Building an infrastructure to improve cardiac rehabilitation: from guidelines to audit and feedback
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A WEB-BASED SYSTEM TO FACILITATE LOCAL, SYSTEMATIC QUALITY IMPROVEMENT BY MULTIDISCIPLINARY CARE TEAMS: DEVELOPMENT AND FIRST EXPERIENCES OF CARDSS ONLINE

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Continuous monitoring and systematic improvement of quality have become increasingly common in healthcare. To support multidisciplinary care teams in improving their clinical performance using feedback on quality indicators, we developed the CARDSS Online system. This system supports (i) monitoring of indicator-based performance, (ii) selecting aspects of care that need improvement, (iii) developing a quality improvement (QI) plan, and (iv) periodically adjusting the QI plan. During educational outreach visits, the system actively involves the team in the improvement effort, and guides them through the process of systematic QI without needing extensive knowledge of the underlying concepts. During the implementation of the system in the field of cardiac rehabilitation (CR) in the Netherlands, we have conducted the first outreach visits to four CR teams. During the visits, the teams formulated QI plans consisting of 4 to 7 improvement goals, each goal accompanied by 1 to 5 QI actions. Currently, we are evaluating the effect of CARDSS Online on the quality of CR in the Netherlands in a cluster randomized trial.

Key words: Quality improvement; Quality indicators; Healthcare; Cardiac rehabilitation; Guideline adherence.
INTRODUCTION

There is persistent room for improvement in health care, but the complexity of healthcare systems makes it difficult to achieve change. A common approach to changing complex systems is systematic quality improvement (QI), which focuses on improving a system’s underlying processes rather than on correcting mistakes of individuals. It relies on data from healthcare professionals’ own setting and encourages working in multidisciplinary QI teams. The teams’ performance should guide them in improving their practice by the Plan-Do-Study-Act (PDSA) cycle, a part of the Model for Improvement [1]. However, clinicians may not be familiar with the fundamental concepts of systematic QI [2], and it is often difficult to actively involve them in activities other than patient care. This makes undertaking successful local QI initiatives a challenging endeavor.

The Model for Improvement consists of two parts: (i) three fundamental questions, which can be addressed in any order (‘What are we trying to accomplish’, ‘How will we know that a change is an improvement’ and ‘What changes can we make that will result in improvement’), and (ii) the PDSA cycle to test and adjust changes in real work settings [1]. The model is not meant to replace change models that organizations may already be using, but rather to accelerate improvement [1].

Performance feedback is a crucial element within the Plan and the Study step in the PDSA cycle. A recent Cochrane review concluded that such feedback may be more effective when it includes both an action plan and explicit goals [3]. This matches goal-setting theory, which states that feedback and goals are indeed a successful combination, especially when the goals are well-specified [4]. The theory also suggests that people tend to be more committed to attaining a certain goal if they are involved in setting it. Goal commitment further increases if (the outcome of) goal attainment is seen as important, and if people believe they are capable of accomplishing it. An electronic system that would incorporate knowledge on goal setting as well as the principles of systematic QI to reach these goals might be an effective way of involving and guiding clinicians in improving their practice.

In the scientific literature, few systems have been described that support the process of systematic QI or its constituents. Some systems have been developed to provide structured performance feedback [5,6]. However, these systems do not support application of systematic QI principles and effective goal-setting. In the Cochrane review on audit and feedback, only one of the included studies described integration of feedback and goal-setting, but software tools were lacking [7]. Although commercial software often offers the functionality to extract management information from electronic patient records (EPRs), to our knowledge, these systems do not support systematic QI or performance benchmarking.

This paper describes the development and first experiences of CARDSS Online, a system that facilitates local, systematic QI by actively involving multidisciplinary care teams in the entire PDSA cycle and goal setting process. Currently, the system is being implemented in the field of cardiac rehabilitation (CR) in the Netherlands.
METHODS

Clinical context
CR is a therapy provided by multidisciplinary care teams to support heart patients recover from a cardiac incident or intervention, and aims to improve their physical and psychological condition [8]. A recent meta-analysis of RCTs shows consistent evidence of the effectiveness of exercise-based and multimodal (e.g. psychosocial and stress management) CR interventions with regard to mortality and cardiac events (relative-risk reduction: 21-47%) [9]. It has proven to be cost-effective in different economic evaluations conducted in North America and Europe [10]. However, in many Western countries, cardiac rehabilitation services are under-utilized, poorly standardized, and do not follow the available scientific evidence [11]. Also, in the Netherlands, CR uptake is low [12].

Consistent with international standards, the Dutch Guidelines for CR [13] state that professionals should conduct a needs assessment procedure where 80 to 130 data items concerning the patient’s medical, physical, psychological, and social condition and lifestyle are gathered. Based on the needs assessment procedure, an individualized rehabilitation programme should be offered which consists of nineteen possible goals (e.g. ‘Optimize exercise capacity’ or ‘Regain emotional balance’) and four possible therapies: exercise training, education and counseling, lifestyle change therapy, and relaxation and stress management training.

