Review article:

Clinical decision support system in nursing: A review of literature

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Abstract

Back ground: CDSS has been shown to lead to significant quality and safety improvements in patient care and improve workflow.

Objective: To review the recent literature clinical decision support system in nursing and application of CDSS to nursing practice.

Methods: A narrative literature research was carried out for evaluation of the literature generated from MEDLINE, CINAHL, OVID, PUBMED and EBESCO systems and the Internet from September, 2007 to February, 2014. The literature reviewed suggests that Clinical Decision support system in nursing. The inclusion criteria were an original study or review studies involving Clinical Decision support system in Nursing. Among selected papers were screened and irrelevant studies were excluded.

Result: The definition, Characteristics, Types. Benefits, Implementation, Use, Barriers of Implementation of CDSS in Nursing, Effectiveness, and Examples, the relationship and difference between HER and CDSS, Instruments to Implement CDSS in nursing were identified and the related research discussed.

Conclusion: The Characteristics, Types. Benefits, Implementation, Use, Barriers, and Implementation of CDSS in nursing, effectiveness of Clinical Decision support system in nursing were identified, each having its own attributes and uses. The current literature, research and reviewed articles which were developed through an evaluation of this literature reviewed article and the assessment of a limited number of research studies that focused on the clinical decision support system in nursing at different health facilities.

Implication of nursing practice: It is proposed that clinical decision support system improves as the nurse gains CDSS experience in their work within a specific specialty and with experience, nurses gain a sense of saliency in relation to clinical decision support system. Nurses may use CDSS independently and concurrently to solve Weak and long time health service at health setting.

Key words: Clinical, Decision support, Clinical Decision Support system, nursing

Introduction

CDSS are a computer-based form of decisiontool, integrating information (ideally from highqualit- yresearch studies) with the characteristicsof individual patients, to provide advice to clinicians (Dowding D et al., 2007). Regarding to the Clinical Decision Support (CDS) Roadmap project, CDS is "providing clinicians, patients, or individuals with knowledge and person-specific or population information, intelligently filtered or present at appropriate times, to foster better health processes, better individual patient care, and better population health."(Duke University hospital 2005, Abdrbo et al., 2009).CDS has been shown to lead to significant quality and safety improvements in patient care and improve workflow. For example, computerized provider order entry (CPOE) with CDS can improve medication safety and reduce medication-related expenditures because it introduces automation at the time of ordering, a key process in health care(Handler et al., 2011, Berner 2009, Bell et al., 2010).few studies have been published discussing hospital nurses' access to and also use of information resources. A study of nurses practitioners in a primary care setting reported that nurses regularly experienced information needs as part of their patient interactions(Tannery et al., 2007).For instance, Patients perceiving mechanical ventilation are at high risk for pneumonia due to respiration. Published guidelines recommended elevating the head of the bed 30 degree to 45 degree, if not contraindicated, to reduce risk ,but this intervention is underused(Lyerla et al., 2010).

There is a pressing need for high quality ,effective means of designing developing ,presenting ,implementing ,evaluating ,and maintaining all types of clinical decision support capabilities for clinicians , patients and consumers(Oroviogoicoechea and Watson, 2009).

1. What is CDSS in nursing?

Nurses have a unique dual role regarding information. They are both generators and consumers of an enormous amount of data in any given patient encounter(Byrne, 2010).CDSS as ''computer software applications that match patient characteristics with a knowledge base to generate specific recommendations. Decision support can take many forms and is often integrated subtly into many aspects of an EHR. It is not intended to replace the provider's knowledge or experience, but rather to facilitate the best decision possible with the best information available. CDSS represent the intersection of clinical decision-making, cognitive sciences, evidence-based practice, and computer science all contextualized by the practice setting, patient population, provider needs, and information technology infrastructure(Anderson and Willson, 2008, Bakken et al., 2008). With all of this said, electronic health records are the way of the future for healthcare industry. It is a way to capture and utilize real-time data to provide high-quality patient care, ensuring efficiency and effective use of time and resources. By incorporating EHR and CDSS it has the potential to change the way medicine has been taught and practiced.Since "clinical decision support systems (CDSS) are computer systems designed to impact clinician decision making about individual patients at the point in time that these decisions are made", the reasons can be seen why it would be beneficial to have a fully integrated CDSS and HER(Berner and La Lande, 2007, Brian et al., 2012). CDSS have the potential to deliver improved quality of care,increased clinician evidence,improved documentation and patient satisfaction.In

