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Review Article

Effects of clinical decision support systems in chronic disease management

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Abstract: The clinical decision support system (CDSS) is an interactive computer system that employs a specific logical reasoning algorithm to integrate various types of data, aiding doctors in making clinical decisions by examining medical knowledge databases and clinical guidelines. In clinical practice, several CDSSs have been developed and applied for different purposes. Chronic diseases exhibit unique characteristics. In this paper, we summarize the application of the CDSS in the field of chronic diseases, with a focus on its impact on the quality and effectiveness of disease care. We also identify its application fields and limitations, envisioning its prospective application in the management of chronic disease.

Keywords: Clinical decision support system, chronic disease management, diabetes, cardiovascular diseases, respiratory diseases

Introduction

Chronic diseases, including diabetes, cardiovascular and cerebrovascular diseases, chronic obstructive pulmonary disease (COPD), malignant tumours, mental disorders, and other diseases, endure over extended periods and currently lack cures. In China, the number of individuals afflicted by chronic diseases continues to increase, along with the steadily increasing proportion of deaths attributed to these conditions. Statistics show that in 2019, fatalities resulting from chronic diseases constituted 88.5% of the total deaths in China, with cardiovascular and cerebrovascular diseases, cancer, and chronic respiratory diseases accounting for 80.7% of all mortalities [1].

The escalating prevalence of chronic diseases is expected to result in higher expenses for long-term medication and a growing demand for evidence-based chronic disease management. This, in turn, will lead to an increase in healthcare expenditures dedicated to chronic disease care. According to statistics, costs of chronic disease care account for approximately 75% of the total medical expenses. Among these costs, the elderly population bears the greatest burden, as 65% of Medicare beneficiaries suffer from two or more chronic diseases, accounting for 96% of all Medicare expenditures [2]. Despite the substantial cost, the effectiveness of chronic disease management remains suboptimal. Moreover, for many patients with multiple comorbidities, the overlapping or divergent care plans further complicates the management of chronic diseases [3]. High medical costs, uneven distribution of resources, and the demand for individualized treatment are critical problems associated with chronic disease care that must be solved.

The clinical decision support system (CDSS) is an interactive computing system that employs

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a specific logical reasoning algorithm for the integration of various types of data, such as patient history, laboratory and imaging indicators, demographic characteristics, living environment and behaviour information, and incorporates a medical knowledge database along with clinical guidelines to assist healthcare providers in making clinical decisions [4]. Traditional CDSS consists of software designed to directly aid clinical decision making, where individual patient characteristics are matched to a computerized clinical knowledge base, presenting patient-specific assessments or recommendations to clinicians for a decision making. In modern practice, CDSS is primarily used at the point of care, allowing clinicians to combine their expertise with the information and recommendations provided by the system. Additionally, there are CDSSs being developed with the capability to leverage data and observations that are unobtainable or uninterpretable by humans [5]. CDSS has been recognized by the U.S. government's Health and Medical Care Act, which financially incentivizes the implementation of clinical decision support (CDS) in electronic medical records. In 2013, an estimated 41% of U.S. hospitals with electronic medical records also had CDSS, and by 2017, 40.2% of U.S. hospitals had advanced CDS capabilities. Canada has received substantial government support, and the adoption rate of electronic medical records, which was approximately 62% in 2013, has been promising. The UK is also a world leader in healthcare IT investment, with €20 billion invested in 2010. In China, CDSS has entered a stage of rapid development since 2014, and 80% of medical personnel believe that CDSS has played a great role in early clinical warning reminders, inspection report interpretation, and the establishment of clinical knowledge bases. Numerous countries, including Denmark, Estonia, Australia and others, have also managed to implement national health records, at least for patient-facing data. The CDSS serves as a tool to enhance the fundamental knowledge of healthcare practitioners and patients, supporting clinical decision-making across a wide range of functions. These functions include diagnostics, alarm systems, disease management, prescription (Rx) control, drug management, and much more, offering numerous advantages for both practitioners and patients. These advantages encompass patient safety, clinical management, cost containment, administrative function/automation, and diagnostic support [5].

CDSS may also be utilized to improve chronic care management [6]. For instance, Petra Augstein et al. assessed the benefits of the Karlsburg Diabetes Management System (KADIS) when combined with the continuous glucose monitoring system (CGMS) in outpatient settings [7]. Their findings indicate that, when compared to using CGMS alone, the combination of CGMS/KADIS may provide physicians with more support in making their therapeutic decisions, leading to improved glycaemic control for patients.