In the Netherlands, two EPR systems for CR clinics exist (MediScore CARDSS® and CR Module CS-EZIS.Net®). Both systems are based on the Dutch guidelines for CR and strictly follow the same data model. In addition, both systems contain computerized decision support functionalities which were previously shown to improve guideline concordance [14]. Currently, twelve CR clinics (about 13% of all CR clinics in the Netherlands) work with one of these systems.

Quality indicators
A set of 18 quality indicators for the field of CR was developed using a modified RAND method [15]. This method combines results from a literature search and guideline review with the knowledge of CR experts and patients in an extensive rating and consensus procedure. From these 18 quality indicators, five indicators address structures (e.g., presence of preconditions to be adherent to CR guidelines), eight indicators address processes (e.g., frequency with which clinical measurement instruments are employed), and five indicators pertain to outcomes of CR (e.g., changes in patient health status after rehabilitation). All quality indicators can be derived from the data that is collected with the two EPR systems mentioned above. Both systems possess functionalities to extract the relevant data from the clinic’s database. Extracted data collections consist of (i) patient identification and hospitalization data (31 items), (ii) CR needs assessment data (80-130 items), (iii) data on selected rehabilitation goals and therapies (79 items), and (iv) CR evaluation data containing results on selected goals and therapies (105 items).
System requirements
The goal of the CARDSS Online system is to actively involve and support multidisciplinary CR teams in improving their clinic’s performance. It should guide them through the process of systematic QI without needing extensive knowledge of the underlying concepts. We designed the system to be primarily employed during educational outreach visits and based on measured quality in terms of the 18 indicators. During these visits, at least two members of the local multidisciplinary CR team, their manager, and the responsible cardiologist are present, jointly acting as the clinic’s QI team. All team members have a login code to access the system, but during visits one of them operates as chairperson, navigating through the system, while the others watch a projection of the screen on a beamer.

The QI team has four main tasks: (i) monitoring their clinic’s performance as defined by the CR quality indicator set, (ii) selecting aspects of care that need improvement, (iii) developing a QI plan, consisting of feasible improvement goals and associated actions, and (iv) monitoring the progress on the QI plan and adjusting it accordingly. Based on the Model for Improvement (which is one approach to systematic QI) [1], goal setting theory [4], and knowledge from previous studies on performance feedback [3,16,17], we defined system requirements that are associated with these four QI tasks.

Monitoring of indicator-based performance – Data on performance play a pivotal role within the Model for Improvement. First of all, they help answering one of the three questions to be asked before entering the PDSA cycle: ‘How will we know that a change is an improvement?’ Secondly, when entering the cycle, performance feedback provides the basis for the Plan and the Study phase [1], where feedback is a summary of clinical performance over a specific period of time [3]. Generating feedback on the 18 quality indicators is, therefore, an apparent system functionality. In the Plan phase, the QI team can use this feedback as the starting point for determining which indicators (i.e., aspects of their practice) warrant an improvement effort. Also, by revealing the (lack of) progress in relation to improvement goals in the Study phase, the feedback may be a moderator of effective goal setting [4].

Selecting aspects of care that need improving – The feedback should facilitate the QI team’s decision on which aspects of care warrant starting a QI initiative. Therefore, the team needs a comparison of their local performance to an explicit standard of excellence (‘benchmark’) [3,4], which is typically based on predefined targets or observed performance in practice. Although a standard of excellence may guide the QI team in selecting the ‘right’ aspects to improve, it does not guarantee that they are dedicated to make the actual effort in matching the benchmarks. To increase the team’s commitment, the system should enable them to select those aspects of their practice that they perceive as important and feasible to improve within their local context [4].
Developing the QI plan – For each selected indicator, the QI team needs to answer the second question from the Model for Improvement; ‘What are we trying to accomplish?’ refers to formulating improvement goals. Locke and Latham suggested that goals should be well-specified to increase the effectiveness of goal setting [4]. For example, goals should be time-specific, measurable, and include information on who is primarily responsible for accomplishing it [1]. To ensure commitment to goal attainment, the QI team should have the opportunity to be involved in the goal setting process [4]. Per goal, answering the third Model for Improvement question – ‘What changes can we make that will result in an improvement’ – results in a set of concrete QI actions. Identifying reasons for underperformance as well as suggestions for (proven) improvement strategies may help teams to define effective actions [1].

The set of all goals and associated actions together form the QI team’s action plan. Ivers and colleagues suggested that such an action plan is formulated in order to increase the impact of performance feedback [3].