addition,they have the potential to improve efficiencies,reduce the amount of unnecessary test duplication,and change in patterns of drug prescribing favoring cheaper but equal effective generic brands.Further,CDSS can support education and training ,use of protocols,ease of extracting research data and creating standard and hospital reports(Open Clinical Organization, 2013).

Terminology and definition for CDSS of vary, depending on the discipline that the system is being used to support. A computer system that can execute the algorithm based clinical rules is also referred to as a clinical decision support system (CDSS) and it can provide around the clock surveillance(Dewit et al., 2013).Studies have shown that guidelines and clinical management tables integrated in a CDSS help health care professionals to avoid errors and improve clinical practice(Jaspers et al., 2011). Clinical decision support systems are computer programs designed to help health care professionals make clinical decisions and can be characterized according to one of three functions provided: information management, focusing attention, and patient-specific consultation(Musen et al., 2006, Bakken et al., 2007a). Clinical decision support systems (CDSS) are computer software applications that match patient characterstics with a knowledge base to generate specific recommendation (Anderson and Willson, 2008a).

2. Characteristics of CDSS in nursing

Decision support systemsgenerally have the following elements: decision model,knowledge base, information model, result specification,and application environment(GreenesRA, 2007). CDSS systems are increasingly often integrated into telemedicine clinical practice. In addition to using the same resources, namely digitally coded clinical data,

CDSS systems are able to enhance the quality of telemedicine services in many cases. CDSS are computer applications that are designed to help health-care professionals with making clinical decisions about individual patients(Berner, 2007). The first CDSS was developed more than 40 years ago and although the concept has developed over time,it appears the technology as a holistic approach still has a long way from maturing into the systems that meet health organization expectations(Open Clinical Organization, 2013).The systems were designed to improve patient safety, through reduced medication errors and adverse events and improved medication and test ordering(Advisory Board Company, 2012). Characteristics of the professionals themselves play an important role in whether new work routines are implemented and actually used(Francke et al., 2008).The nature of a CDSS may be passive and active .A passive system may simply notify a clinician of circumstance, whereas more active systems may offer suggestions or actually place orders when certain criteria are met(Lyerla 2008).Because using CDSSs to support nurses' decision making is widespread, it is worth capturing which features of CDSSs were empirically effective for optimum decision support for frontline nurses. Currently, there are studies on CDSSs used to improve the clinical practice of nurses; however, system features addressing particular nursing care activities have been dispersed in individual reports. Nursing does not have the well-organized knowledge base on the features of nursing practice–oriented CDSSs in real practice settings. The purpose of this study was to organize the features of CDSSs (Seonah, 2013).A computerized decision support system may provide such an intervention, and some decision support systems have been shown to increase

adherence to guideline recommended care(Sitting et al., 2008b)

3. Types of CDSS in nursing

The key element of all CDSS typologies is the corpus of knowledge meant as the necessary expertise and know-how for bringing health care to effect. Representing knowledge is then the primary task of CDSS development and concerns understanding,designing,and implementing ways of formally coding the knowledge necessary for deriving other knoweldege,planning future activities, and solving problems that normally require human expertise(Hsu et al., 2013)

A clinical decision support system has been coined as an "active knowledge systems, which use two or more items of patient data to generate case-specific advice." This implies that a CDSS is simply a DSS that is focused on using knowledge management in such a way to achieve clinical advice for patient care based on some number of items of patient data.

