Building an infrastructure to improve cardiac rehabilitation: from guidelines to audit and feedback

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Citation for published version (APA):
Verheul, M. M. (2016). Building an infrastructure to improve cardiac rehabilitation: from guidelines to audit and feedback

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THE EFFECT OF COMPUTERIZED DECISION SUPPORT ON BARRIERS TO GUIDELINE IMPLEMENTATION: A QUALITATIVE STUDY IN OUTPATIENT CARDIAC REHABILITATION.

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ABSTRACT

**Context:** Computerized decision support systems (CDSSs) can be used to improve the implementation of clinical practice guidelines by changing the behaviour of care professionals. While the influence of system characteristics on the effectiveness of CDSSs is studied, little is known about the relation between cognitive, organizational and environmental factors, and CDSSs’ effectiveness.

**Objective:** To assess the effect of CDSSs on cognitive, organizational, and environmental factors that hamper guideline implementation.

**Design:** In-depth, semi-structured interviews with care professionals, on reasons for improved adherence or persistent non-adherence to the prevailing guideline after successful adoption of a CDSS. All remarks regarding guideline implementation were extracted and classified using the conceptual framework from Cabana et al. [5].

**Setting:** Outpatient cardiac rehabilitation clinics.

**Participants:** Care professionals that used the CARDSS decision support system for therapeutic decision making in cardiac rehabilitation.

**Results:** Twenty-nine rehabilitation nurses and physiotherapists from 21 Dutch clinics were interviewed. CARDSS improved guideline adherence by increasing its users’ familiarity with the guidelines’ recommendations and decision logic, by overcoming users’ inertia to previous practice, and by reducing guideline complexity for example by facilitating calculation and interpretation of data. If the system’s recommendations were shared with patients, refusal to participate in therapies reduced. CARDSS never incited users to target barriers related to organizational or environmental constraints.

**Conclusion:** Our results suggest that computerized decision support can improve guideline implementation by increasing the knowledge of preferred practice, by reducing inertia to previous practice, and by reducing guideline complexity. However, computerized decision support is not effective when organizational or procedural changes are required that users consider to be beyond their tasks and responsibilities.

**Keywords:** Clinical decision support systems; Qualitative evaluation; Guideline adherence; Cardiac rehabilitation
INTRODUCTION

Application of clinical practice guidelines can improve patient outcomes, reduce practice variation, and reduce costs [1–3]. However, care professionals often do not follow the recommendations of practice guidelines [4]. This is due to various barriers that professionals may face when they try to incorporate practice guidelines into care practice [5]. These can be divided into internal and external barriers. Internal barriers relate to the professional’s knowledge of and attitude towards the guidelines. For instance, a professional may not know the details of a particular guideline by heart, or may in certain cases disagree with its recommendations. External barriers are either related to the guidelines 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). For effective guideline implementation, carefully designed change strategies are required to overcome these barriers [6,7].

Computerized decision support systems (CDSSs) are increasingly considered to be one of the most effective instruments to improve guideline implementation [6–10]. However, although the majority of evaluated CDSSs were effective in improving guideline implementation, occasionally CDSSs also proved ineffective [8,9]. While the influences of system characteristics and clinical task on effectiveness of computerized decision support have been well studied, little is known about cognitive, organizational, and environmental factors that affect the impact of these systems [8,9,11].

Despite its proven cost-effectiveness [12], cardiac rehabilitation (CR) services are underutilized and insufficiently evidence based in many western countries [12–14]. To improve the implementation of the Dutch multidisciplinary CR guidelines [15], a CDSS, named CARDSS (CArdiac Rehabilitation Decision Support System), was developed [16] that supports conducting a needs assessment for CR as described in the guidelines. CARDSS actively guides users, predominantly rehabilitation nurses and physiotherapists, through the needs assessment procedure via a structured dialogue, prompting them to record the necessary information. In addition, CARDSS assists in formulating a patient-specific rehabilitation programme by providing computerized decision support: it automatically shows which types of therapy are recommended by the guidelines, based on the patient’s needs assessment data. Upon request, CARDSS provides the rationale behind its recommendations and links to relevant research evidence. To improve CARDSS’ adoption, known success factors for guideline-based CDSSs were taken into account during its development [16,17].

