Chapter 1
Overview of Clinical Decision Support Systems in Healthcare

Jane Dominique Moon
University of Melbourne, Australia

Mary Galea
University of Melbourne, Australia

ABSTRACT

Clinical Decision Support Systems (CDSS) are software designed to help clinicians to make decisions about patient diagnosis using technical devices such as desktops, laptops and iPads, and mobile devices, to obtain medical information and set up alert systems to monitor medication. A Clinical Decision Support System has been suggested by many as a key to a solution for improving patient safety together with Physician Based Computer Order Entry. This technology could prove to be very important in conditions such as chronic diseases where health outlay is high and where self-efficacy can affect health outcomes. However, the success of CDSS relies on technology, training and ongoing support. This chapter includes a historical overview and practical application of CDSS in medicine, and discusses challenges involved with implementation of such systems. It discusses new frontiers of CDSS and implications of self-management using social computing technologies, in particular in the management of chronic disease.

INTRODUCTION

Clinical Decision Support Systems are software applying "active knowledge systems which use two or more items of patient data to generate case-specific advice" (Wyatt & Spiegelhalter, 1991, p. 3). CDSS are information systems designed to improve clinical decision making 'at the point in time that decisions are made' (Berner, 2007, p. 3). The systems use technical devices such as desktops, laptops, iPads and mobile devices to derive medical information from data repositories to support the decision making process in a health organization. Patient characteristics are matched to knowledge database sets, and software algorithms generate patient-specific recommendations (Garg et al., 2010), as well-designed clinical decision support systems have been shown to improve the quality of health care with the use of clinical guidelines (Lamy et al., 2008).

DOI: 10.4018/978-1-4666-9432-3.ch001

The notion of using CDSS has been around for more than 50 years (Kulikowski & Weiss, 1982).

The early CDSS were developed in the 1970s, derived from expert systems where developers tried to emulate machines to think like expert clinicians when treating patients (Stowa et al., 2006). From these early studies, there was growing recognition that they could assist clinicians with routine tasks by providing various functionalities (Callen, Johanna, Westbrook, & Braithwaite, 2006; Georgiou, Lam, & Westbrook, 2008) that would assist clinicians with accurate diagnosis and minimize human error (Kawamoto, Houlihan, Balas, & Lobach, 2005).

However, the adoption of CDSS to their full capacity has not been as substantial as expected. There are barriers to their implementation (Aarts & Koppel, 2009) and challenges to accessing and linking the myriad of information that exists in silos. These challenges remain to be resolved (Sittig et al., 2008).

The potential to improve health via CDSS has been shown to be positive, and work is being done in the domains of geriatrics (Vairaktarakis et al., 2015), in pediatrics, education, laboratories, radiology and health administration.

This chapter covers the development and application of CDSS and discusses functionalities, limitations and challenges with the adoption of new technology. The chapter provides guidelines for better uptake of CDSS and provides a critique of various problems with, and reactions to, their application.

Development of CDSS in Medicine

The development of CDSS in medicine stems from artificial intelligence. Artificial intelligence (AI) systems are intended to support healthcare workers with tasks that rely on the manipulation of data and knowledge. Types of AI that are intended to support clinical decisions are referred to as Expert Systems (Goodman, Grad, Pluye, Nowacki, & Hickner, 2012).

Expert systems are the commonest type of CDSS in routine clinical use. Research into the use of artificial intelligence in medicine started in the early 1970s and produced a number of experimental systems. In the first decade of research, most systems were developed to help clinicians in the process of diagnosis during an encounter with a patient. Most of these early systems did not develop further than the research laboratory, partly because they did not gain sufficient support from clinicians to permit their routine use.

CDSS can be broadly divided into two groups: knowledge-based or non-knowledge based. Knowledge-based systems are the commonest type of CDSS technology in routine clinical use, also known as *expert systems*. The knowledge-based system uses compiled clinical knowledge to provide clinical consultation. By far the majority of CDSS in medicine are knowledge-based (Berner, 2007). Non-knowledge-based systems do not use a knowledge base but use a form of artificial intelligence, machine learning, more like 'trial and error', that finds patterns in clinical datasets, learning the type that is similar to one way that humans learn (Kabachinski, 2013). There are two such types: neural network and genetic algorithms. The development and the application of expert systems in the clinical setting are explained in Figures 1 and 2.

There are many different types of CDSS and they deploy a range of technical functionalities, but a typical CDSS has medical knowledge, a database that contains patient details and an inference engine to generate case-specific advice, as can be seen in Figure 1. These systems contain clinical knowledge, signs, symptoms and laboratory results.

The general model of expert system has an inference mechanism which contains rule-based systems with specifically defined tasks. There are many variations in the system but the typical system is