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Yuan et al(2013) who demonstrated that the usability of the CDSS is suitable for nurses in hospital environments.However,the ultimate success of the CDSS tool depends on many factors beyond usability, such as training and culture(Yuan et al., 2013)

4. Benefits of CDSS in nursing

Using Information Technology for clinical decision support is one way to concretely link technology to improved process and resident outcomes. Moreover,clinical decision support tools provide clinical knowledge and resident –specific information to help clinicians make decisions that enhance

resident care at appropriate times(Buntin et al., 2011). The CDSS included alerts for decline in condition, improvement in condition, constipation, dehydration, loss of skin integrity ,weight loss ,and weight gain(Gregory, 2008). CDS can support disease management by tracking long-term issues that a given patient may need to have addressed for optimal health outcomes. Also, by using CDS with electronic prescribing, the selected drug can be checked against the patient's allergy list, against other drugs for possible interaction, for contraindication based on the patient's problem list, age or pregnancy-related restrictions or against the patient's insurance formulary. Patient registries allow providers to monitor their patient population with a specific condition and implement new protocols to improve quality(Schnipper et al., 2010, Alexander, 2008).

It is important to keep in mind that in order to have a successful CDSS,the system must be incorporated into the existing workflow and existing health information systems; Involve end-users during all stages of the implementation; provide sufficient training,education,and support; keep alerts simple,straightforward,and specialized to the area of use and require users' acknowledgement of prompts,alerts,or suggestions(Castilo and kelmen, 2013)

The frequency and effect of manual data entry error of blood glucose values, the frequency and effect of nurse overrides of CDSS insulin dosing recommendation and comprehensive ethnographic study of CDSS for Intensive Insulin Therapy(CampionJr et al., 2010).

5. Implementation of CDSS in Nursing

There are few CDS implementation s to date in Routine Clinical use that have substantially delivered

on the promise to improve health care promise to improve health care processes andChjaudhry et al (2006) found that outcomes, through there have been an array of successes at specific sites in individual domains(Courtney et al., 2008, Gouda et al., 2010). Implementing Electronic Health Records (EHR) was always going to be an inevitable challenge. The reasons behind this challenge is that it is a relatively uncharted area as it is something that has never been done before, thus there is; and will be many issues and complications during the implementation phase of an EHR. This can be seen throughout the numerous studies that have been undertaken. Challenges in implementing electronic health records (EHRs) have received some attention, but less is known about the process of transitioning from legacy EHRs to newer systems(Stephanie et al., 2008, Goud et al., 2010).Nursing CDSS, are relatively new and will likely increase in number as more hospitals implement information systems. It is important for nurses to be hospital information systems that support nursing CDSS(Lyerla 2008).Advanced practice nurses who practice in critical care settings vary significantly in how they use the clinical decision systems that are in operation in their practice settings(Scott, 2007). A clinical decision support system (CDSS) offers opportunities to reduce medical errors as well as to improve patient safety(Amin et al., 2013).

CDSS design and implementation are complicated endeavors that involve a multitude of variables, including function, user, setting, and desired outcome(Lyerla 2008, Lyerla et al., 2010).The majority of CDSS used in nursing that have been formally   evaluated   possess   some   of thesesdeatures.However, they still appear to have

limited benefit in terms of the improving nurses' behavior and patient outcomes(Randell et al., 2007)

6. Use of CDSS in Nursing

Several kinds of software are used for administrative and information management purpose in health care organization,but the issue has been studied less from nurse managers' perspective (Lammintakanen et al., 2010, Westra and Delaney, 2008, Skytt et al., 2008). CDSS is also important for nurses to communicate with the Vendors of hospital information systems and advocate for systems that support nursing CDSS,that will meet decision –making needs(Lyerla 2008). An Intensive care Unit is known as a data –rich and information technology can improve the quality of care by utilizing stored clinical data and effectively and in a timely manner to clinicians(Mona et al., 2011).The necessity of decision support systems is emphasized now more than ever because patients safety and nursing –sensitive outcomes in the clinical setting have become a critical issue(Mona et al., 2011).