In a recently conducted cluster randomised trial CARDSS was found to increase professional concordance to guideline-recommended therapies [18]. However, for one of the four CR therapies, lifestyle change therapy, there was no increase in concordance, and the overall concordance rates remained moderate also for education and relaxation therapy. There was also a large variation between different clinics in terms of therapy provision, working procedures, and assessed needs of patients [18]. These findings indicate that CARDSS successfully targeted some barriers to guideline implementation, but not all. The fact that CARDSS’ usability was judged positive by
its users [19] and is still used in over 35 Dutch outpatient clinics, suggests that some barriers lie beyond the influence of a successfully adopted CDSS. In this paper we report on a qualitative study to understand which cognitive, organizational, and environmental barriers to guideline implementation were targeted by CARDSS and which barriers persisted. This study can provide valuable insight into the circumstances in which a CDSS can be effectively used as guideline implementation instrument.

METHODS

Participants
CR professionals from all clinics that worked with CARDSS in January 2007 and used CARDSS for more than 1 year were considered eligible to participate in this qualitative study. All eligible professionals with an executive role in conducting and organizing the CR needs assessment and therapeutic decision making procedures (generally a rehabilitation nurse or physiotherapist) were invited to participate in this study.

Interviews
In-depth, semi-structured interviews were conducted with participants of the study to discuss if and why CARDSS did or did not improve the adherence of their team to guideline recommendations. Table 1 lists the different guideline recommendations that were addressed during the interviews. For each of these recommendations it was discussed with participants whether they systematically followed the recommendation prior to the introduction of CARDSS in their clinic, and whether this had changed after they started to use CARDSS. In addition, if participants reported that a recommendation was not systematically followed before or after the introduction of CARDSS, they were asked why, in their opinion, this was the case. Similarly, if participants reported a change in adherence to recommendations, they were asked to describe their perceived reasons for the change. Prior to the interviews, clinics’ quantitative data from CARDSS on the demography, needs assessment criteria, and therapy decisions for individual patients, were collected. This data was used to create a paper report for each clinic in which their recorded information regarding the recommendations presented in Table 1 were outlined in the form of tables and charts. Each clinic’s paper report was studied by two researchers (MvEV and RG) prior to the interviews to be able to verify participants’ statements (triangulation [20]). In case the participants found it difficult to reflect upon their adherence to a particular guideline recommendation, or if a statement regarding guideline adherence appeared to be inconsistent with the paper report, the relevant data from the report were discussed with the participants. Interviews were conducted by one independent researcher (MvEV). She was accompanied by a senior researcher (RG or IH) during the first five interviews. If the three most recent interviews provided no new insights, no additional interviews were conducted (theoretical saturation [20]). Informed consent was obtained from all interviewees to audiotape the interview.
Table 1 – Recommendations of the cardiac rehabilitation guidelines that were discussed during interviews.

<table>
<thead>
<tr>
<th>Recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Use of objective instruments</strong></td>
</tr>
<tr>
<td>An objective exercise test (a bicycle test or a Shuttle Walk Test) should be conducted prior to or during the needs assessment procedure to determine whether the patient’s exercise capacity needs to be increased.</td>
</tr>
<tr>
<td>The MacNew quality-of-life questionnaire should be filled in by all patients to assess whether there is a need for emotional or social counselling.</td>
</tr>
<tr>
<td><strong>The assessment of risk behaviour and lifestyle</strong></td>
</tr>
<tr>
<td>The smoking status of patients at the time of their cardiac incident should be assessed. Patients should be supported to quit smoking when appropriate.</td>
</tr>
<tr>
<td>It should be assessed whether patients’ dietary habits comply with the norms for a healthy nutrition (2 pieces of fruit and 7 ounces of vegetables a day, 2 portions of fatty fish a week, little salt, max 2 glasses of alcohol, etc.). Patients should be supported to develop healthy diet when appropriate.</td>
</tr>
<tr>
<td>It should be assessed whether patients comply with the Netherlands norm for healthy exercise (30 min of moderate physical activity during at least 5 days, but preferably 7 days a week). Patients should be supported to adopt a physically active lifestyle when appropriate.</td>
</tr>
<tr>
<td><strong>Therapeutic decision making</strong></td>
</tr>
<tr>
<td>Patients should be offered education therapy according to their individual needs. Patients should be offered exercise therapy according to their individual needs.</td>
</tr>
<tr>
<td>Patients should be offered relaxation therapy according to their individual needs. Patients should be offered lifestyle change therapy according to their individual needs.</td>
</tr>
</tbody>
</table>

