

Persistent and changed barriers to guideline implementation after successful implementation of computerized decision support in outpatient cardiac rehabilitation: A qualitative study



“According to my new computerized diagnostic software, you need to upgrade your kidneys, defragment your liver, and make a back-up copy of your spleen.”

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Abstract

Computerized decision support systems (CDSSs) are found effective instruments for guideline implementation. In a recent study a CDSS for outpatient cardiac rehabilitation, CARDSS, has proven effective in improving guideline adherence of professionals. However, there still existed important undertreatment of patients and a large variation in procedures between outpatient clinics. This study aims to understand this by analyzing which types of barriers to guideline implementation were reduced by CARDSS and which persisted.

We conducted semi-structured interviews with professionals using CARDSS to qualitatively identify which barriers to implementation of several key recommendations of the national cardiac rehabilitation guidelines were and were not reduced by the CDSS. Twenty-nine professionals from twenty-one Dutch outpatient clinics were interviewed. From the transcribed interviews 129 actual remarks about persistent and changed barriers to guideline implementation after the introduction of the CDSS were analyzed by the research team. We found that internal, mostly cognitive, barriers to guideline implementation faced by cardiac rehabilitation professionals directly using the system were reduced. If the recommendations of the CDSS were shared with patients, patient refusal could also be reduced. External barriers related to organizational constraints and a lack of resources were never reduced by the CDSS. Although some cardiac rehabilitation professionals tried to deal with these external barriers by changing their internal working procedures, the CDSS did not incite anyone to put effort into actually overcoming these barriers.

Our results suggest that a CDSS introduced in an outpatient setting and providing guideline-based recommendations to non-physicians, does not overcome barriers for which its users find they exceed their internal or individual working procedures or responsibilities. For these barriers other or additional guideline implementation strategies should be considered. However if internal barriers to guideline implementation exist among users of the CDSS (professionals or patients), that are not related to environmental barriers, a CDSS can be an effective instrument for guideline implementation.

Samenvatting

Beslissingsondersteunende systemen (BOSsen) zijn effectieve instrumenten gebleken voor de implementatie van richtlijnen. In een recente studie met een BOS voor poliklinische hartrevalidatie, CARDSS, is aangetoond dat deze de richtlijnadherentie van professionals heeft verbeterd. Echter, er bestond nog steeds een aanzienlijke onderbehandeling van patiënten en een grote variatie in gehanteerde procedures tussen verschillende poliklinieken. Deze studie tracht dit te begrijpen door te analyseren welke soorten barrières tot richtlijnimplementatie zijn verminderd door CARDSS en welke niet. We hebben semi-gestructureerde interviews afgenomen met CARDSS gebruikers om kwalitatief te identificeren welke barrières tot implementatie van enkele belangrijke aanbevelingen van de landelijke richtlijnen hartrevalidatie wel of niet zijn verminderd door het BOS.

Negenentwintig professionals uit eenentwintig Nederlandse poliklinieken zijn geïnterviewd. Uit de getranscribeerde interviews zijn 129 aparte opmerkingen over gebleven en veranderde barrières tot richtlijnimplementatie na introductie van het BOS geanalyseerd door het onderzoeksteam. We hebben gevonden dat interne, voornamelijk cognitieve, barrières tot richtlijnimplementatie waarmee hartrevalidatieprofessionals die het BOS gebruikten te maken hadden, waren verminderd. Wanneer de aanbevelingen van het BOS ook met patiënten werden gedeeld, konden ook patiëntbarrières worden verminderd. Externe barrières buiten de polikliniek hartrevalidatie veroorzaakt door organisationele beperkingen of een gebrek aan faciliteiten waren nooit verminderd door het BOS. Hoewel sommige hartrevalidatieprofessionals probeerden deze externe barrières het hoofd te bieden door hun eigen hartrevalidatieprogramma te veranderen, heeft het BOS niemand er toe gezet om deze externe barrières echt te verhelpen.

Onze resultaten suggereren dat een BOS dat geïntroduceerd is in een poliklinische setting en richtlijngebaseerde aanbevelingen geeft aan niet-artsen, geen barrières verminderd waarvan gebruikers vinden dat het hun eigen werkzaamheden of verantwoordelijkheden overstijgt. Voor dergelijke barrières zouden andere richtlijn-implementatiestrategieën overwogen moeten worden. Echter als bij CDSS gebruikers (professionals of patiënten) interne barrières, niet veroorzaakt door een externe barrière, richtlijnimplementatie beperken dan kan een BOS een effectief instrument zijn voor richtlijnimplementatie.

