Collaboratively Improving Diabetes Care in Sweden Using a National Quality Register: Successes and Challenges—A Case Study

Anette Peterson, MSc, RN; Soffia Gudbjörnsdottir, MD, PhD; Ulla-Britt Löfgren, RN; Linus Schiöler, PhD; Mats Bojestig, MD, PhD; Johan Thor, MD, PhD, MPH; Boel Andersson Gäre, MD, PhD

Background: Since 1996, the Swedish National Diabetes Register (NDR) enabled health care providers to monitor their clinical performance over time and compare it with the national average. All health systems of Swedish county councils report data. By 2014, the NDR included data from 360 000 patients. Comparisons among county councils show significant variations in clinical outcomes and in adherence to evidence-based national guidelines. The purpose of this study was to evaluate whether and how a quality improvement collaborative could influence clinical practice and outcomes. **Methods:** Twenty-three diabetes teams from all over Sweden, both primary care units and internal medicine departments, joined a quality improvement collaborative. The project was inspired by the Breakthrough Collaborative Model and lasted for 20 months. Evaluation data were collected from the teams' final reports and the NDR throughout the study period. **Results and Conclusion:** The teams reported improved patient outcomes significantly compared with the national average for systolic blood pressure and low-density lipoprotein levels. In contrast, glycated hemoglobin A_{1c} levels deteriorated in the whole NDR population. Five themes of changes in practice were tested and implemented. Success factors included improved teamwork, with active use of register data, and testing new ideas and learning from others.

Key words: collaborative, diabetes mellitus, guideline adherence, quality improvement, registries

Diabetes mellitus (DM) is a chronic condition that increases the risk of morbidity and mortality from complications over time. Treatment efforts are aimed at reducing risk factors and maintaining or improving the quality of life of people living with DM. Extensive evidence exists regarding which lifestyle and treatment interventions can improve patient prognosis.[1] Yet, many patients do not get the full benefit of these interventions, which increases the risk of health deterioration. Much avoidable suffering remains because of the gap between the best care possible and actual care in regular clinical practice. Variations in clinical practice and the aspiration to improve care prompted the Swedish Association for Diabetology to create the National Diabetes Register (NDR; available at: https://www.ndr.nu), a quality register for improvement, in 1996.

In 2014, Sweden had about 100 National Quality Registers (NQRs; available at: http://www.kvalitetsregister.se). These registers contain individual patient data (based on personal identification numbers) regarding process and outcome indicators for a wide range of conditions. In addition to supporting local improvement efforts, they are used for national open comparisons of the performance of county councils and, sometimes, individual hospitals.[2] The vision for NQRs is that they will be "used in an integrated and active way for continuous learning, improvement, research and management to create the best possible health and care together with the individual."[3] Since quality indicators are essential in improvement efforts,[4,5] there is a largely untapped potential to use these NQRs for systematic improvement in daily work.

In an effort to reduce morbidity and mortality from DM, the NDR was designed to allow comparisons of a number of clinical variables among units that care for patients with DM.[6] Developments have been rapid, especially as health care providers have improved their understanding of the various risk factors relevant to diabetic complications and cardiovascular disease and harnessed the value of modern therapies to address blood glucose, blood pressure, and blood lipids. By 2014, the NDR contained data from approximately 360 000 patients, which equals 90% of all patients in Sweden with DM, based on an estimated diabetes prevalence of

Author Affiliation: *Healthcare Department, Region of Jönköping, Jönköping, Sweden (Ms Peterson and Dr Bojestig); The Jönköping Academy for Improvement of Health and Welfare, School of Health Sciences, Jönköping University, Jönköping, Sweden (Ms Peterson and Drs Thor and Andersson-Gäre); Center of Registers in Region Västra Götaland, Gothenburg, Sweden (Dr Gudbjörnsdottir and Ms Löfgren); Department of Molecular and Clinical Medicine, Sahlgrenska Academy, Gothenburg, Sweden (Drs Gudbjörnsdottir); Section of Occupational and Environmental Medicine, Institute of Medicine, Sahlgrenska Academy, University of Gothenburg, Gothenburg, Sweden (Drs Schiöler); and Futurum, Region of Jönköping, Jönköping, Sweden (Dr Andersson Gäre).*

Correspondence: *Anette Peterson, MSc, RN, Healthcare Department, County Council of Jönköping, Box 1024, S-551 00 Jönköping, Sweden (anette.peterson@rjl.se).*

This research received no specific funding.

