Computerized decision support to improve guideline implementation in cardiac rehabilitation: the CARDSS project
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Summary
One of the main challenges in contemporary healthcare is ensuring that patients receive treatment that is optimally effective according to current scientific evidence. The development and implementation of clinical practice guidelines is considered essential for this purpose. Working according to these guidelines improves patient outcomes, reduces practice variation, and reduces costs of patient care. However, the uptake of guidelines in clinical practice is still low due to different barriers related to the knowledge, attitude, and environment of healthcare professionals.

Despite the large evidence base for their effectiveness and cost-effectiveness, cardiac rehabilitation services are poorly standardised and do not follow the available scientific evidence in many Western countries. Cardiac rehabilitation is a multidisciplinary secondary prevention strategy for patients that have had a cardiac incident (e.g., a myocardial infarction), underwent a cardiac intervention (e.g., heart surgery), and for patients with heart failure. Cardiac rehabilitation is critical to ensure that cardiovascular disease patients are in the best possible physical, psychological and social condition to return to and maintain their normal place in society. In addition, cardiac rehabilitation is important to reduce patients' future cardiovascular risks. To improve the quality of cardiac rehabilitation in the Netherlands, the Netherlands Heart Foundation and the Netherlands Society of Cardiology released new cardiac rehabilitation guidelines in 2004. In these guidelines, the assessment of patient’s needs for cardiac rehabilitation forms an important subject. The project described in this thesis revolved around these Cardiac Rehabilitation Guidelines 2004 and their use in practice by cardiac rehabilitation teams in the Netherlands.

To work according to new clinical practice guidelines it is often required that healthcare providers change their existing working procedures according to guideline recommendations. Disseminating guidelines on paper among their target groups is found to be insufficient to enforce the required change in practice. Ensuring that professionals actually work according to guidelines in practice requires the application of carefully designed change strategies. Providing professionals with computerized decision support (CDS) (i.e. patient-specific advice or interpretation of data at the point of care) has been found to be one of the most effective instruments to improve the use of guidelines in practice. However, although many studies have evaluated the effect of CDS on decision making behaviour of individual healthcare professionals, no studies had yet investigated the effect of CDS in a multidisciplinary setting. Specialist medical care is nowadays often provided not by individuals but by multidisciplinary teams. 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. The objective of the CARDSS (Cardiac Rehabilitation Decision Support System) project, described in this thesis, was
to gain an understanding of aspects of the development, deployment, and effectiveness of a guideline-based computerized decision support system in a multidisciplinary setting.

To be able to provide guideline-based CDS, the guideline’s recommendations for data gathering, data interpretation, and decision making need to be translated into a computer interpretable format, a process called guideline formalization. In published accounts, guideline formalization is done after publication of the guideline concerned. However, as guidelines often contain ambiguous and vague concepts and recommendations, omissions, inconsistencies, and other errors, both guideline formalization and the development of a CDS system has shown to be problematic without a close collaboration with guideline authors. In Chapter 2 the potential benefits of the concurrent development and formalization of a guideline are evaluated. The principles of a strategy in which a guideline was formalized concurrently with guideline development were not yet described in the literature. Therefore, we developed a strategy that combines the principles of existing methodologies for guideline development, knowledge engineering and guideline formalization. Central assets of this strategy are the early involvement of guideline formalization specialists (e.g., medical informaticians) and guideline formalization tools, cooperation between guideline authors and formalization specialists in the development of a clinical algorithm, and verification of the formalized guideline prior to dissemination. We found that this strategy helped to identify vague and inconsistent recommendations and impracticabilities in the narrative guidelines that could be resolved before publication. In addition, the strategy ensured consistency between the narrative and formalized guideline. Findings from this research suggest that the developed parallel guideline development and formalization strategy can be beneficial to both the quality of narrative guidelines as well as to the guideline formalization process.

Chapter 3 addresses the actual development of the CARDSS system. The system was developed concurrently with the guideline, which had the benefit that guideline authors could be involved in the system’s requirements analysis. In general, CDS systems operate in the background of existing electronic patient record (EPR) systems. However, as no EPR system for cardiac rehabilitation was yet in use in Dutch outpatient clinics, the CARDSS system had to provide EPR functionalities as well as CDS functionalities. Although this complicated the development of CARDSS, it had the advantage that CDS and EPR functionalities could be closely integrated. It was decided to let CARDSS actively guide professionals in conducting the needs assessment procedure described in the guidelines through a structured dialogue, prompting them to enter the necessary patient information. Subsequently they are provided with the therapies and goals that are recommended by the guidelines for the patient in
question. Several additional CDS-related and patient information management related functionalities are added to increase the system’s chances of adoption. These functionalities include providing professionals with the rationale behind a recommendation, giving insight into relevant guideline information and scientific evidence, evaluating the progress of patients during cardiac rehabilitation, providing useful patient summaries, and calculation of summary statistics across patients.