1. Introduction

Although practice guidelines are designed to propagate best practices for specific healthcare conditions [1], adherence to guidelines in clinical practice has proven to be low [2]. Apparently, it is not sufficient to provide care professionals with paper guidelines to enforce the required change in practice. Physicians fail to adhere to guidelines due to internal barriers that effect their cognition on and/or attitude towards the guidelines and because of external barriers that are guideline, patient, or environment related [3]. For this reason, several authors have argued that for effective guideline implementation carefully designed implementation strategies need to address these barriers [4;5]. One such strategy that has been advocated in the literature is the deployment of a computerized decision support system (CDSS) that provides patient-specific recommendations to care professional based on the guideline's recommendations [4-7]. Evaluated CDSSs have often proven effective to improve guideline adherence, although different CDSSs in similar target groups and settings have shown different results [6]. CDSSs fail because they are poorly developed, insufficiently integrated into the existing workflow, or because guideline recommendations are ignored or overridden [8;9]. As it is still understudied which guideline implementation barriers CDSSs can actually address in which circumstances [10], the literature has called for further research on this topic [4].

Recently a cluster randomised trial was conducted in 31 Dutch outpatient clinics to investigate the effect of a CDSS on adherence to the national guidelines for cardiac rehabilitation (CR) [11]. CR is a multidisciplinary therapy that is provided to patients that have suffered a cardiac incident. The results of this trial, the CARDSS (CArdiac Rehabilitation Decision Support System) project, will be reported elsewhere [12], but the study showed that the CDSS increased guideline adherence to all four guideline-recommended CR programmes for which it was measured. However for two CR programmes guideline adherence was still low. Also centres still varied greatly in terms of case mix and working procedures [13]. The increased guideline adherence in the CARDSS project shows that the computerized decision support reduced some barriers to guideline implementation. However as guideline adherence was still low for some

recommended programmes and as a large variation between centres existed, some barriers still persisted.

To understand which barriers to guideline implementation were and were not addressed by the CARDSS CDSS qualitative research methods were used. During in-depth interviews with CR professionals using the CDSS we discussed adherence to several key recommendations of the national CR guidelines [11] concerning patient referral, patient needs assessment, and adherence to guideline-recommended therapies. We used the model of Cabana et al. [3] to classify the remarks on persistent and changed guideline implementation barriers. This framework is also used in various studies in different settings reporting on barriers to guideline implementation including [14-17]. The results from this qualitative study can provide better understanding on the circumstances in which a CDSS can be effectively used as an instrument for guideline implementation.

2. Background

2.1. Cardiac rehabilitation

CR is a multidisciplinary therapy for cardiac patients that is provided after cardiac events (e.g. myocardial infarctions) and cardiac interventions (e.g. heart surgery). It encompasses the whole range of activities to favourably influence the cause of disease, and above all to ensure that the patient is in the best possible physical, psychological and social position to return to and maintain her or his normal place in society [18]. Economic evaluations suggest that CR is a cost-effective intervention, as CR has a beneficial effect on medical consumption [19;20]. All cardiac patients can benefit from CR and should therefore be referred to the CR outpatient clinic to be considered for CR. Traditionally, CR consisted of exercise-based and educational therapies, but in the last decade more emphasis has been placed on psycho-social recovery, lifestyle change, and stress management of patients [21-24]. The Dutch CR guidelines [11], which were released in 2004, incorporate these recent notions on CR and may advise treatment programmes such as exercise, education, lifestyle change, and relaxation programmes. The guidelines are developed by the Netherlands Heart Foundation [25], a patients' organization, and the

Netherlands Society for Cardiology [26], a professionals' organization, in association with a large number of field experts.

The exercise programme aims at restoring and optimizing the patient's physical condition. In the education programme patients (and their partners) are informed on the consequences of the disease and (modifiable) risk factors for recurrence. Patients enrolled in the lifestyle change programme are encouraged to change illness-related hazardous behaviours and receive psychological and social counselling. Patients participating in the relaxation programme discuss the effects of stress and tension and learn exercises to reduce tension in daily life and lower their heart rate at rest. The guidelines advocate a multidisciplinary approach in which the rehabilitation programmes are tailored to meet patients' specific needs. To this end, the guideline describes a needs assessment procedure in which the patient's medical, physical, emotional, and social condition and risk behaviour should be assessed. CR professionals that conduct the CR needs assessment procedure are non-physicians, usually specialized nurses or physiotherapists.

2.2. The CARDSS project

In the CARDSS project a CDSS was developed [27] to assist CR professionals with the CR needs assessment procedure and provide them with guideline-recommended CR programmes for consideration. To assess the effect of the CARDSS CDSS on adherence of CR professionals to CR programmes recommended by the guidelines [11], a cluster randomized trial was conducted. To this end 31 outpatient clinics were randomized to either receive patient specific guideline-based recommendations (decision support) or not. After the trial all participants received the CDSS. During the trial all participating outpatient clinics registered all CR needs assessment related information electronically.

