Original Articles

Computerized Clinical Decision Support Systems and their Clinical Application in Health Care Delivery System

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Abstract

Computerized Clinical Decision Support Systems (CDSSs) are defined as computer-based tools using scientific knowledge to generate patient specific advice or interpretation to help health professionals in making clinical decisions. The use of computers has been driven not only by the increasing need to manage large amounts of information, but also by the imperative to make evidence-based and cost-effective decisions on a daily basis. Computer aided medical tools address the growing information needs of the busy health care provider, decrease medical errors and improve healthcare processes as well as patient outcomes. So this paper aimed at presenting different issues related to application, benefits and recent advances of CDSSs within the health care delivery system.

Keywords: Health professionals, clinical decisions, and computerized clinical decision support systems.

Introduction

Computerized Clinical Decision Support Systems (CDSSs) are defined as computer-based tools using explicit knowledge to generate patient-specific advice or interpretation to provide expert support for health professionals in making clinical decisions. [1] The use of computers has been driven not only by the increasing need to manage large amounts of information, but also by the imperative to make evidence-based and cost-effective decisions on a daily basis. Furthermore, there is accumulating evidence to prove that computer aided medical tools address the growing information needs of the busy clinician, decrease medical errors and improve healthcare processes as well as patient outcomes. [2] Medical error is actually the most important cause of death in the developing world. Medical error implies actions such as the conclusion of a wrong diagnosis, the prescription of an incorrect treatment or the inefficient execution of a correct treatment. [3] In the area of clinical activity, health care workers are presented with and manipulate many pieces of data and information, and decision-making occurs under conditions of stress, cognitive overload, uncertainty, and increasing levels of scrutiny. These conditions may lead to clinical decisions that are faulty and produce less than optimal outcomes. The development and use of such system will allow for a significant decrease in medical errors.

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Medical mistakes are greater than deaths caused by AIDS, breast cancer or car accidents. The number of deaths caused by medical error has been estimated to be 98,000 individuals per year.[4] One important filter for preventing Medical Error is CDSSs. These systems use embedded clinical knowledge to help health professionals analyze patient data and make decisions regarding diagnosis, prevention, and treatment of health problems.

Recent Advances in CDSS

Clinical decision support systems have evolved from a foundation based upon statistical algorithms to complex artificial neural networks.[5] The early decision support systems, also termed medical diagnostic decision systems, were based on Bayesian statistical theory, providing crude probability diagnoses based on certain critical variables.[6] In recent years, CDSSs have begun utilizing artificial neural networks (ANNs), which are computational paradigms based on mathematical models that, unlike traditional computing models, have a structure and operation that resembles the mammal adaptive systems, because they are composed of a series of interconnected processing elements that operate in parallel. ANNs is able to integrate greater decision variables than previously possible, able to accept numerous input variables, including demographic information, admission information, previous diagnosis information, and patient history to rapidly create possible diagnoses.[7] Rather than providing a single diagnosis for a specific patient, the system returns a set of possible diagnoses from which the clinician may choose based on their own discretions. Advanced CDSSs are able to return probability estimates of the likeliness of a particular diagnosis and able to propose "best practice" methodologies for care delivery and flow.[8] However, by utilizing such a flexible CDSS, the patient and the health care professionals become the "chooser" in the clinical environment, being able to control what information is relevant and which result to act upon throughout the process of care delivery.

Also, the knowledge bases underlying these systems must be both up-to-date, provide accurate and relevant information that recognizes the roles, responsibilities, and capabilities of the disparate set of stakeholders and users.

Clinical Applications of Decision Support Systems

Clinical knowledge is discovered, acquired, and managed for the purpose of providing decision Support. A clinical application takes a clinical situation as input and produces inference output that can be used to provide assistance in a clinical function.[9] In the clinical situation six major generic uses (levels) of CDSSs have been identified: alerting, interpreting, assisting, critiquing, diagnosing, and managing decision support.[10]

CDSSs intelligently filter clinical knowledge and patient-related information and present alerts, interpretations, critiques, and recommendations at the appropriate time. CDSSs operate on a continuum that includes accessing intelligently filtered information, prompting when appropriate, offering guided choices to enhance care, and providing feedback of outcomes analysis.

Nurses need to use CDSSs

Clinicians are grappling with information overload. It is estimated that 2 million pieces of information are used in decision-making and that biomedical knowledge is doubling every 20 years.[11] Nursing practice has lagged behind knowledge by at least several years, the key tools for closing this gap will be through using information systems that provide decision support to nurses at the time they make decisions, which result in improved quality of care.[12] On the other hand, CDSSs have great potential to improve the quality and lower the cost of health care. Such systems have been used to prevent errors, improve quality, reduce costs, and save time. The best evidence suggests that such systems, when used, can be extremely effective and provide significant value.