The authors declare no conflicts of interest.

Q Manage Health Care
Vol. 24, No. 4, pp. 212–221

DOI: 10.1097/QMH.0000000000000068

4%.[7] The vast majority of health care providers use the NDR; it is used by more than 95% (n = 90) of all internal medicine departments (IDMs) and 95% (n = 1178) of primary care units (PCUs) in Sweden. NDR reports indicate significant differences between clinic and county council health systems in Sweden for both process and outcome measures. There is a substantial gap between guidelines for DM care and actual everyday care. For example, one study showed that a majority of patients did not achieve target levels of glycated hemoglobin A_{1c} (HbA_{1c}), blood pressure, and blood lipids.[8] This is not unique to the care of diabetic patients. Several studies have shown suboptimal adherence to guidelines both in clinical encounters and in support for self-care.[9,10] Other studies have highlighted the difficulty achieving significant long-term performance improvement in patients with chronic diseases.[11]

Quality improvement (QI) broadly aims at enhancing health care performance in terms of patient and population outcomes, the performance of health care services (ie, quality, safety, and value), and professional development.[12] Quality improvement programs are complex social interventions; to be properly evaluated, the connections between context, content, application, and outcomes need to be understood.[13] Despite widespread application, there is ongoing uncertainty regarding whether quality improvement collaboratives (QICs), or the Breakthrough Collaborative Model, are effective and help improve health care.[14]

It remains unclear how best to apply QI principles to services for persons with DM and how much improvement can be expected from such applications. We previously reported on the use of an NQR in a QIC for acute myocardial infarction (AMI) care, with improved performance and patient outcomes, both short and long term.[15-17] On the assumption that similar effects could be achieved for care of a chronic condition such as diabetes, we undertook a QIC to empower teams, both in primary care and in hospitals, and to systematically improve performance in diabetes care, with support from the NDR. Could we transfer insights and replicate achievements from the AMI experience in services for persons with DM?

The purpose of this study was to evaluate whether and how a QIC, using the online NDR as a tool and measurement system, could influence clinical practice and outcomes for patients with DM. Other studies of the program have evaluated patient-reported outcomes and health economics.[18]

METHODS

Setting and design of the QIC

Teams from PCUs and IMDs across Sweden were invited to participate in a QIC, which included use of the NDR for monitoring progress. The invitation was sent to all PCUs and IMDs in Sweden, and the teams that first signed up were enrolled in the program. The QIC started in February 2008 and ended in November 2009. The QIC managers guided participating units to form multidisciplinary teams of 3 to 7 people, including physicians, nurses and/or a secretary, assistant nurse, and nutritionist.

Participation in the QIC was conditional based on a number of requirements, expressed in an agreement that the team signed before the project, which stated:

- Management support was needed to ask for results, to allocate time for teams to attend all of the seminars, and to work with improvements at their respective sites.
- The teams must have started to register data from their patients in the NDR regularly before the QIC started.
- Some baseline data had to be collected from the NDR by each unit and brought to the first learning session.
- Every second month during the QIC period, reports taken from the NDR had to be sent to the project leaders.
- The whole team had to make a commitment to participate in all learning sessions.

The QIC was modeled on the Breakthrough Collaborative Model,[19,20] with 4 learning sessions and 2 follow-up meetings spanning approximately 20 months. At the joint learning sessions, teams received training in QI methods and had time both for teamwork and for sharing experiences among teams (Table 1). They sought to reach jointly agreed DM quality indicator levels (Table 2). Between learning sessions, teams engaged in action periods at home, where they identified problems, formulated action plans, tested changes, and monitored results. Most of the improvements were implemented in the workplace as an integrated part of regular work. During the follow-up phase, participants continued their improvement work, followed up on their results, and reported to the QIC project leaders. This period included 2 follow-up meetings, where teams first presented an interim report and then a final report.

The QIC applied the Model for Improvement, including the PDSA (Plan, Do, Study, Act) cycle.[4,21] Each team had to answer the following 3 questions: What do we want to accomplish? How will we know that a change is an improvement? What changes can we make that will lead to improvement? Teams assessed success factors and obstacles in an evaluation after each learning session.

