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Clinical Decision Support: Strategies for Success

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Abstract

Clinical Decision Support Systems (CDSS) are considered essential tools of evidence-based medicine. These systems provide physicians, caregivers and also patients with clinical knowledge needed and patient or disease specific information to help them make effective decisions that would enhance patient care and improve clinical outcomes. The lack of well-described success factors is the main challenge facing design, development and implementation of CDSS. We need to learn more about the factors that can help in increasing usability and acceptance. The medical informatics department at King Faisal Specialist Hospital and Research Center, Jeddah, Saudi Arabia worked on identifying and describing best strategies and requirements for success of CDSS building a detailed plan for development and implementation. The explored recommendations were categorized into ten main topics that should be addressed. These include the right content of CDSS, delivering valid and reliable information, delivering simple messages, providing users with references, saving users' time, integrating with clinical workflow, improving system response and speed, adopting active and passive alert mechanisms, integrating with other hospital information systems (HIS) and proper management of CDSS knowledge.

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Keywords: Health Informatics; Clinical Decision Support Systems; Implementation Challenges; Hospitals

1. Introduction

Quality of medical care in hospitals needs a lot of efforts to be improved; today these efforts are mainly focusing on increasing the practice of evidence-based medicine through the use of CDSS [1]. CDSS provide physicians, caregivers and also patients with the clinical knowledge needed and patient and/or disease specific information to help them make effective decisions that would enhance patient care and improve clinical outcomes [2]. CDSS include a wide range of variable tools and interventions such as computerized alerts and reminders, clinical

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guidelines, clinical pathways, order sets, patient data reports and dashboards, documentation templates, diagnostic support, and clinical workflow tools [3]. A CDSS actually is any computer system designed to help healthcare professionals make clinical decisions through managing clinical data or medical knowledge [4]. In general, we can identify three types or levels of decision support functions; the first level is providing tools for clinical information management including the automation of data entry and information retrieval, the second level is providing tools for focusing the attention of the users such as the functions that flag abnormal values, possible drug interactions or reminders of missing or incomplete tasks. The third level is providing more specific patient recommendations and advice based on patient specific data. They usually follow algorithms, cost benefit analysis or clinical pathways [5].

CDSS have been shown to improve both patient outcomes as well as the cost of care [6]. Therapeutic CDSS can minimize errors by alerting the physician to potentially dangerous drug interactions while diagnostic CDSS have also been shown to improve physician diagnosis process and decision making in terms of both effectiveness and efficiency [7, 8, 9]. Basic CDSS provide functions of checking on drug to drug interactions, duplicate therapy, drug allergies and dosing. Advanced CDSS provide more in depth advice and functions such as checking on medication contra-indications, individualized dosing support during renal function impairment or guidance for medication related laboratory testing. Basic CDSS are nowadays commonly available in many HISs and despite this support medication errors occur frequently which emphasizes the importance of implementing more advanced solutions [10].

2. Challenges and Barriers to CDSS Design and Implementation

Besides the lack of well-described success factors, an often mentioned barrier to implementation is the low computer skills among physicians. This must be carefully taken into account within the design of the CDSS alerts. New generation physicians, like medical students and junior physicians, may bring a higher level of computer literacy to clinical practice and stimulate implementation of a CDSS in practice [11]. Another barrier, identified by Bates [12] is the loss of physician's autonomy with the use of CDSS. However, CDSS are able to present the best evidence-based practice automatically, without requiring extra thought or work. This allows the health professionals to focus on those areas of special need and adjust care to each individual patient. This not only increases patient safety, but also physician's safety by reducing the risk on malpractice. Even, the system may improve clinical skills through a learn effect of the corrective messages, so it can improve the performance of professionals over time [13].

3. CDS Success Strategies and Requirements

At King Faisal Specialist Hospital and Research Center, Jeddah, Saudi Arabia, the medical and clinical informatics department worked on identifying the best strategies and requirements for the successful implementation of CDSS. A careful review of literature was conducted to identify the main areas of challenge and the factors of success for such systems. A Delphi technique was used over six months' duration to collect opinions, experiences and suggestions from both information technology professionals as well as healthcare professional users through an electronic website portal. The suggestions and recommendations were categorized and sorted into ten main topics that should be addressed during the design, development and implementation of CDSS in the hospital.