To determine whether a first version of CARDSS was usable in practice, a six-week pilot study was conducted in four outpatient clinics. This pilot study is described in Chapter 4. After the pilot study, CARDSS users were requested to fill in a questionnaire. In addition, all data stored in CARDSS, including log files, anonymized patient data, guideline recommendations, and therapy decisions were analyzed. Participants were interviewed to clarify findings. During the pilot study, 11 different cardiac rehabilitation professionals used CARDSS to assess the rehabilitation needs for 134 patients. Five system bugs were identified which all could be resolved in one day. CARDSS’ users were positive about its usability and usefulness. Professionals found CARDSS easy to use even though some users indicated that they had hardly any experience with computers before the pilot study. Most professionals found that CARDSS increased their understanding of the cardiac rehabilitation needs assessment procedures when compared to consulting the narrative guidelines. In addition, all participants indicated they wanted to continue using CARDSS, provided that several additional functionalities were implemented. Based on users’ recommendations several changes were made to CARDSS after the pilot study.

In Chapter 5 the results of a more rigorous study on CARDSS’ usability are described. To evaluate the usability of CARDSS, a questionnaire was developed based on the IBM Computer System Usability Questionnaire (CSUQ). To identify factors that influenced CARDSS’ usability, questions were added referring to the respondents’ clinical experience with cardiac rehabilitation, the way they integrated CARDSS in their working procedures, and the time increase per patient caused by using the system. In addition, questions were added to assess the respondents’ agreement with the content of the national cardiac rehabilitation guidelines and their general attitude towards the use of CDS systems in healthcare. Also basic questions on the respondents’ age, gender, and computer literacy were included. Questionnaires were sent to all 68 professionals from the 28 outpatient clinics that participated in a cluster randomized trial with CARDSS. 63 respondents (93%) from 27 clinics returned the questionnaire. CARDSS’ users were positive towards its ease of use, its quality and clarity of information, and the system’s interface quality. The results of this study showed that satisfaction on the usability of CARDSS was higher in professionals that had successfully integrated CARDSS into their working procedures. Furthermore, a
positive attitude of respondents towards CDS systems in general and a better agreement with the content of the national guidelines were positively correlated to satisfaction with CARDSS’ overall usability and each of its sub-domains.

CARDSS was developed to improve the use of the Cardiac Rehabilitation Guidelines 2004 in daily practice. By providing patient-specific, active guideline-based CDS to cardiac rehabilitation professionals we aimed to bring team therapy decisions closer to guideline recommendations, and achieve a consistency of care across outpatient clinics. Chapter 6, Chapter 7, and Chapter 8, describe three studies that were conducted to provide insight into this issue.