**Analysis**

All interviews were transcribed verbatim for content analysis. Two researchers (RG and MvEV) independently extracted all remarks from the interviews in which the participant (i) addressed to be still non-adherent to a specific guideline recommendation at the time of the interview, (ii) addressed that their adherence to a specific guideline recommendation changed because of the introduction of CARDSS, (iii) addressed that adherence to a guideline recommendation improved since, but not explicitly attributed them to, the introduction of CARDSS. The extracted remarks were assembled and compared. For all remarks selected by only one researcher, a third researcher (NdK) adjudicated upon inclusion in the analysis.

Three researchers (RG, NdK, NP) subsequently classified and analyzed all remarks according to the conceptual framework of Cabana et al. [5] (Fig. 1). In this framework, reasons for physicians’ non-adherence to guidelines can be categorized as different types of internal barriers, affecting the knowledge or attitude of physicians towards the guideline, or as external barriers, related to either the patient, guideline, or environment of the physician, affecting their acting upon guideline recommendations (behaviour). However, it is also possible that external
barriers affect the knowledge or attitude of physicians towards the guideline (e.g., guideline complexity causes inertia to previous practice). In Fig. 1, this is illustrated by the arrows directing from the external barriers to several internal barriers. For each of the internal barriers identified in our study, it was therefore also determined if they were actually caused by an underlying external barrier.

![Figure 1 – Physician barriers to guideline adherence (adapted from Cabana et al. [5]).](image)

**RESULTS**

Eligible professionals from 25 clinics were invited to participate in our study. Except for one clinic who did not respond to our e-mail and telephone calls, one or more professionals from all clinics agreed to take part in the study. Interviews with 29 professionals (21 rehabilitation nurses, 7 physiotherapists, and 1 rehabilitation doctor) from 21 outpatient clinics were conducted after which theoretical saturation was reached. To this end, professionals from the remaining three clinics were not interviewed.

All interviews were conducted in February and March 2007 and lasted between 30 and 60 min. During the interviews the paper reports proved to be a valuable instrument to discuss participants’ working procedures in detail. In most interviews, participants initially stated for one or more guideline recommendations that they worked according to the recommendation while their quantitative data suggested otherwise. Once confronted with the data, participants refined their statements and elaborated upon their working procedures in detail.

The results of the study are presented in the following sections. All types of barriers that persisted or were reduced because of CARDSS are included in tables with a representative sample comment. Changes in procedures since, but not explicitly attributed to the introduction of CARDSS by respondents, are only discussed in the text. In case participants reported an internal barrier to guideline implementation that was however actually caused by an underlying external barrier, the internal barrier is included in the table and the underlying external barrier is discussed in the text.
Barriers to guideline implementation

Table 2 – Barriers to using objective instruments to assess the patient needs for cardiac rehabilitation. Barriers were either reduced (r) or persisted (p) after the introduction of CARDSS. A sample comment is listed with each barrier.

<table>
<thead>
<tr>
<th>Barrier</th>
<th>p/r</th>
<th>Sample comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal barriers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of familiarity</td>
<td>r</td>
<td>“We started to use the QoL questionnaire since the introduction of CARDSS. We immediately said to each other ‘this is a good instrument to use’.”</td>
</tr>
<tr>
<td>Inertia to previous practice</td>
<td>r</td>
<td>“We now use the QoL questionnaire more consistently. Before we had to send it to the psychologist who calculated and interpreted its scores. CARDSS made this much easier.”</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>“At the CR needs assessment we judge the exercise capacity of patients by clinical experience. The bicycle test is performed at the exercise programme...”</td>
</tr>
<tr>
<td>Lack of agreement</td>
<td>p</td>
<td>“We don’t see the surplus value of letting patients perform an exercise test within 4 weeks after cardiac surgery.”</td>
</tr>
<tr>
<td><strong>External barriers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental factors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of time/resources</td>
<td>p</td>
<td>“At the end of the hospitalization, an exercise test is always performed for patients that suffered a myocardial infarction. But that isn’t a standard for all cardiac patients... because our capacity is just not sufficient.”</td>
</tr>
<tr>
<td>Organizational constraints</td>
<td>p</td>
<td>“...the results [of the bicycle test] are not yet here [at the CR needs assessment procedure] by the time we see the patient again. The cardiologist usually does not have his report finished yet. However some patients know what their own results were.”</td>
</tr>
</tbody>
</table>

