Computerized decision support to improve guideline implementation in cardiac rehabilitation: the CARDSS project
Goud, R.

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Chapter 1

General Introduction
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The CARDSS project

In 1996, the Netherlands Heart Foundation and the Netherlands Society of Cardiology published the first national clinical practice guidelines for cardiac rehabilitation [1]. Cardiac rehabilitation is a multidisciplinary secondary prevention therapy that is provided to patients after cardiac events (e.g. myocardial infarctions) and cardiac interventions (e.g. heart surgery). The goal of cardiac rehabilitation is to favourably influence the cause of disease, and above all to ensure that patients are in the best possible physical, psychological and social position to return to and maintain their normal place in society [2-6].

In 2001, the Dutch Cardiac Rehabilitation Committee, instituted by Netherlands Heart Foundation and the Netherlands Society of Cardiology, decided to revise and elaborate the cardiac rehabilitation guidelines, because new scientific evidence on, and more experience with, cardiac rehabilitation was available. As measurements in 1999 had shown that the uptake of the 1996 guidelines in clinical practice was poor [7], the cardiac rehabilitation committee decided that, to improve implementation of the new guidelines, a computer program had to be developed that would support professionals in making therapy decisions according to the new guidelines. In 2002, the department of Medical Informatics from the Academic Medical Centre in Amsterdam became involved in the development of this decision support system. This marked the beginning of the CARDSS (Cardiac Rehabilitation Decision Support System) project.

This thesis describes the various scientific studies that were carried out in the CARDSS project during the years 2004-2008. In this chapter we first provide some background information on the most important concepts of this thesis. Subsequently, we describe this thesis’ objective, the various research questions that will be addressed, followed by an outline of this thesis.

Clinical practice guidelines

An important issue in contemporary healthcare is that patients are provided with treatments whose effectiveness are proven by current scientific evidence [8]. Because of technological advancements and increased insights, treatments that were considered effective five years ago might be outdated today. Keeping up to date with the latest scientific advancements is however not easy. Healthcare professionals need to read and assess hundreds of scientific articles a month that are related to their specialism. Just searching in Pubmed [9] for research papers with the keywords ‘cardiovascular disease’ in their title or abstract results in more than 1.4 million related articles of which over 68,000 were published in 2007 alone. Therefore, there is
a need for effective instruments and strategies that facilitate the delivery of evidence-based care.

One of the instruments considered essential in the delivery of evidence-based care are clinical practice guidelines (CPGs) [8]. CPGs are systematically developed statements, usually developed by a (multidisciplinary) group of expert healthcare professionals, which summarize and describe best practices for specific health conditions [10]. In general, CPGs aim to i) improve the provision of proven-effective care that is tailored to the needs and condition of the individual patient and ii) reduce the variation in the care provided by different healthcare professionals and organizations [10-12]. Healthcare workers are nowadays expected to deliver care according to these CPGs unless they have very good reasons not to. In medical lawsuits adherence to the CPG is increasingly used to judge medical practice [13]. Also for health insurance companies CPG adherence is becoming an important issue [14].

The guideline implementation problem

One of the main challenges in modern healthcare is the dissemination and implementation of CPGs [15]. Despite the fact that working according to CPGs can improve patient outcomes, reduce practice variation, and reduce costs of patient care [10;12;16], several studies have shown that only 60%-70% of the patients are actually treated according to guideline recommendations [17]. This is due to various barriers that professionals may face when they try to incorporate CPGs into care practice [18]. For instance, a professional may not know the details of a particular CPG by heart, or may in certain cases disagree with its recommendations. Barriers can also be related to the CPG themselves (e.g., complexity of rules and recommendations), to the patient (e.g., patients may refuse therapies), to the organization (e.g., insufficient time or resources), or to other environmental factors (e.g., reimbursement policies).