The effect of the CDSS was determined by comparing guideline adherence between both study arms. The actual results will be reported elsewhere [12], but the CDSS increased adherence to all four measured guideline-recommended CR programmes, the exercise, education, lifestyle change, and relaxation programme respectively. However undertreatment for both 'new' lifestyle change and relaxation programmes was still high.

Further analyses on the data from the CARDSS project showed that a large variation existed between outpatient clinics in the case mix and needs assessment procedures [13].

For example the percentage of women referred to the CR outpatient clinic varied from 11% to 38% (mean 26%), although the guideline states that CR is equally beneficial to men and women. Also a large variation existed in the reasons for referral to CR; in one centre 49% of the CR patients were referred to CR because of a PCI (percutaneous coronary intervention) while in another centre 0% of the patients seen at the outpatient clinic received such an intervention (mean 17%). The CR guidelines recommends using an objective exercise test to assess a patient's physical condition and a quality of life (QoL) questionnaire [28] to assess a patient's psycho-social condition at baseline. However, their use varied between centres from 0% to 100% (mean 40% and 70% respectively). Other variation existed in the screening of patients for lifestyle. According to the guidelines it should for example be determined whether the patient has unhealthy eating habits, for which criteria are presented in the guideline. The percentage of patients judged to have unhealthy eating habits by professionals, varied between centres from 3% to 79% (mean 28%), a variation that is unlikely to be based on case mix alone.

3. Methods

3.1. Study design

To understand which barriers to guideline implementation were and which were not affected by the CDSS for CR, in-depth, semi-structured interviews were conducted [29]. During the interviews three themes general to outpatient therapies that can face barriers to guideline implementation were discussed, namely patient referral, patient needs assessment, and adherence to guideline-recommended therapy. These themes were made explicit for CR by discussing adherence to several key recommendations from the national CR guidelines shown in Table 1. The key recommendations were selected because they showed large variation between outpatient clinics in the CARDSS trial. During the interview it was discussed what barriers to guideline implementation still persisted and which changed since the use of the CDSS.

Table 1. Themes discussed during interviews, in reference to key recommendations of the Dutch CR guidelines related to the needs assessment for CR.

Topic	Guideline recommendation
Patient referral	All patients with coronary heart disease and heart failure can benefit from CR, regardless of their age, gender, and intervention. Therefore all these patients should be referred to the CR outpatient clinic for a CR needs assessment procedure.
Patient needs assessment	For the CR needs assessment procedure two key recommendations are provided: 1) Proper assessment of the physical and psycho-social condition of CR patient requires the use of objective instruments such as a bicycle test or the Shuttle Walk Test, and a quality of life questionnaire for cardiac patients. 2) To reduce the individual chances on (new) cardiac incidents, the risk behaviour of each patient should be assessed. If needed patients should be supported to adopt a healthy lifestyle.
Guideline-recommended therapy	Following a patient's needs assessment procedure, the patient should be offered the CR that fits to his or her needs. Programmes that may be recommended by the CR guidelines are an exercise, education, lifestyle change, and relaxation programme.

Four months prior to the interviews all participants received an aggregated feedback report based on the data from the CARDSS trial. The feedback report was designed with the help of several domain experts. Each participating outpatient clinic received a centre specific report in which their data from the CARDSS trial was compared to the other outpatient clinics (peers). This 20 page report consisted of six sections (Table 2) in which also the themes described in Table 1 were addressed.

3.2. Participants

All outpatient clinics that had received a feedback report based on their data from the CARDSS trial were considered eligible to participate in the study. All these centres had worked with the CDSS for at least nine months before the start of our study. Outpatient clinics that had stopped working with CARDSS more than six months prior to the study were excluded to avoid a potential recollection bias.

Each CR outpatient clinic has one or more professionals who have a leading role in the CR needs assessment procedure. This is generally the CR coordinator (usually a specialized nurse or physiotherapist), sometimes assisted by one or more other CR team

members. In each eligible outpatient clinic these professionals were invited to participate in this study as they are most familiar with the organization of their CR needs assessment procedure and programmes.

Table 2. Overview of the sections of the feedback report provided to the CR outpatient clinics that had participated in the CARDSS trial.