**Barriers to the use of objective instruments**

Table 2 shows that both persistent and reduced barriers to using objective needs assessment instruments were identified. In many clinics a patient’s need for exercise therapy was still determined by a nurse’s subjective appraisal and not via an objective exercise test as recommended by the guidelines. In several clinics this was due to a lack of capacity at the clinic’s functional department (e.g., insufficient exercise bicycles). However, none of the participants tried to target these capacity problems. Only one clinic reported to have started conducting a Shuttle Walk Test instead as recommended by the guidelines (“*We didn’t use the Shuttle Walk Test until CARDSS. We now do it before [the needs assessment procedure] and afterwards [after the CR programme]*”). Several clinics reported that they do conduct an exercise test, but only
after the therapy decisions have been made, making it impossible to take account of test results in the decisions. No participant had put effort into rescheduling these exercise tests with the functional department to solve this problem.

Most participants did report that CARDSS stimulated the use of the MacNew quality-of-life questionnaire [21] which is advocated by the guidelines. Most participants did not know the questionnaire or did not know how to apply it, but started to use the questionnaire because CARDSS guided them in its use and interpretation. CARDSS sometimes reduced professionals’ inertia to previous practice regarding the use of the questionnaire: some of the participants did not use it prior to CARDSS because they found calculating and interpreting its results too laborious.

**Barriers to assessment of risk behaviour and lifestyle**

Several interviewees reported that CARDSS had improved the assessment of risk behaviour and lifestyle of patients. CARDSS users are automatically prompted to record various aspects of each patient’s lifestyle. This raised the awareness that attention should be paid to lifestyle assessment and lifestyle change. Nevertheless, the assessment of lifestyle parameters was often not carried out according to the recommendations of the guideline because rehabilitation professionals disagreed with the guideline, had poor expectations of the methods prescribed by the guideline, stuck to previous practice, or because there were external barriers related to patient factors and guideline factors (Table 3). However, all internal barriers to the assessment of risk behaviour and lifestyle reported by participants appeared to be caused by underlying patient and guideline factors. Participants frequently reported that the criteria for a healthy lifestyle presented in the guidelines are too stringent, and the associated assessment procedures are too shallow. For instance, many patients know what the norms for healthy nutrition are and claim that they do follow them. Interviewees stated that they often do not believe these claims, but the guideline offers no instruments to objectify patients’ dietary habits. As a result, the assessment of dietary habits is subject to considerable variation among clinics; some use BMI as a proxy, others simply ask their patients whether they have unhealthy eating habits, while others try to assess the patients’ dietary habits by self-developed methods. Similar barriers were found for the assessment of the patient’s exercise habits. Respondents stated that they would like to put more effort in lifestyle assessment, but that the guideline should provide more elaborate and practical directions.
Table 3 – Barriers to using the proper assessment of the risk behaviour and lifestyle of patients. Barriers were either reduced (r) or persisted (p) after the introduction of CARDSS. A sample comment is listed with each barrier.