Considering the unique characteristics of chronic diseases, the aim of this literature review is the application of CDSSs in chronic disease management. We specifically focus on the impact of the CDSS on the quality of care and effectiveness of clinical practice in the context of chronic conditions. Studies cited are summarized in **Table 1**.

Application and effects of CDSS in chronic disease management

Diabetes

The use of CDSS in diabetes management has a positive effect on physician performance, leading to favourable outcomes in patients. Petra Augstein et al. conducted a multicentre trial involving 49 outpatients with either type 1 diabetes or insulin-treated type 2 diabetes [7]. Patients were randomly to assigned to receive decision support based on the CGMS data alone or a CGMS/KADIS-based decision support system. After monitoring, the outcome parameter HbA1c (%) was measured to assess the benefits of combining KADIS with CGMS in outpatient settings. Multiple regression analysis revealed that HbA1c outcomes depended on KADIS-based decision support. This suggests that the CGMS/KADIS combination is more effective than CGMS alone in supporting the therapeutic decisions of physicians, ultimately helping patients achieve better glycaemic control. Perestelo-Pérez L et al. conducted a cluster randomized trial involving 29 clinicians and 168 Spanish patients with type 2 diabetes [8]. Various factors were evaluated immediately after the intervention, including statin

Table 1. Characteristics of included studies and participants

Diseases	Source	Sample Size	Follow up	Outcome measures	Functions and advantages of CDSS
Diabetes	Augstein P, et al. (2007) [7]	49	3 months	HbA1c	If physicians were supported by CGMS/KADIS in therapeutic decisions, they achieved better glycaemic control for their patients compared with support by CGMS alone.
	Perestelo-Pérez L, et al. (2016) [8]	Clinicians =29 Patients =168	3 months	Knowledge of statins, cardiovascular risk perception, decisional conflict, anxiety, satisfaction with the decision making process, and self-reported adherence	Improve the quality of decision making about statins.
	Buhse S, et al. (2018) [9]	279	6 months	Patient adherence to antihypertensive or statin drug therapy	Help patients and GPs to pursue common treatment goals as recommended in DMP guidelines.
	Vervloet M, et al. (2014) [10]	161	6 months	Refill adherence to oral anti-diabetic medication	Improve refill adherence, strengthen the self-management of people with diabetes.
Cardiovascular diseases	Beeler P, et al. (2014) [12]	15736	30 hours	Rate of prophylaxis	Improve awareness of VTE prevention in both admission and transfer wards.
	Eckman MH, et al. (2016) [13]	240	1 year	Proportion of patients with antithrombotic therapy that was discordant from AFDST recommendation	Tool discordant therapy decreased significantly over 1 year.
	Mazzaglia G, et al. (2016) [14]	21230	2 years	Effectiveness in increasing the prevalence of recommended cardiovascular drug use among high-risk patients	Increased the use of recommended cardiovascular drugs in diabetic patients, but it did not influence the exposure to potential interactions.
	Christensen A, et al. (2010) [15]	398	6 months	Patient compliance	Improve compliance in patients.
	Zwart JJ, et al. (2008) [17]	371021	2 years	Incidence, case fatality rate, possible risk factors, and substandard care	Improve management of pregnant women with hypertension.
Cerebrovascular diseases	Anderson JA, et al. (2010) [18]	15	-	Usability of the model	Produce a usable and useful clinical decision support system for secondary stroke prevention.
	Lee JS, et al. (2015) [19]	48	12 hours	A modified Rankin scale score	Help physicians to develop individualized stroke treatments.
	Keke Shi, et al. (2021) [20]	305	-	Accuracy, sensitivity, specificity, and area under the receiver operating characteristic curve	Provide rich temporal and spatial distribution characteristics of cerebral blood vessels.
Respiratory diseases	Sesen MB, et al. (2014) [21]	126986	1 year	1-year survival	Assist the experts in the treatment selection decisions in the lung cancer MDTs.
	Hashimoto S, et al. (2011) [22]	95	6 months	Cumulative sparing of prednisone, asthma control and asthma-related quality of life	Internet-based management tool is superior to conventional treatment.
	Bellos CC, et al. (2014) [25]	30	-	Real-time evaluation of patient's condition	Provide an informative and instructive message/advice to the patient and the clinical supervisor.