Earlier, the use of computer was to build a knowledge based Clinical Decision support system which uses knowledge from medical experts and transfer algorithms manually (Anooj, 2012)The purpose of modern Clinical decision support system is to assist clinicians at the point of care because of that a clinician would interact with a Clinical decision   support   system   (CDSS)   to   help determine diagnosis, analysis, etc. of patient data. Previous theories of CDSS were to use the CDSS to literally make decisions for the clinician. The clinician would input the information and wait for the CDSS to output the "right" choice and the clinician would simply act on that output(Brianm et al., 2012) The new methodology of using CDSS to assist forces the clinician to interact with the CDSS utilizing both

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the clinician's knowledge and the CDSS to make a better analysis of the patients data than either human or CDSS could make on their own. Typically the CDSS would make suggestions of outputs or a set of outputs for the clinician to look through and the clinician officially picks useful information and removes erroneous CDSS suggestions. There are two main types of CDSS Knowledge-Based and Non-Knowledge-Based(Murali et al., 2012b, Stephanie et al., 2012b). Functions of CDSS, may include alerting, reminding, critiquing, Interpreting, predicting, diagnosing,assisting, and suggesting(Lyerla 2008)

7. Instruments to Implement CDSS in nursing

Personal digital assistant (PDA) is small,handheld electronic devices that can provide instant accessto patient care guidelines and information at the point –of-care.However, nurses, as with other professions, sometimes,struggle with incorporating this kind of technologyinto their day-to –day clinical practice(Polen et al., 2009, DiPieto et al., 2008, Harwick et al., 2007).The standard nursing documentation model consists of four processes of the nursing process:needs assessments,determining of nursing diagnoses and nursing care aims,planning and delivering interventions,and evaluation of outcomes and terminologies used(Haynes and Wilczynski 2010, Tornvall et al., 2007, Tantuu, 2009).

Even though the benefits can be seen, to fully implement a CDSS within an EHR, it will require significant planning by the healthcare facility/organization, in order for the purpose of the CDSS to be successful and effective. The success and effectiveness can be measured by the increase in patient care being delivered and reduced adverse events occurring. In addition to this, there would be a saving of time, resources, autonomy and financial benefits to the healthcare facility/organization(Murali et al., 2012a).The issue underlying critical care clinicians' support or rejection of decision support technology must be examined more carefully to better define how to use this tool to optimally benefit patients and families and to better understand how sue of these systems are influencing nursing or medical decision –making. Technological advancement has created ethical practice dilemmas in critical to both further complicate and to contribute to resolution of changing practice patterns(Weber, 2011).Efforts to facilitate application of evidence into nursing practice are unlikely to be successful unless the approaches used are integrated into the clinical workflow. Our approaches use a variety of informatics methods to integrate evidence into clinical information systems (CISs) as a mechanism for providing decision support for evidence-based practice in a manner consistent with nursing workflow(Bakken et al., 2007b).Tools for information management enable access to information needed by the clinician, but do not help apply that information to the task. Information management tools include electronic resources such as bibliographic databases, Cochrane Collaboration, and pharmacy knowledge bases. Tools for focusing attention remind the user of problems that might otherwise be overlooked (e.g., abnormal lab values, potential drug interactions) or relevant care protocols. Tools for patient-specific consultation provide custom-tailored assessments or advice based on sets of patient-specific data (e.g., decision analysis, diagnostic decision support, protocol eligibility, treatment recommendations). Each type of decision support tool has relevance for evidence-based nursing practice as illustrated through the following examples

from our work at CUMC (Anderson and Willson, 2008a, Anderson et al., 2012, Bakken et al., 2007a).