Section	Description
Background	Description of the background and goal of the CARDSS trial and the feedback report.
Methods	Explanation of the methods and statistics used in the report. Some basic statistical concepts such as standard deviation and statistical significance were also explained.
Demographics *	Overview of the patient demographics of the outpatient clinic concerned as registered during the CARDSS trial. This included the number of patients seen at the CR outpatient clinic per month, and (the distribution of) the age, body mass index, and gender of the patients.
Indications for CR *	Overview of the interventions or diagnoses with which their patients were referred to the CR outpatient clinic.
CR needs assessment procedure *	Overview of two different aspects of the CR needs assessment procedure of patients; 1) the methods used to determine the patient's physical, psychological, and social condition, 2) The resulting assessed physical, psychological, and social condition and an unhealthy lifestyle of patients.
CR programmes offered to patients *	Overview of the number of patients that were offered an exercise, education, relaxation, and lifestyle change programme. Also the number of patients for which the guideline had recommended these programmes where shown including the times they did and did not adhere to guideline recommendations.

* These sections also showed aggregated information of the peer CR outpatient clinics.

3.3. Interviews

Prior to the study the research team developed a generic interview guide that contained questions on the selected themes and key recommendations that could probe for answers if the interviewee did not respond spontaneously [30]. The interview guide was finalized after a pilot interview in one outpatient clinic. As part of further preparation, the feedback report of each participating outpatient clinic was examined prior to the interviews to formulate several subquestions specific to that centre.

In-depth, semi-structured interviews with participants were conducted by one researcher (MV). She was accompanied by another researcher (RG or IH) during the first seven interviews, after which MV had become sufficiently acquainted with the field of CR to conduct the interviews individually. During the interviews the participants were asked on the local implementation of the key recommendations presented in Table 1, including the rationale for doing so. It was also discussed what did and what did not change since the use of the CDSS. Informed consent was obtained from all interviewees to audiotape the interview.

3.4. Analysis

All audiotaped interviews were transcribed verbatim for content analysis. The transcriptions were independently reviewed by two researchers (RG and MV). Both reviewers independently collected all remarks concerning perceived persistent or changed barriers to implementation of the discussed CR needs assessment topics after introduction of the CDSS. The collected remarks were assembled and compared. For all the extracted remarks that were not selected by both researchers individually, a third reviewer (NdK) adjudicated whether they were or weren't associated with a persistent or reduced barrier to guideline implementation. Three researchers (RG, NdK, NP) subsequently classified all remarks according to the different categories of barriers to guideline implementation described in the conceptual model by Cabana et al. [3]. According to this model physicians are confronted with both internal and external barriers that prevent optimal guideline adherence. Internal barriers influence the knowledge (cognition) about and attitude towards the guideline in question which affects their behaviour. The model identifies lack of familiarity (too unfamiliar with guideline content to apply it in practice) and lack of awareness of guideline existence as cognitive barriers. Next to cognitive barriers, the attitude of physicians towards the guideline is also influenced by a lack of

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agreement with the specific guideline in question or guidelines in general, a lack of outcome expectancy (sceptical towards whether the guideline will improve condition), a lack of self efficacy (lack of confidence in own ability to adhere to the guideline), and inertia of previous practice or a lack of motivation to change habits and routines. Finally external barriers that influence the behaviour of physicians towards guideline adherence are patient barriers (e.g., patient refusal), guideline factors (e.g., complexity), and environmental barriers (e.g., lack of resources, organization constraints).

4. Results

All interviews were conducted in February and March 2007. Of the 28 outpatient clinics that had received a feedback report, three were excluded because they stopped using CARDSS more than six months prior to the study. The CR coordinator(s) of the remaining 25 centres were invited to participate. Except for one CR coordinator who didn't respond to our e-mail and telephone calls, all invited CR coordinators agreed to take part in the study. However one scheduled interview was cancelled because the CR coordinator was ill, and with the CR coordinators in two other outpatient clinics it was not possible to plan an interview within the study period. Therefore 29 professionals from 21 outpatient clinics were initially interviewed. The characteristics of the outpatient clinics and interviewees are shown in Table 3. Interviews lasted between 30 and 60 minutes. As the later interviews did not lead to new insights, we decided that it was unnecessary to schedule interviews with the four remaining outpatient clinics [30]. As the first interview was conducted to finalize the interview guide, its results were not used for our final analysis.

We identified a total of 129 distinct remarks that could be categorized of which 103 concerned persistent barriers and 26 comments were related to reduced barriers to guideline implementation by the CDSS. The analysis of the results showed different combination of persistent and reduced barriers for the different themes. The results concerning the different themes are presented in the following sections. We sub-divide barriers that were mentioned occasionally (≤ 2 times), regularly (≥ 3 and ≤ 10 times), and frequently (≥ 10 times) by different interviewees. All types of barriers that were mentioned for the specific theme are presented in different tables inclusive of a

representative sample comment. Some of the reported internal barriers are actually associated with an external barrier. These associated external barriers are not presented in the tables but are described in each of the sections concerned.