The teams were supported by a facilitator before, between, and during the learning sessions. An important factor in the QIC was the use of the online NDR. The facilitator helped the teams learn how to use the NDR and how to get data from the registry. The facilitator also helped the teams learn how to use the different improvement tools.

Study design and data analysis

We used a case study design[22] to describe and evaluate the QIC improvement effort, combining multiple data collection and analysis methods, drawing on the following data sources:

1. Participating team project reports: summaries and lessons learned

Table 1. Activities During Seminars and Homework in Between Seminars

Sessions	Theme for Seminars	Activities at Seminars	Homework
Learning session 1	• Why do we need to do this? • Understanding the need for improvement • Set goals: What do we want to accomplish? • Measures: How can we know if a change is an improvement? • Start to map the current situation	• Clarify the gap between what clinical research indicates is possible and what is performed in everyday work • Lecture and discussion • Set goals for the work • Start to map own processes and identify problem areas Tools: PDSA cycle, value compass, flowchart, fishbone diagrams	• Discuss goals with leaders and colleagues at home • Start to measure • Complete mapping • Follow project joint measurements and submit them to project management every second month
Learning session 2	• Processes and baseline measurements • Why measure over time? • Problems and improvement areas • What changes can we make that lead to improvements?	• Analyze measures and identify improvement areas • Make an action plan on what improvement ideas will be tested at home Tools: PDSA cycle, action plan	• Work with action plan and prioritize improvement ideas • Test ideas on a small scale • Continue to follow project joint measurements and submit them to project management every second month • Talk about the work and change proposals at home with colleagues and leaders
Learning session 3	• Present the work so far • Analyze results of tested ideas • Share ideas • Learn from others and find new ideas • Plan new tests	• Share results and lessons learned in smaller groups • Analyze improvement work and reflect on consequences it may have for daily work with patients • Inspiration from teams that have gone through the same kind of improvement journey previously Tools: Inspiration for new ideas through accessing a variety of known change concepts [4]	• Continue with PDSA cycles • Continue to follow project joint measurements and submit them to project management every second month • Talk about the work and tested changes at home with colleagues and leaders
Learning session 4	• Analyze and share ideas and results • Plan for new tests • Change psychology	• Presentation of guidelines, goals, and treatment strategies in diabetes care to gain further understanding of the importance of proper treatment • Discuss change psychology to understand why it can be hard to change habits	• Continue with PDSA cycles • Continue to follow project joint measurements • Plan to proceed with new ideas to further improve performance • Compile interim report
Follow-up meeting 1	• Presentation of work so far: Are the results sustained? • Get new ideas • Sustainability and spread	• Presentation of interim report and discussion in small groups • Adopt good ideas from each other • Plan for how to continue and how to sustain results	• Continue with PDSA cycles • Continue to follow project joint measurements • Plan for how to continue and how to sustain results • Compile a final report
Follow-up meeting 2	• Final presentation of results • How to continue the work • Celebrate the work and results	• Presentation of final report submitted in advance to project management • Posters made for all teams with their own results	Teams received their poster to take home after the learning session to display and to continue the discussion and work with colleagues and leaders

Abbreviation: PDSA, Plan, Do, Study, Act.

2. Teams' evaluations from the QIC learning sessions
3. Quality indicator data from the NDR
4. Project documentation

The study was also inspired by an interactive research approach,[23] where the researcher, together with the project leaders, was active in the development of the program and during the learning sessions. This evaluative case study thus combined qualitative and quantitative methods. All teams, except one of the PCUs, submitted a final report on the project, which included a list of changes they had made. We characterized the changes reported by thematic content analysis.[24] The text was condensed into meaning units and then abstracted into themes. To identify and summarize a number of conditions associated with success in the QIC, we thematically analyzed teams' evaluations from each learning session, their project reports, and project documentation.