<table>
<thead>
<tr>
<th>Barrier</th>
<th>p/r</th>
<th>Sample comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal barriers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of familiarity</td>
<td>r</td>
<td>“Since CARDSS we focus more on these [lifestyle related] questions.”</td>
</tr>
<tr>
<td>Inertia to previous practice</td>
<td>r</td>
<td>“Before CARDSS we hardly paid any attention to it [assessment of eating habits], but now we do, because we are automatically prompted for it.”</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>“If I would ask about [healthy eating habits] extensively it would take me a lot of time.”</td>
</tr>
<tr>
<td>Lack of agreement</td>
<td>p</td>
<td>“We do not follow the guideline but use the BMI to assess eating habits instead. The guideline prescribes two ounces of vegetables [per day], two pieces of fruit [per day] and a minimum of two portions of fatty fish [a week], but I do not know anyone who complies to that.”</td>
</tr>
<tr>
<td>Lack of outcome expectancy</td>
<td>p</td>
<td>“The eating habits of patients are difficult to determine. I generally use the BMI [body mass index] of patients as a guideline. This way all patients are judged similar. Because patients always say that they do it [eat healthy].”</td>
</tr>
<tr>
<td><strong>External barriers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient factors</td>
<td>p</td>
<td>“We assess the lifestyle of patients based on what they tell us, but of course you don’t know whether that is the truth. It is hard to determine because you need to question very deeply. Nowadays everybody knows what you should eat and drink. “No I eat healthy and I use liquid fats”, but for some people I just don’t believe that.”</td>
</tr>
<tr>
<td>Guideline factors</td>
<td>p</td>
<td>“We determine that [unhealthy eating habits] by reading patients that list [of healthy eating habits presented in the guideline] and ask ‘do you do this?’ Then people usually say ‘yes I know and follow them’... I just don’t think that asking about the list is sufficient.”</td>
</tr>
</tbody>
</table>
Table 4 – Barriers to therapy decision making according to guideline recommendations. Barriers were either reduced (r) or persisted (p) after the introduction of CARDSS. A sample comment is listed with each barrier.

<table>
<thead>
<tr>
<th>Barrier</th>
<th>p/r</th>
<th>Sample comment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Internal barriers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of familiarity</td>
<td>r</td>
<td>“We have become more aware of its [relaxation therapy] importance. That is why we incorporated it in our exercise therapy.”</td>
</tr>
<tr>
<td>Inertia to previous practice</td>
<td>r</td>
<td>“What has changed that we have become more aware of certain things. We now offer CR to more patients, mostly on a psycho-social basis.”</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>“We don’t have lifestyle change therapy. We have not thought about it yet. I think that is just because of a lack of time.”</td>
</tr>
<tr>
<td>Lack of agreement</td>
<td>p</td>
<td>“Relaxation therapy is always recommended [by the guideline]. If exercise therapy is recommended, then relaxation therapy is also recommended.”</td>
</tr>
<tr>
<td><strong>External barriers</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient factors</td>
<td>r</td>
<td>“At first there were only few patients who wanted to participate in lifestyle change therapy. The resistance was very high. This has improved greatly because of CARDSS since we now tell patients ‘see, according to the computer programme you should follow it’.”</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>“Patients often have a lot of resistance towards it [lifestyle change therapy]...They say ‘I will not see a psychologist because there is nothing wrong with me’.”</td>
</tr>
<tr>
<td><strong>Environmental factors</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of time/resources</td>
<td>p</td>
<td>“It [exercise therapy] is currently full due to a lack of accommodation. The physiotherapist says he just wants five patients in his group, because otherwise the hall is too small for sports activities.”</td>
</tr>
<tr>
<td>Organizational constraints</td>
<td>p</td>
<td>“I wished that we could put more effort in our CR programme. However our hospital is now in a turbulent situation and then CR is not the main priority.”</td>
</tr>
<tr>
<td>Lack of reimbursement</td>
<td>p</td>
<td>“The insurance companies do not reimburse relaxation therapy.”</td>
</tr>
</tbody>
</table>
Barriers in therapeutic decision making

In therapy decision making, participants reported persistent barriers to guideline implementation related to inertia to previous practice, a lack of agreement, patient refusal, a lack of time or resources, organizational constraints, and a lack of reimbursement (Table 4). Participants often reported that they do not follow the guidelines' decision making rules with respect to lifestyle change and relaxation therapy due to a lack of facilities and resources. This was usually also the underlying cause for participants' inertia to previous practice. In some outpatient clinics a lack of management priority was reported as a reason for not following the guideline. However, none of the participants had tried to establish a lifestyle change therapy since the introduction of the CDSS by discussing the lack of facilities or resources with their managers or cardiologists. Some centres did start to offer relaxation therapy to patients after CDSS introduction, but only within the limits of the available resources: it was usually offered as part of their exercise or lifestyle change therapy and not separately, as the guideline recommends. Clinics that did have the facilities to offer lifestyle change therapy frequently reported that patient refusal was the main reason for non-adherence to guideline recommendations due to the stigma associated with psychological counselling. Some interviewees were non-adherent to guideline recommendations as they believed that relaxation and lifestyle change therapy was recommended too often.

