse practitioner involvement in the design, implementation, utilization, and optimization of CDS in the hospital setting. Finally, the informaticist and nurse practitioner must work as partners to optimize current decision support systems and design future CDS to meet the goal of providing the best possible patient care.

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