We analyzed quality indicator data from the NDR—blood pressure and low-density lipoprotein (LDL) and HbA_{1c} levels, mirroring key areas in the national guidelines for DM care—using descriptive statistics over time stratified by participating health care provider units, dividing patients into 3 groups: (*a*) patients with type 2 DM treated at PCUs (QI-PCU type 2), (*b*) patients

Table 2. Variables and Targets

Variable	Target for Teams in Collaborative
HbA_{1c} levels	≤7.0%[a]
Systolic blood pressure	≤130 mm Hg
LDL cholesterol levels	<2.5 mmol/L

Abbreviations: HbA_{1c}, glycated hemoglobin A_{1c}; LDL, low-density lipoprotein.
[a]Units for HbA_{1c} in Sweden have changed: the international measure ≤7% Diabetes Control and Complications Trial (DCCT) HbA_{1c} standard = 52 mmol/mol.

with type 1 DM treated at IMDs (QI-IMD type 1), and (*c*) patients with type 2 DM treated at IMDs (QI-IMD type 2). Aggregated data from all units in these groups were analyzed in the study. Data from collaborative teams' patients were compared with the NDR national average for the same patient groups during the same time periods to control for any secular trends.

We undertook a post hoc analysis of the 2 QI-IMDs and the 3 QI-PCUs whose patients exhibited the greatest improvements in HbA_{1c} and blood pressure to identify what changes these teams made. We analyzed outcomes—HbA_{1c} levels, systolic blood pressure, and LDL levels—and compared QIC units with register data from all non-QIC units in the NDR, for 3 time periods during the project:

Period 1: February 2008 to January 2009 (the QIC started February 2008)
Period 2: February 2009 to January 2010 (during the project; the QIC ended in November 2009)