Use of CARDSS reduced barriers in therapeutic decision making related to a lack of familiarity with the guidelines, inertia to previous practice, and patient refusal (Table 4). Some participants stated that they changed their CR programme because the CDSS provided them with more insight in, and made them more aware of, their working procedures. Several interviewees report that they changed their CR programmes since the use of the CDSS, but often found it hard to say whether that was actually attributable to the CDSS (“Whether it was because of CARDSS I don’t know, but we came to realize that it was important to have it [relaxation therapy]”). Although several participants reported that the CDSS changed their decisions regarding lifestyle change and relaxation therapy, no changes in decision making regarding the exercise and educational therapies were mentioned. However, a clear change that was reported was the following. Several participants confront patients with the recommendations provided by CARDSS during the needs assessment procedure. These participants reported that patients are now more willing to participate in lifestyle change therapy as they saw that CARDSS, and thus the national guideline, recommends that they should do so (“We notice that patients say ‘Well if the system says that it is good for me to follow that therapy, I will do so’. ”). Patients seemed to be more receptive to guideline recommendations than to ‘professional opinion’.
DISCUSSION

In this study we have identified cognitive, organizational, and environmental barriers to guideline implementation in cardiac rehabilitation, and assessed which barriers were successfully levelled by the introduction of a CDSS. We found that the CDSS improved guideline implementation by increasing its users’ familiarity with the recommendations and decision logic of the guidelines, by overcoming users’ inertia to previous practice, and by reducing guideline complexity, for example by facilitating calculation and interpretation of assessment results. If CDSS recommendations were shared with patients, fewer patients refused to participate in psycho-social therapy. Environmental barriers related to a lack of time or resources, organizational constraints, and a lack of reimbursement, were never reduced by the CDSS.

Previous studies of the effects of CDSSs have predominantly relied on quantitative methods [8]. Although such methods can point out whether or not the evaluated system was successful in improving practitioner performance (e.g. guideline adherence), they cannot provide insight into why or how the CDSS in question was or was not effective [22–24]. Therefore, to date little is known about the relation between cognitive, organizational, and environmental factors and the effectiveness of these systems [8,24,25]. Our study provides a start in filling this gap.

In our study, the assessment of barriers to guideline adherence may have been biased by using the framework of Cabana et al. [5]. This framework was designed for classifying the reasons why physicians do not follow guideline recommendations but we used it to assess which barriers are reported by nurses and physiotherapists. These are the main types of care professionals in cardiac rehabilitation. The categories that were defined by Cabana et al. may not be suitable for these types of care professionals, resulting in a classification that is too coarse. Because the reported barriers are evenly distributed over the categories defined by Cabana et al., we do not believe that this is the case though.

A qualitative approach is the best method to get insight into reasons why guideline implementation was or was not improved [22–24]. However, such methods have some limitations. The answers of the participants of our study may have been socially desirable or prone to recollection bias, and several participants remarked that they found it difficult to attribute the changes to CARDSS. These circumstances may have negatively influenced the completeness of our results. For instance, CARDSS’ quantitative evaluation showed that the system stimulated its users to let their therapy decisions better correspond to recommendations in the guidelines [18], but none of the interviewees in the current study explicitly remarked that the CDSS influenced their decisions concerning exercise and education therapies. Either such changes in therapeutic decision making go by unnoticed or participants did not remember these behavioural changes at the time of the interview, which was held nearly 2 years after the introduction of the CDSS. We nevertheless believe that the majority of relevant barriers was uncovered in our study because (i) there was a relatively large number of participants, (ii) quantitative data on clinics’ working procedures were used to verify participants’ comments, and (iii) the primary interviewer (MvEV) was not involved in the design and quantitative evaluation of the system [18,20]. Although
Barriers to guideline implementation

Interviews with a group of non-CDSS users might have been on option, triangulation would be difficult as no quantitative data of these CR outpatient clinics are available.

The results of our study cannot be generalized to CDSSs that are not yet adopted and implemented in practice. It is known that the implementation of a CDSS is a challenge of its own as it affects the working procedures of its users [26,27]. Also, the generalizability of our results might be restricted to settings where these users are predominantly nurses and paramedics. However, contemporary healthcare is increasingly shifting towards care models in which specialized nurses are responsible for the ‘case management’ of patients [28]. This study therefore provides important insights into the effectiveness of CDSSs in these types of care models.