8. Barriers of Implementation of CDSS in Nursing

There has been different research, which was conducted regarding to grand challenges of clinical decision support.For Instance,Setting et al(2008) who describes grand challenges in clinical decision support .These are: Mine large clinical databases to creates new CDS,use free text information to drive clinical decision support, create internet-accessible clinical decision support repositories, prioritize CDS content development and implementation, combine recommendations for patients with co-morbidities,create an architecture for sharing executable CDS modules and services, prioritizeand filter recommendations to the user,summarize patient-level information, Disseminate best practices in CDS design,development,and implementation and improve the human-computer interference(Sitting et al., 2008a).

Implementing electronic health records (EHR) in healthcare settings incurs challenges; none more important than maintaining efficiency and safety during rollout but in order for the implementation process to occur effectively, an understanding of the EHR users' perspectives is key to the success of EHR implementation projects. In addition to, adoption needs to be actively fostered through a bottom-up, clinical- needs-first approach. This can be said for CDSS too. The main barriers associated with CDSS and EHRs consist of feasibility (cost), poor usability/ integration, uniformity, clinician non-acceptance, alert desensitization, as well as the key fields of data entry that need to be addressed when implementing a CDSS to avoid potential adverse events from occurring. These include: Correct data is being used,All the data has been implemented, Current best

practice and Evidence based .The main areas of concern with moving into a fully integrated EHR system are: Privacy,Confidentiality,User-friendliness, Document accuracy and Completeness, Integration ,Uniformity, Acceptance, and Alert desensit-ization(Stephanie et al., 2012a, Carrie A et al., 2012, Ronen et al., 2011, Berner and La Lande, 2007, Gerry et al., 2012).With the increase in the use of CDSS in nursing practice, itis importantto understand the factors which influence how such systems are used in practice. The nurse mangers made several comments on the implementation of immature electronic information systems which caused ineffectiveness in working processes.

However,they considered electronic information systems to be essential elopements of their daily work(Lammintakanen et al., 2010). Unfortunat-ely,research suggests than an organization's failure to align the information system with its strategies can result in last opptunities,wasted resources, andunfavorable performance(Eichner and Das, 2010). A recent survey conducted by sitting and Colleagues(2008) identifies several top challenges in clinical decisionsupport, amongwhich "Prioritized and filtered recommendations to the user's the one for researchers in decision science area to overcome (Sitting et al., 2008a).For example, organizational structure Culture(s) resources available and management are factors with an impact on the implementation use of information systems. Inaddition, individual attitudes ,competencies and information needs are connected to the use of Information systems(Bolton et al., 2008). The usability and integration of electronic information systems into the work processes affect the activity of use among health care workers(Wakefield et al., 2007). In addition, nursingstaffsmembers must be

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able and willing to work with computers. several studies have described nurse's negative attitudes towards growing computerization(Dahm and Wadensten, 2008). Nowadays, the need for more efficient, cost-effective and personalized care has led to a renaissance of clinical decision support systems (CDSS).One imperativerequirement was to tailor the process to the routine work flow of medical professions. This means that the CDSS must be designed to be appropriately active and accessible, so as to require neither too much learning nor significant changes in clinicians' routine activities, while meeting their needs as far as possible(Chiargui et al., 2010, Goud et al., 2008).

Byrne (2010) found that clinical decision support sounds like a deceptively simple means of improving the quality and safety of care for patients in any setting. However, many barriers impend the rapid infusion of this technology into perianestia and nursing care settings (Byrne, 2010)

9. Effectiveness of CDSS in Nursing

Mechanisms in place to evaluate the system's effectiveness once it has been introduced are vital. If the purpose of the CDSS is to improve either care processes or patient outcomes procedures must be in place to measure whether improvements are occurring(Dowding 2008). It may also be useful to monitor if and how the CDSS is being used by staff, and whether it has changed to the way individuals work in other areas that may threaten safety elsewhere in the care system (Dowding 2008, Kesselheim AS et al., 2011, Koppel R et al, 2008). Increasingly, organizations and practitioners have focused on computerized clinical decision support systems (CDSS) to promote improvements in the quality of care, and manage resource utilization. Such systems have been defined as "an automated process