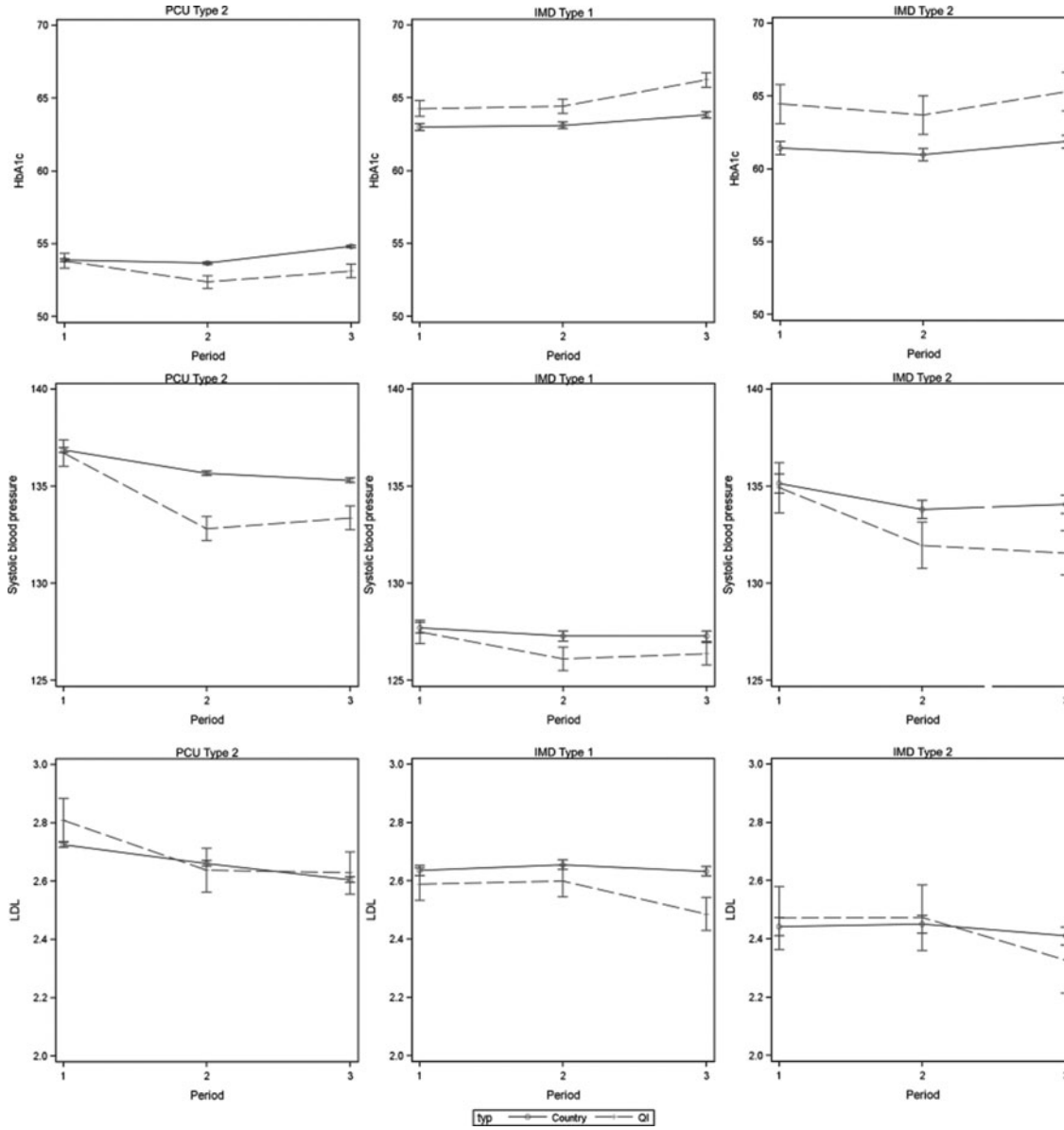

Figure 1. Mean and 95% confidence interval of HbA_{1c} levels, systolic blood pressure, and LDL levels over 3 time periods. HbA_{1c} indicates glycated hemoglobin A_{1c}; LDL, low-density lipoprotein.

Period 3: February 2010 to January 2011 (long-term follow-up)

For period 1, the study included data from the first visit after the start of the QIC. For periods 2 and 3, we included the last registered values for each patient in those periods. Only patients with measurements in all 3 periods were included.

Boxplots (Figures 2-4) display these measurements, with data from the first visit after the start of the intervention (February 2008 to January 2009) and after the intervention (November 2009 to January 2011). The last measurement was designed to indicate the long-term impact.

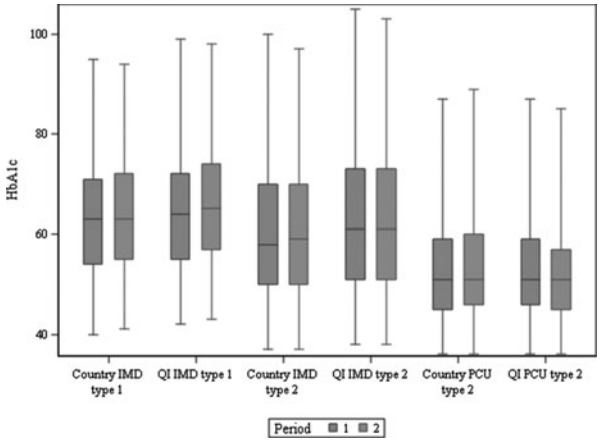

Figure 2. Boxplot showing the distribution of HbA_{1c} levels for different units over 2 time periods. Boxplot is designed to capture different percentiles of the distribution. Lines that extend from the boxes show the 2.5th and 97.5th percentiles; hence, 95% of the observations are between these lines. Boxes extend from the first (Q_1) to the third (Q_3) quartile and thus capture the middle 50% of the observations, with 25% below the lower edge and 25% above the upper edge of the box. Line inside the box shows the median. HbA_{1c} indicates glycated hemoglobin A_{1c}; IMD, internal medicine department; QI, quality improvement; PCU, primary care unit.

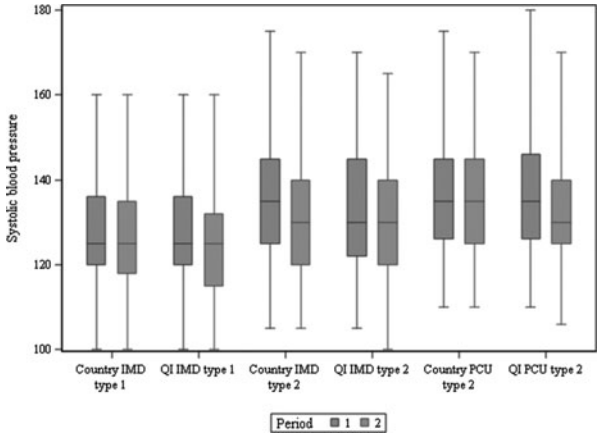

Figure 3. Boxplot showing the distribution of systolic blood pressure for different units over 2 time periods. IMD indicates internal medicine department; QI, quality improvement; PCU, primary care unit.