KADIS, Karlsburg Diabetes Management System; CGMS, Continuous glucose monitoring system; DMP, Disease management programme; GPs, General practitioners; VTE, Venous thromboembolism; AFDST, Atrial fibrillation decision support tool; MDT, Multidisciplinary team.

knowledge, cardiovascular risk perception, satisfaction with the decision-making process, decision conflict, and anxiety. The results demonstrated significant improvements in knowledge (P=0.01), cognition of the 10-year risk of myocardial infarction without statins (P=0.01) and with statins (P=0.08), and satisfaction (P=0.01) following the intervention. Therefore, the use of a decision aid (DA) for statin selection led to an improved decision-making process when choosing quality statins.

In some studies, the use of a real-time medication monitoring (RTMM) system integrated with short message reminders has demonstrated significant benefits, including improved patient compliance and a reduction in missed medication doses [9-11]. Susanne Buhse et al. conducted a patient-blinded, two-arm, multicentre, cluster randomized controlled trial with the goal of transitioning an informed shared decision-making programme (ISDM-P) for patients with type 2 diabetes from a specialized diabetes centre to a primary care setting [9]. A total of 363 eligible patients were included in the study, and 279 patients without myocardial infarction or stroke were enrolled. The ISDM-P comprises a patient decision aid, a corresponding group teaching session provided by medical assistants, and a structured patient-physician encounter. The results showed that the ISDM-P was successfully implemented in general practice, and the drug compliance rates for antihypertensive or statin treatment was very high. Vervloet M conducted a randomized controlled trial involving 161 participants with Type 2 diabetes who exhibited suboptimal adherence to their antidiabetic medications [10]. The study aimed to investigate the short-term and long-term effects of a combination of real-time medication monitoring and short message service (SMS) reminders for missed doses [10]. After one year, the compliance rate in the SMS group was significantly higher than that in the control group (79.5% vs. 64.5%, P<0.001), which was significantly improved from baseline (+16.3%, P<0.001). In contrast, there was no significant difference in the compliance between the non-SMS group and the control group (P=0.06). After two years, the compliance rate in the SMS group continued to rise and remained significantly higher than that in the control group (80.4% vs. 68.4%, P<0.01). Meanwhile, the compliance rate in the non-SMS group had reverted to the baseline level (65.5%). These results revealed that this innovative reminder system can effectively enhance and improve self-management activities among diabetic patients.

Cardiovascular diseases

Clinical decision support systems have the potential capability for assessing and improving cardiovascular disease prevention. Beeler P et al. analysed the effect of electronic reminders on the thromboprophylaxis rates for patients in admission and transfer wards [12]. In six departments of a university hospital, the level of venous thromboembolism (VTE) prophylaxis and the proportion of prescribed prophylaxis increased within 6-24 hours of admission for hospitalized patients. The findings indicated that the electronic reminders improved awareness and adherence to VTE prevention in both admission and transfer wards. This approach may help to improve the quality of patient care and facilitate safer patient handovers. In another study, a cluster randomized trial including 15 primary care practices and 1,493 adult patients with nonvalvular atrial fibrillation was conducted within an integrated medical system [13]. Doctors in the intervention group received information on patient-level treatment recommendations using the atrial fibrillation decision support tool (AFDST). The CDSS provided treatment suggestions, thus reducing variations in thromboprophylaxis treatment between doctors. Moreover, data from 21,230 patients with diabetes, 3,956 with acute myocardial infarction and 2,158 with stroke were analysed using the computerized decision support system. The results revealed that the use of the computer decision support system significantly increased the utilization of antiplatelet drugs (intervention: +2.7% vs. control: +0.15%, P<0.001) or hypolipidaemic drugs (+4.2% vs. +2.8%; P=0.001) among diabetic patients. This suggests that the computerized decision support system was associated with a notable increase in the use of recommended cardiovascular medications in individuals with diabetes [14].