Traditionally, CPGs are disseminated on paper among their target groups (e.g., via publication in a scientific journal). However, it has been found that providing care professionals with paper guidelines is not sufficient to enforce the required change in practice [19]. For this reason, several authors have argued that for effective guideline implementation carefully designed change strategies need to be applied [15;17]. Instruments that are frequently used as part of a change strategy include educational meetings, conferences, audit and feedback, and computerized decision support (CDS).
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Guideline-based computerized decision support

The provision of CDS has been found to be an effective instrument to let healthcare professionals make better decisions [15;17;20;21]. A medical CDS system is a computer program that provides patient-specific reminders, advice, or interpretation of data at the point of care [22]. Although the majority of evaluated CDS systems have proven effective in letting healthcare professionals make better decisions [20;21;23], these systems are still not in widespread use. This is due to technical factors (e.g., usability, flexibility, and stability of the system), human factors (e.g., attitude of professionals towards the use of computers, perceived usefulness of the system), and organizational factors (e.g., lack of incentives or support from the organization) [24]. It is even estimated that about half of all CDS system development projects fail in practice [25]. However, as the use of computers in health care is increasingly accepted the last years, it has become increasingly attractive to use CDS as part of a guideline implementation strategy.

To be able to provide guideline-based CDS, the CPG’s recommendations for data gathering, data interpretation, and decision making need to be translated into a computer interpretable format, a process called guideline formalization. A formalized CPG should correspond to the original CPG and reflect the intentions of the guideline authors. However, CPGs often contain ambiguous concepts and recommendations, omissions, inconsistencies, and other errors [14;26-29]. Also, to automatically provide computerized decision support, vague concepts and recommendations in the CPG (e.g., ‘low’ or ‘poor’) need to be clearly delineated (e.g., ‘low is lower than 3.0’). As CPGs are often formalized after their development, proper guideline formalization is difficult and time consuming without close collaboration with CPG authors due to these errors and vagueness in narrative CPGs [27;28;30-32].

Objective of this thesis

Many studies have evaluated the effect of CDS on decision making behaviour of individual healthcare professionals [20;23]. But although multidisciplinary settings are common in contemporary healthcare, to our knowledge, no studies have investigated the effect of CDS in such a setting. While individual decision making is mainly a cognitive process, decision making in teams is additionally influenced by the social context, such as the interpersonal relationships within the team [33;34]. Therefore, in multidisciplinary settings both CDS systems’ requirements and effectiveness might be different.

The objective of the CARDSS project, described in this thesis, was to gain an understanding of aspects the development, deployment, and effectiveness of a
guideline-based computerized decision support system in multidisciplinary outpatient care. To this end, the following research questions were addressed:

Q1: How to develop a computerized decision support system that can assist professionals in working according to the Cardiac Rehabilitation Guidelines 2004?

Q2: Do cardiac rehabilitation professionals consider the developed system usable and useful in practice?

Q3: Does the provided computerized decision support improve implementation of the Cardiac Rehabilitation Guidelines 2004?

**Thesis outline**

The research questions above were addressed during different studies that were conducted as part of the CARDSS project. The results from these studies are described in the following chapters of this thesis, which are outlined below.

In Chapter 2 and Chapter 3, we describe two studies that were conducted to address research question Q1. In order to provide guideline-based CDS the guideline in question has to be formalized. In **Chapter 2**, we describe the guideline formalization strategy that was used to formalize the Dutch Cardiac Rehabilitation Guidelines 2004 and report on our experience with this strategy in practice. **Chapter 3** describes the results of the requirements analysis and development process of the computer system that provides guideline-based decision support for cardiac rehabilitation: the CARDSS system.

Research question Q2 is addressed in Chapters 4 and 5. **Chapter 4** describes results of a pilot study with the CARDSS system in four outpatient clinics to pilot test CARDSS’ usability in practice and verify the quality of the formalized guideline. In **Chapter 5** the results of a more rigorous usability study amongst 63 CARDSS users from 27 different centres are described.

Finally, to answer research question Q3, a multi-centre cluster randomized trial with CARDSS was conducted. In this trial, multidisciplinary teams from 31 participating outpatient clinics were randomized to receive either of two versions of CARDSS: the full version providing CDS on guideline-recommended therapies, or a version that does not provide these therapy recommendations. This trial and the effect of the CDS on multidisciplinary team concordance to guideline recommended therapy decisions are described in **Chapter 6**. In **Chapter 7** we determine the variation between centres in assessed patient needs for cardiac rehabilitation, and identify the influence of different measurement instruments on assessed needs. **Chapter 8** describes a
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Qualitative study amongst professionals in 21 centres that implemented CARDSS to understand the circumstances that influenced CDS' effectiveness.

This thesis concludes with Chapter 9, in which the results from the various studies described in this thesis are synthesized and discussed, and recommendations for further research are provided.

Reference List


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