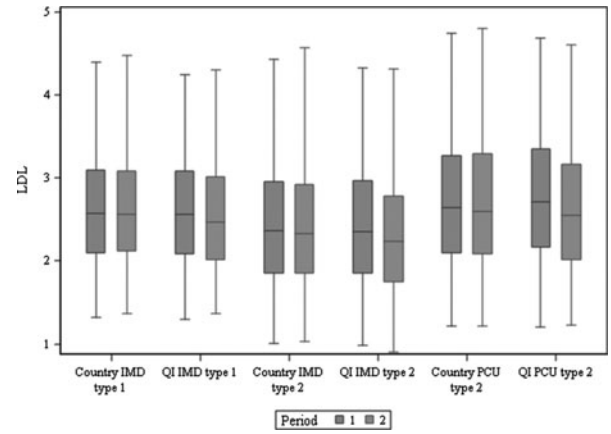

Figure 4. Boxplot showing the distribution of LDL levels for different units over 2 time periods. LDL indicates low-density lipoprotein; IMD, internal medicine department; QI, quality improvement; PCU, primary care unit.

Ethical considerations

The study did not handle any data for identifiable individual patients, only aggregate data for different health care organizations. The study concerned improvement efforts undertaken by these organizations, not the actions or performance of individuals. Therefore, this study did not require ethical approval according to Swedish law. To protect participants' privacy, we reported data in such a way that individual patients and participating organizations could not be identified.

RESULTS

Altogether, 23 teams from all over Sweden participated in the project: 16 teams from PCUs and 7 teams from IMDs. The sizes of these units varied. Participating PCUs had between 56 and 462 DM patients, whereas the IMDs had between 220 and 857 DM patients enrolled when the project started. At baseline, patient characteristics were similar at units participating in QIC and non-QIC units in the NDR (Table 3). Team members remained the same throughout the QIC and participated in all learning seminars, with a few exceptions; for example, when staff changed jobs. In addition, colleagues and coworkers at participating units were also involved in the improvement work.

Teams reported how they used the improvement methods, what changes they made (thematically summarized in Table 4), the lessons they learned, and the results (Figures 1-4).

Figure 1 shows that the average HbA_{1c} levels among patients at QI-PCUs decreased modestly during the QIC whereas HbA_{1c} levels among patients at non-QI-PCUs increased. Among both QI-IMDs and non-QI-IMDs, average HbA_{1c} levels did not improve.

The average systolic blood pressure declined, as intended, among patients with type 2 DM, particularly at QIC units. The average LDL levels for patients at PCUs declined, as intended, with QI-PCUs approaching the national average in period 3, although neither PCUs nor IMDs reached the treatment target level. Among

Table 3. Care Sites and Patient Characteristics at Baseline

Baseline	Units in NDR QIC	Rest of Sweden in NDR
Number of sites participating in NDR QIC	23	
Number of PCUs type 2	16	1 104
Number of IMDs types 1 and 2	7	81
Total number of patients in the intervention		
PCU type 2	3 762	114 149
IMD type 1	3 489	18 497
IMD type 2	909	7 662
Age, mean (SD), y		
PCU type 2	64.3 (9.7)	64 (9.5)
IMD type 1	45.6 (14.8)	45.5 (15)
IMD type 2	59 (12.2)	60.7 (11.2)
Proportion of women, mean		
PCU type 2	43.9	42.4
IMD type 1	44.2	44.3
IMD type 2	35.9	35.7
Diabetes duration, mean (SD), y		
PCU type 2	7.6 (6.8)	7.6 (6.7)
IMD type 1	22.9 (14.2)	22.9 (14.5)
IMD type 2	15 (10.2)	13.5 (9.2)
BMI, mean (SD), kg/m^2		
PCU type 2	30.5 (5.5)	30.3 (5.3)
IMD type 1	25.9 (4.1)	25.7 (4.1)
IMD type 2	30.4 (5.4)	30.5 (5.6)
Systolic blood pressure, mean (SD), mm Hg		
PCU type 2	137.1 (16.5)	137.1 (16.2)
IMD type 1	127.6 (15.4)	127.5 (15.4)
IMD type 2	134.8 (16.1)	135.1 (16.9)
LDL, mean (SD), mmol/L		
PCU type 2	2.77 (0.9)	2.73 (0.9)
IMD type 1	2.62 (0.77)	2.65 (0.78)
IMD type 2	2.44 (0.84)	2.46 (0.87)
HbA_{1c}, mean (SD), mmol/mol		
PCU type 2	54 (12.8)	53.8 (12.8)
IMD type 1	64.7 (14.7)	63.3 (13.9)
IMD type 2	63.7 (17.4)	61.3 (16.2)

Abbreviations: BMI, body mass index; HbA_{1c}, glycated hemoglobin A_{1c}; IMD, internal medicine department; LDL, low-density lipoprotein; NDR, National Diabetes Register; PCU, primary care unit; QIC, quality improvement collaborative.