Table 3. Characteristics of the centres and interviewees that have participated in the study.

Nr of centres visited	21
Type of centre	
Small outpatient clinic (< 20 ppm) *	6
Medium outpatient clinic (20-30 ppm) *	8
Large outpatient clinics (> 30 ppm) *	4
Rehabilitation clinic	2
University Medical Centre	1
Total number professionals interviewed	29
Gender	
Male	10
Female	19
Profession	
CR coordinator	20
Specialized nurse	5
Physiotherapist	3
Rehabilitation doctor	1

* Patients per month. Determined from the data used to generate the feedback reports.

4.1. Patient referral

Persistent barriers to the referral of all cardiac patients to the CR outpatient clinic are associated with a lack of outcome expectancy and patient factors but are mostly related to environmental factors (Table 4). Occasionally interviewees report a lack of outcome expectancy when they feel the patient is too old to participate in CR. A lack of motivation of patients towards CR in general is another reason that patients do not receive a CR needs assessment procedure. However interviewees frequently report that the main barriers to assess the needs of all cardiac patients at the CR outpatient clinics lay elsewhere. CR outpatient clinics rely on residents, cardiologists and nurses in the cardiology departments for the referral of patients. However this referral process is

usually the bottleneck (“*In January new residents started: A complete relapse of referrals*”). The professionals responsible for patient referral often have a lack of familiarity (“*Some cardiologists think their patients who receive outpatients’ treatment do not need CR, while the actually do.*”) and a lack of agreement with the guidelines (“*...the one cardiologist sends in all his patients, while the other with a different opinion about CR only those patients with certain diagnosis*”). As the CDSS is only implemented at the CR outpatient clinic and is therefore unable to directly target the cognition and attitude of those professionals, we consider these barriers external barriers related to organizational constraints. However the cognition and attitude of these ‘external’ professionals is also not indirectly influenced, although all participating outpatient clinics, except the two rehabilitation centres, are located in a hospital. Some CR coordinators report that they partly overcome this ‘external barrier’ to patient referral to CR by making a daily round on the cardiology department to recruit patients themselves, although this provides no solution to the poor referral of patients that receive outpatients’ treatment.

Interviewees did not report that the referral of patients to the CR outpatient clinic actually improved because of the CDSS. One CR coordinator did state that she had now become more aware of the importance of CR for heart failure patients, but she could not tell whether that was actually caused by the CDSS or not.

Table 4. Types of persistent barriers to the referral of all cardiac patients to the CR outpatient clinic with sample comments

Persistent barrier	Sample comments
Internal barriers	
<i>Lack of outcome expectancy</i>	<i>“85 year old patients are not going to follow CR after all.”</i>
External barriers	
Patient factors	“Some patients already say in advance that they don’t need CR.”
Environmental factors	
Organizational constraints	“We have a great problem with the referral of patients to the CR outpatient clinic due to the changing of residents...Residents often think they only need to refer patients with a myocardial infarction.”

Barriers shown in italics, normal font, and bold font were respectively reported occasionally (≤ 2 times), regularly (≥ 3 and ≤ 10 times), and frequently (≥ 10 times) by different interviewees.

4.2. Patient needs assessment

For the adherence to guideline recommendations concerning the CR needs assessment procedure we identified both different persistent barriers (Table 5) and barriers that were reduced by the introduction of the CDSS (Table 6). The CDSS improved the use of objective instruments and healthy lifestyle assessment, but only if adherence to these procedures was hampered by the cognition or attitude of the CR professionals using the CDSS or the guideline's ease of use. The CDSS does not seem to overcome barriers to guideline implementation for which procedures outside the CR outpatient clinic should be changed or additional resources are required. Because there is a great difference in patterns of persistent and changed barriers between the use of objective instruments during the CR needs assessment procedure and the assessment of risk behaviour, they are separately discussed in the following sections.

Table 5. Types of persistent barriers to performing the CR needs assessment procedure according to guideline recommendations with sample comments

Barrier	Sample comments
Internal barriers	
Lack of Agreement	“The guidelines [for healthy eating habits] are too strict. I don't think that if people don't like fish, they are automatically unhealthy eaters.”
Lack of outcome expectancy	“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].”
Inertia to previous practice	“At the CR needs assessment we judge the exercise capacity of patients by clinical experience. The bicycle test is performed at the exercise programme...”
External barriers	
Patient factors	“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 deep... 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.”
Guideline factors	“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.”