**Chapter 6** describes a cluster randomized trial with CARDSS that was conducted to measure the effect of CDS on multidisciplinary team concordance to guideline recommended therapies. Participating centres worked with either of two versions of CARDSS: an intervention version or a control version. The intervention version had full functionality, while the control version comprised all patient information management services but did not provide therapy recommendations. This way we controlled for the potential positive effect of the information management services and dialogue structure provided by CARDSS on the decision making of rehabilitation professionals, a phenomenon known as the ‘checklist effect’. In the control arm, multidisciplinary teams selected rehabilitation therapies using their own judgment; the written guidelines could always be consulted on paper or electronically within CARDSS. Guideline concordance was assessed for four rehabilitation therapies, namely exercise training, education therapy, relaxation therapy, and lifestyle change therapy. Data from 21 centres, including 2787 patients, were analysed. Results from this trial showed that CDS significantly increased concordance with guideline-recommended therapy decisions for exercise therapy by 7.9%, for education therapy by 25.7%, and for relaxation therapy by 25.5%. CDS reduced both cases of over- and under-treatment. These findings showed that CDS can also be an effective instrument to improve the decision making of multidisciplinary teams. However, CDS was not evenly effective in all outpatient clinics and not for all therapies. CDS did not improve guideline concordance for the lifestyle change therapy which was, across both study arms, received by only 26% patients for which it was recommended. Similarly, despite the positive effect of the CDS, there remained still considerable undertreatment for relaxation therapy. Both the lifestyle change therapy and relaxation therapy were newly introduced in the Cardiac Rehabilitation Guidelines 2004. It appeared that a considerable number of clinics lacked the facilities to offer these therapies to all eligible patients. In addition, there remained to exist a large variation between centres in their levels of guideline concordance for all four therapies.
The studies in Chapter 7 and Chapter 8 were conducted to gain insight into reasons for persistent non-concordance and variation in following the guidelines between centres. In Chapter 7 we determine the variation between centres in assessed patient needs for cardiac rehabilitation, and measured the influence of different assessment methods on assessed needs. Intra-cluster correlation coefficients (ICCs), a measure to express inter-practice variation, were calculated for all rehabilitation needs and lifestyle parameters, before and after adjusting for patient case mix, and stratified by assessment method. High ICCs, indicating a high inter-practice variation, were found for insufficient exercise capacity (0.301), unrealistic subjective exercise capacity (0.165), and social problems (0.188). Moderate ICCs were found for psychological problems (0.096), absence of partner (0.052), unhealthy eating habits (0.080), and inactive lifestyle (0.059). Adjustments for case mix hardly influenced ICCs, but stratification by assessment method revealed large differences between results from clinical interviews and measurement instruments. The assessment by clinical interview led to fewer patients being judged as having an insufficient exercise capacity compared to when a measurement instrument (e.g., bicycle ergometry) was used (73.4% vs. 84.1%). In either case, however, substantial variation remained between clinic means. When assessed by clinical interview, 32.8% the patients were judged as having an unrealistic subjective exercise capacity, whereas use of the MacNew quality of life questionnaire resulted in 62.3% of the patients being judged as such. Even greater differences between clinical interview and the use of the MacNew questionnaire were found for the psychological and social problems. The variation in clinic means was somewhat smaller when the MacNew was employed. This study shows that assessments of cardiac rehabilitation needs are subject to moderate to high inter-practice variation. This is especially true when the assessments are solely based on clinical judgment instead of clinical assessment instruments. Furthermore, the numbers of patients judged to have rehabilitation needs are smaller in that case. Therefore, we recommend that guidelines for cardiac rehabilitation provide well-defined and unambiguous procedures for assessing the rehabilitation needs of patients and that assessing the needs solely by clinical judgment should be avoided.

Chapter 8 describes a qualitative study amongst CARDSS users to understand in which circumstances CDS was and was not effective in improving guideline use in practice. In-depth, semi-structured interviews were conducted with care professionals, on reasons for improved guideline concordance or persistent non-concordance after successful adoption of CARDSS. Twenty-nine rehabilitation nurses and physiotherapists from 21 Dutch clinics were interviewed. We found that CARDSS improved guideline use by increasing its users’ familiarity with guidelines’ recommendations and decision logic, by overcoming users’ inertia to previous practice, and by reducing guideline complexity, for example by facilitating calculation
of scores and interpretation of data. Finally, participants reported that sharing guideline recommendations with patients increased their willingness to participate in the cardiac rehabilitation programme. We were also able to identify circumstances in which the CDS was ineffective in either improving concordance to guideline recommendations or consistency of care. Also this study showed that part of the variation in needs assessment procedures and therapy decisions were caused by room for subjective judgment in the cardiac rehabilitation guidelines. However, persistent non-concordance to guideline recommendations was mainly caused by a lack of facilities or resources, a lack of reimbursement, or a lack of priority from other parts of the organization. For example, many outpatient clinics still lacked the facilities to provide relaxation therapy or lifestyle change therapy to all eligible patients. Some clinics hadn’t even developed such a therapy three years after guideline introduction. This fact explained the high undertreatment of patients for some therapies and, as some centres did have sufficient facilities, a large variation in concordance between centres.

The research in this thesis has shown that we succeeded in developing and implementing a comprehensive guideline implementation system for cardiac rehabilitation that is useful in practice. In addition, this research shows that CDS can be an effective instrument to improve guideline use in multidisciplinary settings. CDS increases professionals’ knowledge of preferred practice and facilitates guideline interpretation and application. Therefore CDS could be considered to improve guideline use also in other multidisciplinary settings. However, if following the guideline requires changes in the organization of care that professionals consulting the CDS consider beyond their direct responsibilities or control, the provision of CDS alone appears to be insufficient to realize such changes. More research is needed to understand which additional instruments or strategies should be developed to overcome organizational constraints or environmental barriers to following guidelines.