Some hypertension-related studies have demonstrated improvements in the care process. Christensen A et al. conducted a randomized controlled trial involving hypertensive patients

(N=1577) who were treated with telmisartan once daily [15]. These patients were randomized to two groups, one group received electronic compliance monitoring equipped with a reminder system and monitoring equipment, while the other group received standard medical treatment for six months [15]. The trial showed that this reminder system was highly suitable for newly diagnosed patients with hypertension, resulting in a 6% improvement in compliance. Currently, this device does not have any impact on blood pressure control. Therefore, it proved to be a simple and effective method for improving the compliance among selected patients. Moreover, studies have highlighted the positive influence of CDSS, combined with clinical guidelines and laboratory tests, on physician performance in managing hypertension [16]. Zwart et al. evaluated the impact of the CDSS on adherence to clinical guidelines and reported effective outcomes in treating pregnant women with hypertension [17]. Through the use of CDSS, physicians' awareness of special care for hypertension during pregnancy improved the quality of care and patient adherence [16].

Cerebrovascular diseases

In the United States, stroke stands is the third leading cause of death and is a major contributor to permanent disability. A multidisciplinary team within the Veterans Health Administration Office of Nursing Services developed and tested an evidence-adaptive CDSS. This system was designed to assist healthcare providers in applying clinical practice guidelines for the secondary prevention of ischaemic stroke [18]. Multidisciplinary providers evaluated the functionality and usability of the prototype by using before-after comparisons and descriptive methods. Guidelines were documented and compared using test case scenarios, including standard care versus the prototype, as well as two documentation systems. Additionally, usability was evaluated through a questionnaire designed by the investigator, along with an open-ended question. The results indicated that the prototype led to a significant increase ($P<0.05$) in provider documentation for six out of eleven guidelines when compared to baseline documentation using the standard care system. The usability score of CDSS was rated highly, with a mean score of 48.9 ± 6.8 out of a possible 56 points. These results indicate that guidelines for secondary stroke prevention have been successfully engineered in the CDSS.

The computerized CDSS has been proven to support physicians in developing personalized stroke treatments. Ji Sung Lee et al. developed a novel CDSS with good performance in facilitating thrombolysis after an ischaemic stroke [19]. The research involved the establishment of a clinical prognosis model based on data from 958 patients admitted within 12 hours of the onset of ischaemic stroke at a representative clinical centre in Korea. Subsequently, data from an additional 954 patients from five university hospitals or regional stroke centres were included for external validation. The discriminative ability of the prognostic model showed a C-statistic of 0.89 for the global outcomes and 0.84 for the safety outcomes. Both internal and external validations yielded similar C-statistic results. Following model updates, the calibration slopes were corrected from 0.68 to 1.0 for the global outcomes and from 0.96 to 1.0 for the safety outcome models.

Brain arteriovenous malformation (AVM) is a congenital vascular disorder that stands as one of the leading causes of intracranial haemorrhage in adolescents. Keke Shi et al. introduced an innovative approach involving a deep learning network extracting vascular temporal features from digital subtraction angiography (DSA) videos, which provides valuable guidance for further clinical decision-making [20]. Then, an AVM-assisted diagnostic model was established, which combined temporal features with spatial radiomic features. After analysing the anteroposterior position (AP) DSA videos from 305 patients (153 normal cases and 152 with AVM), it was found that, for an AVM diagnosis, the models relying on temporal feature, radiomics feature, and the combination of both exhibited area under the curves (AUCs) of 0.916, 0.918, and 0.942, respectively. Additionally, for the AVM grading task, the proposed combined model achieved an AUC of 0.871 in the independent testing data set. These results underscore the rich temporal and spatial distribution characteristics of the cerebral blood vessels and clear lesion sites within DSA videos, which is a solution based on deep learning and traditional machine learning. It successfully combines the complex temporal and spatial feature extraction in DSA, which confirms the significance of this scheme in the diagnosis of AVM.

Respiratory diseases

The lung cancer assistant (LCA) is a CDSS developed by Oxford University [21]. According to clinical guidelines and the lung cancer audit database (LUCADA), this CDSS proposed two distinct logic reasoning algorithms: a guideline-based decision support algorithm and a probabilistic decision support algorithm. The performance of the CDSS was evaluated by comparing the consistency of the treatment plans generated by the multidisciplinary team (MDT) obtained from the CDSS and those obtained by the physicians in the LUCADA database. The exact and partial concordance rates of the guideline-based decision support algorithm are 0.57 and 0.79, respectively. Due to the lack of some important parameters in the database, the exact and partial concordance rates achieved with the probabilistic decision support algorithm are slightly lower at 0.27 and 0.76, respectively. Compared with recorded treatment, both methods within the CDSS showed potential to improve the resection rate and multimodal treatment.