Table 4. Identified Themes of Improvement Activities

Theme 1: Development in use of the registry
Changes in using NDR in daily work and registration at every visit
Using the diabetes profile; a printed copy of NDR data for patients
Regular analysis of NDR statistics
Theme 2: More active and involved patients
Information letter/sheet to patients with, eg, explanations of target values
Questionnaire sent to patients before the visit
Working more actively with patients' individual targets
Introduction of Diasend, which transfers, stores, and displays patient data from different types of glucose meters, insulin pumps, and continuous glucose monitors
Active smoking cessation
Procedures for blood pressure measurement at home
Theme 3: Improved work practices and guidelines
Blood sampling procedures improved
Revised invitations to clinics
Better structure during patient meetings
Using a visit bundle
Using guidelines and action plan for patients
Customized reception activities
Telephone follow-up
Theme 4: Improved communications within the unit
Continuous information on staff meetings
Theme 5: Improved teamwork
Improved teamwork and more effective team meetings with patients

Abbreviation: NDR, National Diabetes Register.

patients at IMDs, average LDL levels declined but with overlapping confidence intervals.

Figures 2-4 illustrate, in a cross-sectional manner, the changes in data between the 2 time periods (before and after the intervention) for HbA_{1c}, systolic blood pressure, and LDL. The same patients were not necessarily observed in both periods.

Very small changes were seen for HbA_{1c} (Figure 2). The QI-PCUs showed a slight improvement; the first and third quartiles were slightly lower in the second period. In general, the 97.5th percentile was lower in the second period, with the exception of non-QI-PCUs. Although the changes were slight, they might be an indication of improvement in patients with the highest HbA_{1c} levels.

Lower systolic blood pressure was seen in most groups after the QIC (Figure 3). In all groups, except at non-QI-PCUs, 75% of the patients had blood pressure below 140 mm Hg, with 50% of patients having blood pressure below 130 mm Hg. For QI-PCUs, the median and the third quartile showed an approximately 5-unit decrease in period 2 and a smaller decrease in

the first quartile. This is in line with the targeting of patients with the highest values by the intervention.

Figure 4 shows that there was a slight decrease in average LDL levels among patients at the QIC units after the QIC. The changes for the rest of the country were small.

The teams whose patients experienced the largest improvements in HbA_{1c} levels and blood pressure (Figure 5) used similar improvement concepts. The 2 QI-IMD teams with the greatest improvement in HbA_{1c} levels were the only IMD teams to report that they actively gave their patients information and discussed target levels of HbA_{1c} with them. They were also the only 2 teams to improve their HbA_{1c} testing procedure so that results were available at patients' visits. To improve patients' blood pressure, the best QI-IMD teams used the "diabetes profile," a printed copy of each patient's values given to the patient at the visit, to discuss at appointments. They also used documented action plans and individual targets for their patients.

The 3 QI-PCU teams whose patients experienced the largest improvement in HbA_{1c} levels all changed their way of using the NDR. They sent an information letter before patient visits to help patients prepare. The QI-PCU teams whose patients experienced the largest improvements in blood pressure also used information letters to their patients, which focused on lifestyle questions (eg, diet, physical activity, and smoking habits). They also emphasized the importance of teamwork. For example, they met regularly and discussed results so that the unit would be able to quickly act on them.