Environmental factors

Lack of resources / time “An exercise test is always performed for patients that suffered a myocardial infarction at the end of the hospitalization. But that isn’t a standard for all cardiac patients...because our capacity is just not sufficient.”

Organizational constraints “...*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 yet have his report finished. However some patients know what their own results were.*”

Barriers shown in italics, normal font, and bold font were respectively reported occasionally (≤ 2 times), regularly (≥ 3 and ≤ 10 times), and frequently (≥ 10 times) by different interviewees.

4.2.1 Use of recommended objective instruments

Persistent barriers to use objective instruments to assess the physical and psycho-social condition of the patient include inertia to previous practice and external barriers related to guideline factors and environmental factors. The use of an objective exercise test frequently faces barriers in outpatient clinics. Several interviewees report that all patients do perform a bicycle test, but it is still conducted after the needs assessment procedure. As the guideline also allows to assess the physical condition of patients by clinical experience, although only if performing an exercise test is not possible, they haven’t put effort into changing the current working procedures. Interviewees also report a lack of resources and organizational constraints as barriers that prevent the use of an exercise test during the needs assessment procedure. However none of them reported that they have tried to obtain the necessary resources.

Interviewees did report that the CDSS reduced barriers to guideline implementation related to the use of objective instruments associated with a lack of familiarity and inertia to previous practice. Interviewees occasionally remark that they started to use and exercise tests with patients since the introduction of the CDSS (“*We didn’t use the Shuttle Walk Test before CARDSS. We now do it before [the needs assessment procedure] and afterwards [after the CR programme]*”). Interviewees frequently report that the CDSS reduced different barriers to using the QoL questionnaire as visible in Table 6. Most CR outpatient clinics didn’t use the QoL questionnaire prior to the introduction of CARDSS because they found it too laborious to calculate and interpret its

results, but mostly because they weren't familiar with the instrument. Since the use of the CDSS they integrated the QoL questionnaire into their existing needs assessment procedure (*"I now standard use the QoL questionnaire for every patient. Before CARDSS it [psychological and social condition] was purely determined by personal judgment. That has changed a lot."*).

Table 6. Types of changed barriers to performing the CR needs assessment procedure according to guideline recommendations with sample comments.

Reduced barrier	Sample comments
Internal barriers	
Lack of familiarity	"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'."
Inertia to previous practice	"Before CARDSS we hardly paid any attention to it [assessment of eating habits], but now we do, because we are automatically prompted for it."

Barriers shown in italics, normal font, and bold font were respectively reported occasionally (≤ 2 times), regularly (≥ 3 and ≤ 10 times), and frequently (≥ 10 times) by different interviewees.

4.2.2. Assessment of healthy lifestyle

Proper assessment of healthy lifestyle is hampered by internal barriers related to a lack of outcome expectancy and inertia to previous practice and by external barriers related to patient factors and guideline factors. However the internal barriers reported are usually actually also caused by patient factors and guideline factors. Interviewees regularly report that the criteria for a healthy lifestyle presented in the guideline are too stringent (*"We still use the BMI as a guideline. 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 know nobody who actually complies to that."*) and too shallow. Many patients know what the norms for healthy eating habits are and claim that they do follow them. Interviewees state that they often don't believe these claims, however the guideline presents no (objective) instruments for further assessment. This makes that an extensive assessment of the patients eating habits is not high on the priority list during the CR needs assessment. Because of these barriers, the assessment of healthy lifestyle is handled differently by different CR outpatient clinics; some use the BMI as a guideline, some just

simply ask their patients whether he or she has unhealthy eating habits and fill in their answers, while others really try assess the patients' lifestyle by self-developed methods. The use of these different methods leads to different outcomes and therefore explains the large variation between lifestyle assessments in CR outpatient clinics observed in the CARDSS trial. Interviewees state that they would like to put more effort in the assessment of unhealthy lifestyle, but that the guideline should provide more elaborate and more realistic measurements.

Interviewees do report that, although not optimally, the CDSS has improved the assessment of healthy lifestyle by reducing barriers related to lack of familiarity and inertia of previous practice. CR professionals using the CDSS are required to indicate whether the patient has an unhealthy lifestyle or not. This raised the recognition that more attention should be paid to the assessment of the patient's lifestyle (*"Since we are using CARDSS we focus more on all these questions [on a healthy lifestyle]"*).