For example, a recent systemic review by Garg et al. [13] found that, in 100 studies of clinical decision support, CDSS improved practitioner performance in 62 (64%) of the 97 studies assessing this outcome, including 4 (40%) of 10 diagnostic systems, 16 (76%) of 21 reminder systems, 23 (62%) of 37 disease management systems, and 19 (66%) of 29 drug-dosing or prescribing systems.

With the rapid increase in health care expenditures, technology has developed to provide support to health care delivery staff. Throughout the evolution of medical technology, the development of an efficient, useful, and practical CDSSs have become a significant focus in health care delivery system. [7] However, nurses and physicians resistance to the implementation of helpful technology that is common within the health care market has limited the maximization of the potential of CDSSs. Nurses need to accelerate the utilization of CDSSs in order to maximize their benefits in the clinical practice, optimize the level of health for patients and to deliver cost-effective nursing care.

Potential Benefits of CDSSs

According to Coiera [5] the potential benefits of using electronic decision support systems in clinical practice fall into three broad categories: Improved patient safety e.g. through reduced medication errors and adverse events, improved medication prescriptions and test ordering; Improved quality of care e.g. by increasing clinicians' available time for direct patient care, increased application of clinical pathways and guidelines, facilitating the use of up-to-date clinical evidence, improved clinical documentation and patient satisfaction; Improved efficiency in health care delivery e.g. by reducing costs through faster order processing, reductions in test duplication, decreased adverse events, changed patterns of drug prescribing favoring cheaper but equally effective generic brands, automatic provision of relevant, personalized expert advice, expertise and recommendations sourced from up-to-date, best practice knowledge, reduced variation in the quality of

care, support medical education and training; help overcome problems of inefficient coding of data and provide immediate feedback to patients. CDSSs have the potential of universalization of the electronic medical record, which will increase the accessibility of clinician's to patient information as well as increase the amount of data available for clinical use and reduce medical errors significantly.

However, the greatest tool to increase the standardization of care, reduce practice pattern variation, successful and effective diagnosis, and correct care path choice will result from the development of the clinical decision support domain of the clinical information system. Clinical decision support software offers the possibility to improve the quality and reduce the cost of care by influencing medical decisions at the time and place where decisions are made. The next generation of clinical decision support systems should not only be evidence-based, but also "evidence-adaptive," with automated and continuous updating to reflect the most recent advances in clinical science and local practice knowledge. [14]

Unfortunately, the successful implementation of effective clinical decision support is a challenging task involving interactions between health care professionals, technologies and organizations, and there are no easy solutions to guarantee success or to avoid failure in this complex process.

CDSSs do not always improve clinical practice, however. In a systematic review study of computer-based systems, (66%) significantly improved clinical practice, but 34% did not, relatively little sound scientific evidence is available to explain why systems succeed or fail.[15]

Kawamoto, Houlihan, Balas, Lobach[16] conducted a study to identify features critical to the success of CDSS, the study concluded that 75% of interventions succeeded when the decision support was provided to clinicians automatically, whereas none succeeded when clinicians were

required to seek out the advice of the decision support system. Similarly, systems that were provided as an integrated component of charting or order entry systems were significantly more likely to succeed than stand- alone systems. Systems that used a computer to generate the decision support were significantly more effective than systems that relied on manual processes. Also, systems that prompted clinicians to record a reason when not following the advised course of action were significantly more likely to succeed than systems that allowed the system advice to be bypassed without recording a reason. Moreover, systems that provided a recommendation were significantly more likely to succeed than systems that provided only an assessment of the patient. Finally, systems that provided decision support at the time and location of decision-making were substantially more likely to succeed than systems that did not provide advice at the point of care. The benefits and how people evaluate CDSSs with regard to how they fit within their practices are the key factors indicative of success. [17] If CDSSs are appropriately used, they will lead to important improvements in professional practice and patient outcomes. Therefore, health care professionals including nurses must conduct studies with rigorous methodology to identify the features of effective CDSSs in providing care to clients.

Potential drawbacks related to the use of CDSSs

CDSSs can improve the quality of patient care and they are strong and necessary incentives for clinicians to use electronic medical records. [18] The potential drawbacks that were perceived by clinicians and act as a barriers to the adoption of CDSS as 'deskilling' effect; were perceived as a threat to clinical judgment; considered too inflexible; difficult to depart from ordered, pre-prepared paths; Promote over-reliance on software; limit clinicians' freedom to think; Difficult to evaluate, cause lack of accepted evaluation standards; time-consuming to use, possibly lead to longer clinical encounters and create extra work; in addition to their uncertain and untested ethical and legal status.

According to Coira [5] there are numerous reasons why more CDSS are not in routine use, some require the existence of an electronic patient record system to supply their data and most institutions practices don't have yet all their working data available electronically. Others suffer from poor human interface design and so they do not get used even if they are of benefit. Reluctance to use CDSS arose simply because they did not fit naturally into the process of care, and as a result; using them required additional effort from already-busy individual. Some of the reluctance to use these systems was due to techno-phobia or computer illiteracy of health care workers. If the system is perceived by those using it to be beneficial, then it will be used, if not, independent of its true value, it will probably be rejected. [19] Similarly, CDSS can be perceived as a complex task requiring a knowledgeable practitioner, reliable informational inputs, and a supportive environment. [20]

The researchers agreed that the level of "collaboration and co-operation" and "setting goals, courses and user acceptance" are essential for the success or failure of CDSSs.