Adjusting the QI plan – With their QI plan at hand, the team enters the Do phase of the PDSA cycle to execute the actions in the daily practice of their clinic. In the Study phase, the performance feedback will reveal if this has actually resulted in attaining the improvement goal or not [1]. Based on this knowledge, the team needs to decide if any new actions should be added to the plan, and if the existing ones are either completed or should be continued or cancelled.

RESULTS

System architecture
CARDSS Online was designed as a web-based application which can be consulted by CR clinics. At the server side, CARDSS Online consists of a Microsoft SQL Server database and a Java web application running on Apache Tomcat for generating the graphical user interface in HTML. The Java application consults and performs calculations on the database by calling stored SQL procedures. At the client side, clinics can use any browser that is capable of rendering HTML and executing JavaScript.

The system architecture is shown in Figure 1. CARDSS Online consists of five components: (i) a data upload tool, (ii) a data validation and import tool, (iii) a relational database containing all imported data, derived values for quality indicators, and QI plans, (iv) a feedback report tool, and (v) a QI plan tool.
System description

After login into CARDSS Online, users can choose between four principal functionalities of the system: uploading datasets that were extracted from their EPR system; receiving feedback on quality indicators; generating and updating QI plans; and entering information about their local QI team.

Upload – The data upload tool allows the QI team to upload datasets that are extracted from their local EPR database to CARDSS Online. The data format is generic (e.g. a CSV file). These datasets are subsequently checked for validity and imported to the CARDSS Online database.

Feedback – Figure 2 shows a screenshot from the feedback report page in CARDSS Online. Performance results on structure indicators are always ‘yes’ or ‘no’ values. Results on process and outcome indicators are typically means and percentages. After clicking on an indicator, a pop-up screen opens with detailed information about data underlying the calculation, national averages for comparison, and benchmark values.

To assist the QI teams with selecting the indicators that require improvement, a colored icon next to each indicator score indicates whether the performance is acceptable (green checkmark), borderline (orange checkmark), or poor (red exclamation mark). Threshold values for these interpretations are determined with the achievable benchmarks of care (ABC) method [16]. ABCs are calculated from the performance of all members in a peer group. In essence, the achievable benchmark represents the average performance for the top 10% of clinics being assessed. Adjustments are made to account for differences in the numbers of patients per clinic and also to allow the inclusion of clinics with small numbers of eligible patients without unduly distorting the overall performance assessment [16]. Guided by the colored icons users can make a pre-selection of quality indicators they would like to take into account for improving their performance. Each of the pre-selected indicators is subsequently rated by the entire team on importance (5 categories), feasibility (5 categories) and expected time needed for improvement (3 categories). CARDSS Online then orders the indicators based on assigned ratings, and the
team can select indicators for inclusion in the QI plan. The number of indicators to be selected for the final plan is unlimited, but during the outreach, visiting teams are encouraged to focus on a small number instead of trying to improve all at once.

![Screenshot CARDSS Online (feedback report)](image)

**Figure 2** – Screenshot CARDSS Online (feedback report)

**QI plan** – Per quality indicator included in the improvement plan, users can specify in free text the problem, presumed causes, improvement goal, and concrete actions on how to reach that. The system does not provide tools, other than documentation, for systematic problem analysis or suggestions for improvement actions. For each action, the names of responsible team members and a deadline have to be entered.

During, but also in between, follow-up outreach visits, the team can access the system to revise the existing QI plan based on new results on the quality indicators. For each action, users can enter if it was completed, cancelled, or should be continued. Actions marked as ‘to be continued’ are automatically transferred to the revised QI plan belonging to the new cycle.

**First experiences**
Currently, seven CR clinics have uploaded patient data that was extracted from their local EPR database to CARDSS Online. Overall, data from 1130 patients was uploaded, representing a mean of 161.4 (range 64 to 442) patients per clinic. Below, we describe our experiences with CARDSS Online during the first four educational outreach visits to discuss the indicator-based feedback and develop QI plans.
The local QI teams consisted of 5 professionals on average. All teams included a nurse, a physiotherapist, a cardiologist and a manager (one manager and cardiologist were unable to attend the meeting). Three teams had a caregiver from an additional discipline (sport physician, psychologist or social worker). The duration of the visits was between two and three hours. Besides structuring the discussion on measured performance and the action plan, the investigator instructed the team on how to use the system. Since we expect no further instruction to be required, subsequent visits will probably take less time.

**Feedback** – The feedback reports gave rise to substantial discussions about local performance within the QI teams. Often, there was a tension between a wish to improve (e.g. ‘We should improve the content of our lifestyle change therapy to better adapt it towards patients’ needs and wishes’) and various barriers at the organisational level (e.g. ‘Our psychologist is too busy and we need to cut back on our expenses’).