It is known that involving patients in therapy decision making increases their feeling of autonomy and motivation and to manage their disease [29]. In this study we found that confronting patients with on-screen CDSS recommendations resulted in an increased patient receptiveness towards participation in psycho-social programmes. This finding supports the recommendation by Kawamoto et al. [11] to share a CDSS’ advice with patients to improve CDSS effectiveness.

A recently conducted cluster randomised trial showed that CARDSS increased professional guideline concordance in therapeutic decision making for exercise therapy from 84.7% to 92.6%, for education therapy from 63.9% to 87.6%, and for relaxation therapy from 34.1% to 59.6% [18]. There was no (significant) change in the concordance to rules with respect to lifestyle change therapy (54.1% vs. 57.4%). The qualitative findings on therapeutic decision making that were reported here (Table 4) provide explanations for these quantitative results. Most of the persistent barriers in the table pertain to lifestyle change therapy (inertia to previous practice, patient factors) and relaxation therapy (lack of agreement, lack of reimbursement). The CDSS was not effective in reducing these barriers because they are not related to professional familiarity with the guidelines.

Generally speaking, recommendations from a clinical CDSS will not directly influence barriers that are outside the CDSS user’s professional responsibility. When a care professional cannot follow a guideline’s recommendation because there is a lack of facilities or there are other organizational constraints, computer advice will not help. One could hypothesize that CDSS users, once regularly confronted such advice that they are unable to follow, would bring these problems to the attention of their superiors. Although all study participants used the CDSS for over 1 year, none of them actually put effort in overcoming these ‘higher level’ barriers. For example, no outpatient clinic tried to change the planning of bicycle test appointments with the functional department in order to have the test results available to inform therapy decisions. Apparently, CDSSs like CARDSS do not incite its users to realize changes that, according to its users, exceed their ‘own’ tasks, responsibilities, or control. This phenomenon, that barriers faced by front-line, non-physician, hospital workers do not reach managers, doctors, and policy makers, was also described by Tucker and Edmondson [30].

Our results suggest that CDSSs, consulted by nurses or physiotherapists, can improve
adherence to guidelines by increasing the knowledge of preferred practice and facilitating the guidelines’ application in practice. In case such barriers hamper guideline implementation, we recommend policy makers and guideline implementers to consider the use of a CDSS as an implementation strategy. However, during implementation one has to be aware of organizational and procedural changes that are required and are beyond the tasks and responsibilities of the users as to secure that the DSS can be used to its fullest breadth.

FUTURE RESEARCH

Although the literature emphasises that many different types of barriers to guideline implementation exist which may require different change strategies [5–7], little is known about the types of barriers that different change strategies can address [6,7]. Our results suggest that a CDS system alone is insufficient realize changes that users consider beyond their tasks, influence, and responsibilities. We are currently setting up a study to evaluate whether the provision of regular feedback reports to users and the management in addition to CDS can help to realize such changes.
SUMMARY POINTS

What was already known on this subject
- Although computerized decision support systems are found to be one of the most effective instruments for guideline implementation, these systems also regularly fail to improve the quality of care in practice.
- While the influence of system characteristics on the effectiveness of computerized decision support systems is studied, little is known about the relation between cognitive, organizational and environmental factors, and computerized decision support systems’ effectiveness.

What this study adds
- Computerized decision support can improve guideline implementation by increasing the knowledge of preferred practice, by reducing inertia to previous practice, and by reducing guideline complexity.
- Computerized decision support is not effective when organizational or procedural changes are required that users consider to be beyond their tasks and responsibilities. In that case other or additional guideline implementation instruments should be considered to empower CDSS users or involve the actual decision makers.

CONTRIBUTIONS

Rick Goud and Mariette van Engen-Verheul were the primary researchers of this study, supervised by Niels Peek, Nicolette de Keizer, Arie Hasman, Roland Bal and Irene Hellemans. All authors were involved in the conception and design of the study and the interpretation of the data. All authors contributed in the drafting of the manuscript, critically revised its content and approved its final version.

ACKNOWLEDGEMENTS

This project was funded by the Netherlands Organisation for Health Research and Development, Health Care Efficiency Research Programme 2004, subprogramme Implementation, under project no. 945-14-205.
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