4.3. Adherence to guideline-recommended therapy

Most persistent barriers to guideline implementation were identified for adherence to guideline-recommended therapies. These barriers are associated with a lack of agreement, inertia to previous practice, and external barriers related to patient factors and environmental factors (Table 7). Some interviewees report that in their opinion the relaxation programme and lifestyle change programme is recommended too often for patients and they are therefore regularly non-adherent to guideline recommendations. Inertia to previous practice is a barrier that was identified regularly in CR outpatient clinics, but was usually caused by the fact that there was not yet a lifestyle change or relaxation programme. However the CDSS does not seem to have incited CR professionals to put effort into setting up these programmes although CR professionals are confronted daily with the guideline recommendations (*"We are unable to start it [a lifestyle change programme]. We don't have the time for that. But it is also a matter of how to what extent you want to adhere to the guidelines. I am convinced that patients benefit a lot from the way we offer CR now"*). Only some hospitals started to offer relaxation therapy to patients because of the CDSS, but usually supervised by the CR

physiotherapist coupled to the exercise (or lifestyle change) programme and not as a separate programme as recommended by the guideline.

Some CR outpatient clinics face organizational constraints to improve the quality of their CR programmes usually due to a lack of accommodation (*“The fact that it [exercise programme] is currently full, is 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.”*) or a lack of priority of the management (*“We have requested the insurance company for permission to start a lifestyle change outpatient clinic and we hope they will approve it. The board of directors will then decide whether it will be actually carried out. If it is going to cost them any money they will certainly not agree.”*). CR outpatient clinics who do have the facilities to offer a lifestyle change programme frequently report that patient refusal is the main reason for non-adherence to guideline recommendations. A lifestyle change programme is usually conducted by a psychologist and social worker. However patients that are considered eligible to participate in this programme according to the guidelines based on their psycho-social condition are often not receptive to participate in this programme (*“Patients often have a lot of resistance towards it [lifestyle change programme]...They say ‘I will not see a psychologist because there is nothing wrong with me’.”*).

Table 7. Types of persistent barriers to adherence to guideline-recommended therapy with sample comments.

Barrier	Sample comment
Internal barriers	
Lack of agreement	“That relaxation programme is always recommended [by the guideline]. If the exercise programme is recommended, then the relaxation programme is also recommended.”
Inertia to previous practice	“We don’t have a lifestyle change programme. We have not thought about it yet. I think that is just because of a lack of time.”
External barriers	
Patient factors	“The biggest problem with the lifestyle change programme is the resistance of patients. They often say ‘I don’t need that’ or ‘ridiculous’.”
Environmental factors	
Lack of resources /	“We would like to extend our lifestyle change programme. But that is

time	currently not possible due to organizational problems and lack of time.”
Organizational constraints	“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.”

Barriers shown in italics, normal font, and bold font were respectively reported occasionally (≤ 2 times), regularly (≥ 3 and ≤ 10 times), and frequently (≥ 10 times) by different interviewees.

Some barriers to adherence to guideline recommended therapy associated with inertia to previous practice and patient factors were reduced by the CDSS (Table 8). Some respondents state that they changed their CR programme because the CDSS provided them with more insight in and made them more aware of their working procedures (“*With the help of CARDSS we didn’t just change our needs assessment procedure, but we now also focus more on the personal goals [for CR] of the patient*”). Although several interviewees report that they changed the organization of their CR programmes since the use of the CDSS, most find it hard to say whether that was actually attributable to the CDSS (“*Whether is was because of CARDSS I don’t know, but we came to realize that is was important to have it [a relaxation programme]*”). However a clear change that was reported was the following. Several CR outpatient clinics confront the patient with the recommendations provided by the CDSS during the needs assessment. Interviewees who use the CDSS this way report that patients are more willing to participate in the lifestyle change programme as they see that 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 programme, I will do so’.*”). Patients seemed to be more receptive to national guideline recommendation than to the opinion of a CR professional.

Table 8. Types of changed barriers to adherence to guideline-recommended therapy with sample comments.

Barrier	Sample comment
Internal barriers	
<i>Lack of familiarity</i>	<i>“We have become more aware of its [relaxation programme] importance. That is why we incorporated it in our exercise programme.”</i>
Inertia to previous practice	“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.”
External barriers	

Patient factors	“At first there were only few patients who wanted to participate in the lifestyle change programme. 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’.”
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Barriers shown in italics, normal font, and bold font were respectively reported occasionally (≤ 2 times), regularly (≥ 3 and ≤ 10 times), and frequently (≥ 10 times) by different interviewees.

5. Discussion

In this study we have qualitatively identified barriers to guideline implementation that were and were not reduced by a successfully introduced CDSS in Dutch CR outpatient clinics. We found that internal barriers faced by professionals directly using the system were reduced, and also patient related barriers were occasionally diminished by the CDSS. External barriers related to organizational constraints and a lack of resources were never reduced by the CDSS; it did not incite its direct users to put effort into overcoming barriers for which professionals feel they exceed their internal or individual routines or responsibilities.