for comparing patient-specific characteristics against a computerized knowledge base with resulting recommendations or reminders presented to the provider at the time of clinical decision making" Three features common to most CDSS tools include:an automated process for delivery of alerts or reminders,patient-specific content resulting from the comparison of patient information against a set of knowledge 'rules' or guidelines, and delivery of alerts or reminders at the point of care(Bryan and Boren 2008, Goud et al., 2008). The influence of system characteristics on the effectiveness of CDSS,is studied ,little is known about the relation between cognitive,organizational,and environmental factors, and CDSSs effectiveness(Goud et al., 2010). Nurses' experience in a clinical area and their experience using a specific CDSS are likely to influence exactly how they use the system in practice to inform the decision they take(Goud et al., 2008) Despite a lack of evidence from randomized controlled trials on the potential efficacy of CDSS use in nursing, there has been an increase in the use of CDSS to support nurses in extended roles such as prescribing or the management of chronic condition(Randell et al., 2007). There is a lack of information useful for understanding why CDSSs may or may not be effective, resulting in making less informed decisions about these technologies and, by extension ,other medical informatics applications(Dowding et al., 2008).CDSS implementations often suffer from poor usability ,which directly impacts their adaptation and effectiveness, Forinstance, user interference work around have been shown to widely diminish the effectiveness of widely used CDSS(Zhou et al., 2008, Koppel et al., 2008, Goud et al., 2008).

10. Examples of CDSS in Nursing

Nurse managed electrolyte replacement protocols were used in the adult hospital and clinicians ordered discrete was in the pediatrichospital. To increase efficiency and minimize delays in electrolyte replacement, thepediatrics' hospital also elected to implement a nurse managed protocol if sufficient CDS safeguards were available. Because replacement doses are dependent on patient and laboratory result variables, the protocol orders entered in to Computerized Provider Order Entry(CPOE) were essentially permission orders without any dose or administration details(Ranji et al., 2013). Intensive Care Unit (ICUs) is settings can which ethical and other practice dilemmas often arise. This conflicted work environment has the potential to powerfully impact staff. In fact,455 of ICU nurses reported having left or considered leaving a position because of distress over professional decision-making and ethical practice(Hamric and Blackhall, 2007).The American Association of critical-care Nurses' public policy statements indicates that the critical care nurses' role includes respecting and supporting the right of the patients designated surrlegate to "autonomous informed decision making(American Association of Critical care Nurses, 2009).

11. HER and CDSS in nursing

Huizenga (2013) who reported that assisting a nine-provider, rural critical-access hospital that operated three satellite clinics, Stratis chose one measure on which to focus their EHR-based CDS efforts: blood pressure monitoring control, which Stratis practitioners did only 44% of the time in 2008. They then evaluated current processes, taking care to understand both office and information workflow in the clinic, as well as the patient experience as a whole(Huizenga, 2013)

Leyera et al(2010) described that nursing clinical decision support system integrated into a patient's electronic flow sheet can increase nurses' adherence to guidelines. Pulmonary and gastrointestinal diagnoses, body mass index, and tube feeding are predictors of elevation of the head of the bed(Lyerla et al., 2010). In addition, Dowding (2009) increasingly, new and extended roles and responsibilities for nurses are being supported through the introduction of clinical decision support systems (CDSS)(Dowding et al., 2009).When CDSSs apply evidence-based recommendations at the point of care ,they are termed evidence-adaptive;moreover,these systems show promise as a means for bridging the gap between evidence and practice(Anderson and Willson, 2008b, Randell and Dowding, 2010). Nurses have historically been left out of informatics and technology decision-making and have not been the focus of CDSS development (Anderson and Willson, 2008).

Conclusion

The Characteristics, Types. Benefits, Implementation, Use, Barriers, and Implementation of CDSS in nursing, effectiveness of Clinical Decision support system in nursing were identified, each having its own attributes and uses. The current literature, research and reviewed articles which were developed through an evaluation of this literature reviewed article and the assessment of a limited number of research studies that focused on the clinical decision support system in nursing at different health facilities.

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