The results of randomized controlled trials on asthma have demonstrated the possibility of CDSSs in enhancing the prognosis and health management process of patients with chronic diseases. Hashimoto et al. used the CDSS with a web interface for the follow-up of 95 adults with severe asthma at six pulmonary disease outpatient clinics to evaluate whether oral hormone use could be reduced [22]. The patients' symptoms, pulmonary function, fraction of exhaled nitric oxide (FE(NO)) and other relevant indicators were recorded daily, and the corresponding questionnaire was completed on a weekly basis. After a 6-month follow-up, the CDSS was employed to determine whether hormone usage should be reduced. Compared to traditional follow-up strategy, the CDSS demonstrated its ability to justify the reduction of oral hormone usage while achieving asthma control, thereby reducing the adverse reactions associated with hormone therapy. In addition, the CDSS for childhood asthma management has been integrated into the electronic medical record system, reducing the burden of cumbersome data entry work [23].

As the global population continues to age, the prevalence of chronic obstructive pulmonary disease (COPD) increases with socioeconomic development. By 2030, COPD is expected to become the third largest cause of death worldwide [24]. Therefore, there is an urgent need to develop a CDSS for COPD, especially for early diagnosis and chronic disease management of COPD. Bellos et al. designed a CDSS to evaluate the health statuses of COPD patients [25]. The system receives patient information via the CHRONIOUS wearable device, classifies the severity of 30 COPD patients in the acute phase or chronic stage by the severity estimation algorithm, and informs the medical staff of the results through an early warning system. The CDSS achieves a classification accuracy rate of up to 94%.

Discussion

This comprehensive review has summarized the effectiveness of the CDSS for chronic disease management. The effect of the CDSS was assessed using multiple methods in the included literature, which generally suggest that CDSS plays a beneficial role in enhancing the process of patient care.

The results of the CDSS in diabetes management are encouraging. The application of CDSS in diabetic patients has yielded positive effects on various patient outcomes and improved physician performance [7-11]. The CDSS developed for diabetes management provides dietary change plans and insulin treatment prescriptions for both healthcare providers and patients, and assists in the early screening and diagnosis of diabetes. The feasibility and acceptability of the system were preliminarily evaluated. Some of these systems have been deployed in general community practice settings, and those involving both patients and healthcare providers have consistently demonstrated effectiveness. With the advent of patient-controlled electronic medical records, these systems may become increasingly popular. In general, the application of the CDSS assists nurses in gaining more accurate and effective understanding of patients' blood glucose pattern, facilitates more convenient and individualized diet and exercise guidance to patients, aids doctors in making informed decisions, reduces the risk of medical errors, improves clinical outcomes, eases the workload of clinical staff, and conserves valuable medical resources [26-29].

The use of the CDSS for patients with cardiovascular disease has a positive impact on patient outcomes, such as improvements in medication adherence and adoption of a nutritional Mediterranean diet [30-32]. The CDSS has been shown to improve physician performance in terms of increasing the number of prescriptions for recommended medications, such as anti-inflammatory drugs, antithrombotic drugs, lipid-lowering drugs, and blood pressure drugs, which are known to reduce cardiovascular disease risk in patients with diabetes. Additionally, CDSS has contributed to a reduction in inadequate prescriptions and improved adherence to clinical guidelines. The user-friendliness and cost-effectiveness of the CDSS system further enhance its efficiency in the process of care delivery [12, 14, 33, 34]. Furthermore, CDSS has proven beneficial in the management of hypertension, where it has improved physician understanding of the need for specialized care for hypertensive disorder complicating pregnancy (HDCP), which led to improvements in patient care and adherence [16]. There are a small number of trials for heart failure, ischaemic heart disease, cardiac rehabilitation, and angina pectoris, those data showed improvements in the rehabilitation process. Additionally, in dyslipidaemia, the CDSS system was employed to enhance blood lipid monitoring and treatment, presenting a promising field for future research.