It is emphasized in literature that overcoming different types of barriers to guideline implementation requires different strategies [5]. Although different interventions have shown to improve guideline implementation, it is still unclear which barriers they can reduce in which settings [31]. The literature has called for further research on this topic [4]. CDSSs are considered one of the most effective instruments to improve guideline implementation [32]. However we found no studies that tried to identify which types of barriers to guideline implementation can actually be reduced by a CDSS. In our study we found that the CDSS was able to reduce different types of barriers, predominantly if adherence to these procedures was hampered by the cognition or attitude of the CR professionals directly using the CDSS or the guideline's ease of use. Inertia to previous practice that required changing working procedures which involved 'external' professionals or departments did however not change if the CDSS users felt that existing procedures were satisfactory, although not optimal. The CDSS could not overcome barriers to guideline implementation for which procedures outside the CR outpatient clinic should be changed or additional resources are required.

Although the CDSS confronts its users daily with guideline recommendations, this apparently does not incite its users to put effort into realizing changes that exceed their own working procedures. For example several interviewees report to have introduced the QoL questionnaire in their needs assessment procedure since using the CDSS; they just replaced their own psycho-social questions with the QoL questionnaire. However no interviewee reported to have started using the results of a bicycle test which, in some CR outpatient clinics, would 'only' require reversing the order of the needs assessment procedure and bicycle test of the patient. This phenomenon that the barriers faced by the front-line, non-physician, hospital workers do not reach managers and decision makers was also described by Tucker and Edmondson [33].

The CDSS did help to overcome external barriers related to patient refusal; interviewees who confront patients with CDSS recommendations, and thus actually make patients CDSS users, report an increased receptiveness towards participation in psycho-social programmes. Sharing CDSS recommendations with patients increases their feeling of autonomy and control over their disease management which improves their motivation [34]. This finding is in line with the recommendation of Kawamoto et al [7] that sharing decision support results with patient can improve the effectiveness of CDSSs.

In this study we decided to categorize all barriers that were not located at the CR outpatient clinic as external barriers. One could however argue that some could also be categorized as internal barriers as they are caused by other professionals inside the hospital in which most CR outpatient clinics are located. However as the CDSS could not directly influence these barriers as it was only used at the CR outpatient clinic, we considered them external barriers related to organization constraints.

The use of qualitative methods has the disadvantage that, unlike quantitative methods, it can not measure the effect of an intervention as no numerical data can be statistically analyzed. However a qualitative approach is the best method to understanding why and how interventions effect the behaviour and actions of healthcare professionals [30;35]. Therefore the literature has called for a better integration of both qualitative and quantitative research methods for the evaluation of medical information technology [36-38].

Our study design could have introduced bias to our results. We only interviewed professionals that participated in the CARDSS trial about their perceived change in barriers to guideline implementation since the introduction of the CDSS. The vision and remarks of the interviewees could have been socially desirable or prone to a recollection bias. The relatively large number of participants and the fact that we designed a feedback report specific to each hospital reduced the chances on these biases. However we do think that a recollection bias caused underreporting of reduced barriers to guideline adherence, as our findings can not explain the significant increased adherence to the exercise and educational programme found in the CARDSS study. Several interviewees explicitly state that they find it difficult to say whether the CDSS changed their cognition and attitude towards the national CR guidelines. Although in most studies assessing barriers to guideline implementation internal barriers form an important reason for non-adherence of professionals [3], in our study only few persistent internal barriers were identified. It might have been the case that interviewees disremember their cognition about and attitude towards the guideline prior the implementation of the CDSS and therefore underreported reduced internal barriers to guideline implementation. Although a study design with a control group of non-CDSS users would have been methodologically more sound, we decided not to do so as no electronic information of these CR outpatient clinics was available to confirm their claims. Triangulation in such a study design would have required far more resources.

Our results suggest that a CDSS such as CARDSS which actively provides guideline-based recommendations to non-physicians in an outpatient setting does not automatically overcome environmental and guideline related barriers to guideline implementation. Such a CDSS does not seem to incite its users to put effort into realizing changes for which they find it exceeds their internal or individual working procedures or responsibilities. Therefore, other or additional guideline implementation strategies should be considered to overcome these environmental barriers, possibly audit and feedback [4;5]. If internal barriers to guideline implementation exist among potential users of the CDSS (professionals or patients) then we recommend policy makers and guideline implementers to consider the use of a CDSS as an implementation strategy. However it must be

recognized that for the CDSS to be effective it must first be adopted by its users, which has proven to be quite a challenge by itself [36;38].

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