Clinicians need to put in place systems that will facilitate the easy integration of electronic patient records with existing care pathways and local guidelines later. In summary, as the culture and social issues in a health care setting is very complex, as there are many types of people involved in the system, not only are there patients, nurses and physicians, but there are also, the administration, technical experts, and other staff that add to the issues. Therefore, adopting a clinical decision support system requires an overall acceptance and support from all relevant parties to ensure successful implementation.

Current State of CDSSs in Jordan

In Jordan, the vision is to be the reference, the winner and the competitors in adopting any new technology in the Middle East. In terms of competition support, the adoption of an effective clinical information system will place Jordanian health care organizations in an advantageous position relative to other competitors. Therefore, Jordanian organizations that are able to adopt

facilities in these areas will have a competitive edge over other care delivery organizations. Furthermore, such comparisons will allow delivery organizations to increase the quality of care, hence; learn from other firms, adjust price according to competitor levels, and adjust to community demand levels. Moreover, CDSSs has been utilized within the Jordanian health care delivery system in the laboratory and radiology fields, in most of the private and governmental hospitals, but still; it is not yet utilized in the medical and nursing services and care. It was just utilized in the critical care units in the form of Clinical Reminders and Alerts systems, so to integrate CDSSs within nursing and medical services and care. There is a need to prepare our institutions in relation to technical, organizational and personal facilities through the following steps:

1. Identify stakeholders and goals: CDSS developers must identify the key persons and committees with a stake in proposing, validating, supporting, communicating, or using the CDSS. Together, developers and stakeholders will determine the organizational goals, objectives, clinical goals, and clinical actions for adopting CDSS.
2. Establish a CDSS implementation team composed of clinicians, information technologists, managers, and evaluators to work together to customize and implement the CDSS.
3. Develop financial and organizational policies that enable Jordanian health-care providers to implement and use CDSSs in an effective manner.
4. Implement health information systems that utilize electronic patients' records as prerequisite to enable the health care organizations to adopt CDSS effectively.
5. Catalog available information systems: The CDSS developer must review all existing information systems to determine which tools already exist that could help in implementation and which tools must be added.

The functionality and content of each system along with the type of data each system contains and how they're coded, communicated, and aggregated helps the developer identify existing systems that may propel or hinder the CDSS implementation process. Increasing CDSSs acceptance depends on the culture and climate of the organization as well as the involvement of health care professionals. The involvement of all Jordanians health care professionals, especially nurses and physicians in the selection and implementation of CDSSs, will ensure support and increase frequency of communication amongst them.

Conclusions

The necessity for innovative and dependable clinical information systems with CDSS capabilities is crucial to adapt with continuously evolving nursing and medical knowledge. Although, the promise of clinical decision support system is strong, substantial work through research to be done to realize the potential benefits and to evaluate the impact of utilizing this system within the health care delivery system with special emphasis on nursing care. So, more evaluation of CDSSs are needed to produce valid and generalizable findings on the clinical and organizational aspects of CDSS use. The evaluation methods could be quantitative and qualitative methods to provide complementary insight into the use and effects of CDSSs.

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الحاسوب ونظم دعم اتخاذ القرارات السريرية الصحية

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الملخص

الحاسبات الآلية الداعمة للقرارات السريرية هي أدوات حاسوبية تستخدم معلومات واضحة لاستخراج نصائح متخصصة للمريض، وتقدم معلومات وتفسيرات لمقدمي الرعاية الصحية لمساعدتهم في اتخاذ القرارات السريرية. جاء استخدام الحاسبات نتيجة الحاجة لإدارة الكميات الكبيرة من المعلومات إضافة إلى الحاجة إلى أخذ قرارات مبنية على الشواهد العلمية الصحيحة والفعالة بصورة يومية. تهتم هذه الورقة بطرق استخدام الحاسوب كأداة لتقديم المشورة للفريق الصحي في صنع القرارات السريرية او المشورة المتعلقة بتقديم عناية طبية ذات كفاءة وجودة عالية في ظل المعلومات الكثيرة وانشغال مقدمي الرعاية الصحية. وكذلك تحسين عمليات الرعايه الصحية المقدمة للمريض، وتخفيض التكلفة الطبية، والأخطاء الطبية. تهدف هذه الورقة إلى مناقشة القضايا المختلفة المتعلقة بتطبيق استخدام الحاسوب وفوائده في النظام الصحي.

الكلمات الدالة: الفريق الصحي، القرارات السريرية، الحاسبات الآلية الداعمة للقرارات السريرية.