3.1. Including the right content

The clinical guidelines and protocols of the hospital have to be processed and transformed into computerized formats from which clinical rules are derived and formatted to be integrated into the HIS which then can support evidence based medicine. This is not a simple or an easy task to do, it is really challenging since these clinical guidelines, protocols and evidence based recommendations are usually generic not patient specific and usually very complicated [14, 15, 16]. For example, according to the clinical guidelines, complete blood counts should always be measured frequent during chemotherapy, but we do not know exactly how frequent this test should be done and what are the cut-off levels that we should act on in case of abnormality [17].

This implementation challenge is planned to be managed by assigning a multidisciplinary team of clinical experts to create, validate and optimize the relevant clinical rules [2, 14, 17, 18, 19]. The hospital should work on composing this expert team carefully, to ensure that they are representing the end users and are all experts in their clinical fields,

as this will affect the validity and reliability of the clinical rules developed. This is more like developing a new clinical guideline. The advantages of this method, to involve expert physician users from the beginning in the development of clinical rules, are mainly to increase the compliance and acceptance to these guidelines and to enhance user commitment as these experts will be the end-users of the system and will motivate other users to accept and utilize the system once implemented in practice [2, 17, 20]. The hospital should also work on activating different clinical pathways as a part of CDSS, this is very essential for standardizing the healthcare processes [21].

3.2. Providing valid and reliable information

Simple medication ordering systems usually generate a huge number of inaccurate or irrelevant alerts, with false positive messages, which might lead eventually to a persistent condition of users' alert fatigue as a consequence of the high sensitivity but low specificity of these alerts [22]. This occurs more with basic drug interaction detection function of the CDSS. The study of Van Der Sijs showed that more than 90% of alerts are not responded to by physicians and usually are overridden without reading the message of the alert [23]. The main conditions which weaken or decrease the value of such systems are mainly the low alert specificity, being very generic, the unclear content of information, the very high sensitivity of the system, so it would generate an alert for all levels the same. Physicians usually do not receive the proper or sufficient training on how to read, interpret or respond to alerts and they usually depend on the clinical pharmacists to check their medication orders before dispensing them.

Basic CDSS usually increase the risk of overriding a potentially harmful alert due to increasing numbers of alerts [12, 22]. Alert fatigue may cause clinicians to override both important and unimportant alerts compromising the desired safety effect of CDSS [24, 25]. Even pharmacists have been found to override nearly third of the life-threatening drug-drug interactions [12, 26]. Therefore, it is very crucial to ensure the high validity of the clinical rules by reviewing them thoroughly before implementing these into practice to ensure reliability of messages and alerts. One suggested method of for highly reliable clinical rules is to measure the positive and negative predictive values (PPV/NPV) during the process of developing clinical rules and afterwards to be tested before their implementation, another suggestion was to focus alert priority on the most critically important information [27].

3.3. Delivering simple messages to understand and respond

A CDSS is most effective when it can decrease the effort and time required by users to read, understand and respond to the system advice [6, 13]. This can be achieved by providing clear recommendations and a direct advice on how to respond to the message and what to do exactly [2, 12, 13, 28]. System developers should predict users' needs for summarizing and interpreting data into actionable recommendations [6, 12, 28]. For example, we might need to develop a clinical rule to check if a patient needs some dosage adjustment for certain medications because of renal insufficiency. When you make it easy people will do it right.

3.4. Providing users with scientific references

CDS messages would be much more credible and reliable if they can provide users with the source of the information included in the message and/or the clarification of the logic behind the recommendation [6, 28, 29, 30]. This would build more trust in the validity, reliability and credibility of the whole system. Physicians usually like to read more in certain topics related to new practice or evidence in their field of specialty. It is a valuable addition that literature citations and web-based evidence are available when desired [12].

3.5. Saving users' time

Physicians face a great challenge in terms of time and effort invested in learning and using computer systems. CDSS should save time for users by providing links and associations between different fields of data to enable their users to focus on the most important elements and tasks, this is considered one of the most critical success factors [28]. It is essential to achieve the optimal balance between presenting and providing too much and too little data

according to the preferences of the system users and in the same time ensure that the returning value of effectiveness and quality healthcare worth the invested time and effort in learning and using such systems [29].

3.6. Integrating CDS into clinical workflow

One of the most important success factors for CDSS is to make them fit smoothly into regular and normal clinical workflow [2, 6, 28], otherwise any CDSS will not have any positive effect and will never be used. When electronic systems in hospitals require that users break their workflow routines for data entry or data retrieval, users will avoid such systems and will resist their implementation. Information provided at the time of decision making should not disturb or break the workflow. This is why it is important to customize different types and mechanisms for alerts; each is best for a specific context or suitable for a certain priority [2]. The full understanding of the clinical workflow and user needs and expectations can be a very positive factor in achieving systems success [12].