The colored icons focused the discussion on aspects of care where performance was below accepted levels (e.g. ‘The red checkmark indicates that the percentage of patients finishing their lifestyle change therapy is too low’). The comparison with national averages and benchmark values was often especially convincing to managers and cardiologists with respect to the need to start improvement actions (e.g. ‘On a national level, 85% of the patients finish their lifestyle change therapy, in our clinic, only 54%’). In the fervour of the discussion, the mean number of indicators pre-selected for possible QI was 6 (range 5 to 8). The rating of the pre-selected indicators on importance, feasibility and time-frame, forced the QI team to discuss their performance more rationally and to make choices for the final selection. During the rating, there was often already a whole range of potentially important and feasible improvement actions passed in review (e.g. ‘Perhaps we can ask the social worker to improve our lifestyle therapy’).

The mean number of selected indicators for inclusion in the final QI plan was 5 (range 4 to 7). The indicator ‘Percentage of patients with an evaluation of the rehabilitation goals afterwards’ was selected by all four clinics for their QI plan, and ‘The average time between hospital discharge and start of rehabilitation’ by three clinics. Furthermore, most indicators selected were process indicators (3 to 6), instead of structure or outcome indicators (either none or only one).

**QI plan** – After the preceding discussion, the QI teams were encouraged to actually formulate and enter problems, presumed causes, improvement goals and actions into the system. During this step, the system stimulated them to make the goals measurable (e.g. ‘We aim to improve the percentage of patients finishing their lifestyle program from 54% towards 70% within half a year’). The breaking down of a goal into multiple actions made it manageable for the team (e.g. ‘(i) Checking which patients abandoning their lifestyle change therapy and why; (ii) Organizing a brainstorm with the social worker and nurse to discuss new content for the therapy; etc.’). The mean number of actions per QI goal was 2 (range 1 to 5). Entering one or more responsible team members and a deadline into the system made the action real for the QI team (e.g., the social worker and nurse noted the planned date for the brainstorm in their
personal agendas). At the end of the meeting, all four QI teams were enthusiastic about the outreach visits and using CARDSS Online. One cardiologist stated that ‘We have many ideas for QI, but often they stay fuzzy. The meeting and the system were very helpful to capture our ideas, talk about them and crystallize them into a plan to operationalize.’

DISCUSSION

In the current study, we developed CARDSS Online, a system to support local, systematic QI in multidisciplinary care teams, and presented the first experiences during the implementation in the field of CR in the Netherlands. CARDSS Online is based on the principles of systematic QI including the Model for Improvement with the PDSA cycle [1] and results from literature that underline the importance of a QI action plan with concrete, self-formulated goals rated as important and feasible[3,4]. CARDSS Online distinguishes itself from existing QI interventions by actively involving multidisciplinary care teams in using indicator-based feedback to improve their clinic’s performance, without needing extensive knowledge of underlying QI concepts. The system can easily be used in other healthcare domains by replacing the underlying database and adapting the SQL procedures.

Previous research in the field of CR showed that computerized decision support can improve guideline concordance of multidisciplinary teams’ decisions [14]. However, to address barriers for guideline concordance at management and organizational levels, additional interventions are required [18]. For this reason we introduced the CARDSS Online system, accompanied with quarterly outreach visits to local QI teams, to specifically involve the management and organizational level in the QI process [19].

Our study has some limitations. A prerequisite for working with CARDSS Online is the electronic availability of patient data. The current CR clinics that work with an EPR for CR should probably be classified as innovators [20] and are therefore not a representative sample of all Dutch CR clinics. However, during regular contacts with the field, we have noticed a growing interest and we expect to include another 10 CR clinics within the next few months. A second limitation is that we can currently only report on the experiences with CARDSS Online during the first four outreach visits to CR clinics. Broader implementation of the system is needed to assess actual benefits (quality improvement) and costs (time needed for developing and performing QI actions) of CARDSS Online.

Currently, we are performing a cluster randomized trial to assess the effectiveness of CARDSS Online accompanied by quarterly educational outreach visits on the quality of care (guideline concordance and performance on quality indicators) in the field of CR in the Netherlands. A qualitative process evaluation will be used to gain insights into actual exposure and barriers and success factors of CARDSS Online as experienced by participating clinics.
CONCLUSION

A web-based system to facilitate local, systematic QI by multidisciplinary care teams, called CARDSS Online, was developed. The system supports active involvement in the entire Plan-Do-Study-Act cycle and goal setting process by guiding its users during (i) monitoring of indicators-based performance (including a visual comparison to benchmark values), (ii) selecting indicators for QI that are locally perceived as important and feasible, (iii) developing a QI plan including QI goals and concrete actions to accomplish these goals, and (iv) periodically adjust the QI plan based on new results on the quality indicators and ongoing experiences in the daily care process. The first experiences with the system in four CR clinics are promising. The effects of CARDSS Online on the quality of CR in the Netherlands are currently assessed in a cluster randomized trial.

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