Currently, the CDSS play a significant role in management of patients with cerebrovascular disease [18-20, 35, 36]. Kummer et al. described the usage patterns of frequently employed stroke-related medical calculators for clinical decision-making from a web-based support system in the USA [35]. The most frequently used stroke calculators were the CHA2DS2-VASc, mean arterial pressure, HAS-BLED, NIHSS, and CHADS2. The Stroke Navigator, a purpose-built CDSS, is designed to improve the diagnosis and treatment of acute stroke cases [36]. The effect of employing CDSS in cerebrovascular disease is noticeable [18-20]. In clinical practice, CDSS usage can effectively assist doctors in the prevention and treatment of stroke. An innovative CDSS developed by investigators within the Veterans Health Administration's computerized patient record system significantly improved the documentation of clinical practice guidelines for secondary stroke prevention by multidisciplinary providers in the electronic medical records [18]. Ji Sung Lee et al. introduced a novel CDSS, demonstrated excellent performance in aiding physicians performing thrombolysis procedures after ischaemic stroke [19]. Furthermore, a study utilizing a deep learning network to extract vascular time-domain features from DSA videos showed great value in the diagnosis of AVM [20].

For patients with respiratory diseases, the utilization of CDSS has yielded positive impact on the prognosis in certain cases, such as reducing antibiotic resistance and reducing the number of antibiotic prescriptions [37, 38]. Moreover, employing CDSS for respiratory patients has facilitated physicians' self-efficacy in managing patients with chronic respiratory diseases and reducing antibiotic prescriptions [39, 40]. The system's positive impact on physician performance can be attributed to the collaborative nature of the decision-making process, where physicians often work in conjunction with CDSS recommendations rather than simply adhering to mandatory directives [38, 41-44]. It can be inferred that the cooperative relationship between patient, healthcare providers, and CDSS guidelines plays an important role in prescription medication, elucidating the constructive role of CDSS in curbing unreasonable antibiotic prescriptions and countering drug resistance [37, 38].

The challenges stemming from the intricate fusion of computer science and clinical medicine, lack of support for extensive clinical knowledge databases, and the suboptimal application of electronic medical record systems have led to the acceptance of only a few CDSSs among clinical professionals for practical application [45]. The application of CDSS in chronic disease management remains relatively uncharted terrain, rife with technical and regulatory hurdles that impede their seamless integration into clinical care processes [46]. It is also worth noting that the evidence of CDSS effectiveness is limited, particularly in terms of the number and scale of studies on patient outcomes, few studies have provided in-depth research to unravel the mechanism behind the results.

At present, clinical trial endpoints for CDSS are diverse. Some focus on the CDSS itself, such as the satisfaction of medical staff and patients. Others concentrate on process optimization, aiming to reduce waiting times and medical expenses. Meanwhile, some trials assess disease-related improvements, such as shorter hospital stays and better disease indicators. It is worth noting that there can be discrepancies in the trial results of different CDSSs for the same disease. Therefore, a thorough evaluation of CDSS details, including implementation and application, is crucial. Moreover, according to the available data, assessing the economic impacts of CDSS is challenging. The costs associated with system design, local implementation, ongoing maintenance, and user support can be substantial, especially in the context of chronic disease care.

Despite the technical and regulatory challenges, the remarkable clinical and economic effects of CDSS on chronic disease management can still help us address medical challenges. The development of CDSS is a prominent trend in medical informatics, and it will play an essential role in future medical care. The CDSS is primarily designed to make decisions based on clinical practice guidelines and expert experience. It enables the integration of evidence into clinical practice and provides evidence-based decision support for clinical staff. Leveraging CDSS to facilitate decision making in accordance with clinical practice guidelines can elevate compliance among clinical staff and promote the best clinical decisions, which will be a key focus in the ongoing development of chronic disease management.

However, it's important to acknowledge several potential limitations in this review. Currently, there is limited evidence regarding the use of CDSS in screening, and some of the included studies may have relatively small sample sizes or short follow-up periods. Additionally, this review primarily focuses on diabetes, cardiovascular diseases, cerebrovascular diseases and respiratory diseases, while they may not fully represent all major chronic diseases.

Conclusion

CDSS play a pivotal role in enhancing the entire chronic disease management process. These CDSS systems have demonstrated their positive impact on patient health outcomes and physician practice performance. However, the effectiveness of CDSS depends on many factors, including system performance, user friendliness, patient volume, adherence to clinical guidelines, data registration, availability of electronic medical records, patient treatment compliance, and collaboration between patients and healthcare providers. Therefore, future trials should focus on aspects such as system design and development, local environment, implementation strategy, adverse results, user workflow, user satisfaction and cost-effectiveness of CDSS application. These comprehensive evaluations will provide insights into CDSS benefits in the field of chronic disease management.

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Disclosure of conflict of interest

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