3.7. Improving system response and speed

We need to ensure that our system is fast enough to perform the tasks required and provide work efficiency. Computer systems are usually considered effective only when they are of high speed and low response time, achieving user acceptance and satisfaction [28, 31, 32]. System recommendations and advice should be available to the users in a timely manner and at the correct point in the decision making process. When the response or the speed of a system or software is slow, user satisfaction usually decreases significantly. Many studies found that speed criteria are appreciated most by end users and therefore it should have a top priority as a factor of the CDSS [12].

3.8. Adopting active and passive alert mechanisms

The performance of active systems, where users are informed about doing the right things automatically, is much more effective than the performance of passive systems, where users need to inquire about the correct things to do, since this will need an extra step and can simply be overlooked [6, 11]. Much greater positive results are seen when the recommendations are requiring an immediate action and are not easily ignored [12, 18]. The researchers in one study found that relatively minor changes that could be done to the presentation of alerts in terms of style can make a big difference and achieve a significant increase in users' response. So it is very crucial to determine the mechanism and style of alerts, since the level, style and type of alerts will significantly change the effect of the CDSS [18].

The team classified the alerts into three levels; critically, moderately and minimally important, the first class only was suggested to generate an active alert, that would interrupt the work of the users through a pop-up window that provides the information or the advice or asks for a decision to be made, while for the moderately and minimally important alerts and reminders, a passive side screen would be available for users to refer to when they decide to learn more about the system recommendations. The advantage of active CDSS is that they work in real-time and information is retrieved immediately without users need to look or ask for it. Active CDSS require more accurate design with special focus on the details, which might be very essential so that the systems are not intrusive or noisy, generating too many false-positive alerts, while passive CDSS require more users effort, since they need to recognize when consultation would be useful and they must make a specific query to request advice [33, 34].

3.9. Integrating CDSS with HISs

Users' acceptance of CDSS depends a lot on the degree of their integration with HISs. Standalone CDSS that require special efforts and redundant entry of patient specific data are rarely adopted in clinical routines [5]. All types and levels of CDSS should be smoothly integrated with HIS, interacting with all of its components, in particular with electronic health records. However, despite decades of developments, most CDSS lack interoperability features [35]. Computerized physician order entry systems usually achieve better success rates than independent stand-alone systems [6, 11, 28] since these integrated systems can provide relevant information to physicians and users at the appropriate time related to the processes of decision making such as providing prompt drug interaction alerts or contraindications during drug prescription or chart review [13, 15].

3.10. Managing CDSS knowledge

Continuous efforts are usually needed to guarantee the long term success of CDSS, mainly maintaining the currency of the information and knowledge content [36]. This needs an established mechanism of updating clinical rules and related guidelines and pathways [2]. Many adjustments and customizations could be needed especially when users are still unsatisfied with what they have or their expectations are still not met [12, 14]. This is why it is essential to keep on-board specialized physicians, regularly evaluating and updating clinical rules. Since CDSS depend largely on clinical knowledge which is in a state of continuous change, system developers need to consider regular reviewing and updating of such knowledge to maintain successful use and effective results [37]. Two types of information and knowledge are associated with CDSS and are essential for their success; the patient related clinical information, which needs to be valid, accurate and up-to-date, and this is the responsibility of the system users who enter data and information, and the clinical knowledge of the domain or specialty, such as the clinical rules, guidelines and pathways, which informs the alerts and reminders of the system, and this also needs to be valid, accurate and up-to-date [38].

When the size of the knowledge content in a CDSS is small, maintaining it current is usually feasible with local resources. However, as the size of the knowledge content grows and gets more complicated, the process of maintaining its up-to-date status becomes more difficult and sometimes completely unfeasible. Clinical knowledge changes so quickly that it needs dedicated resources to keep an eye on the ever growing number of guidelines, protocols and algorithms with new clinical evidence appearing every day [39]. Many studies recommended outsourcing the clinical knowledge management function to third party commercial vendors or other organizations [40, 41]. The most recent trend for CDSS is to separate rules and processes, which correspond to the clinical knowledge and hospital operations, from the system application, since it is difficult to review, manage, and update knowledge if the knowledge is included as an integral part of the system application [42].

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