The following actions that promoted QIC success, in terms of better performance and sustainable improvement efforts, emerged in our analysis of the teams' final reports, in their evaluations of QIC joint meetings, and in the project documentation:

1. *Teamwork, having everyone involved*. Teams characterized by strong multidisciplinary teamwork and a workplace culture supportive of improvement were more successful.
2. *Review your own data iteratively over time.* The data collection routine in the NDR was crucial for the teams; it enabled them to review performance and learn from the results.
3. *Analyze and reflect on the results, and discuss what changes to test.* Successful teams allocated time to analyzing their data together.
4. *Make changes in the work process; test a lot of ideas*. More successful teams ran multiple tests of change on a small scale in their daily work using the PDSA cycle.
5. *Learn from others*. The collaborative improvement framework facilitated learning from others' experiences and encouraged teams to take on good ideas. Teams had time to exchange experiences at each learning session.
6. *A structured improvement program and facilitation is helpful.* The program with learning sessions gave the teams the time and structure to

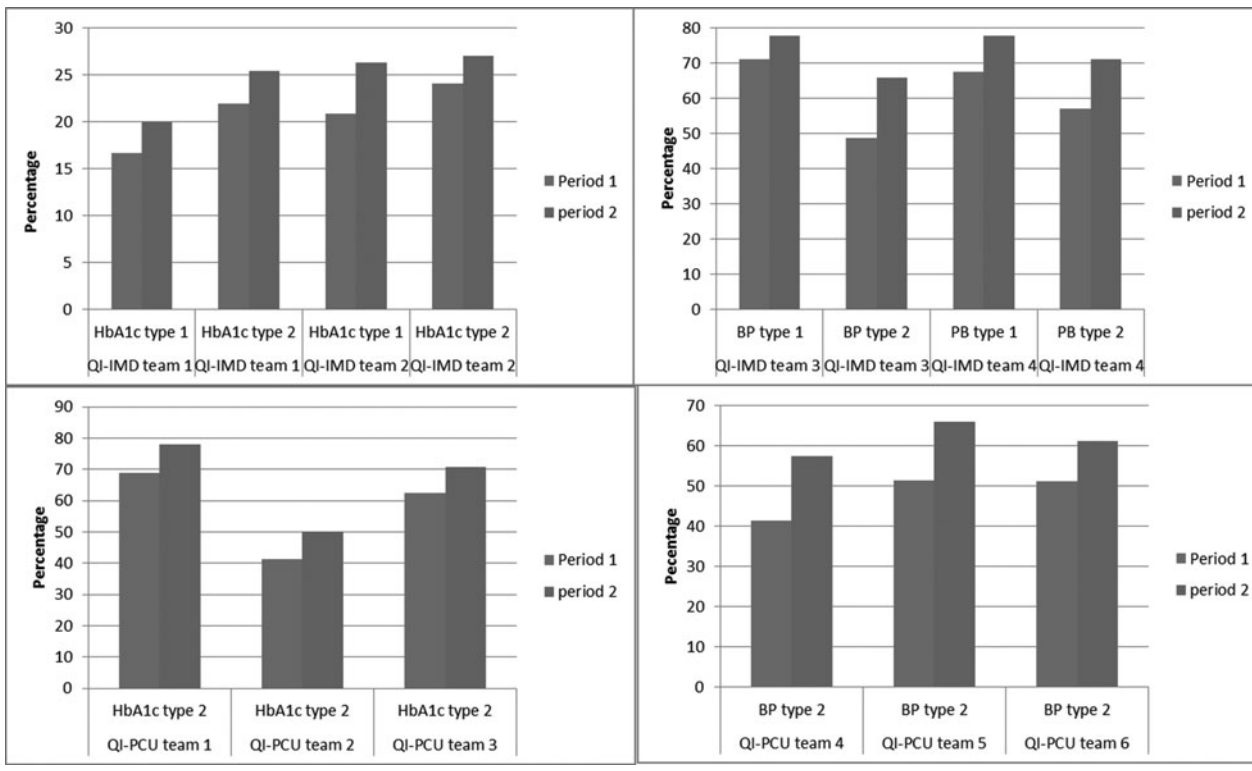

Figure 5. Teams with greatest improvements in HbA_{1c} levels and BP. Percentage of patients who reached HbA_{1c} levels of 52 mmol/mol or less and percentage of patients who reached BP of 130 mm Hg or less. HbA_{1c} indicates glycated hemoglobin A_{1c}; IMD, internal medicine department; QI, quality improvement; BP, blood pressure; PCU, primary care unit.

work with their improvement ideas. Having a QIC facilitator provided support, both at the learning sessions and at visits, for the teams' work settings.

7. *Leaders can help by showing interest and asking for results*. Teams found it useful when their leaders showed interest and gave them time for improvement work.

DISCUSSION

In this study, we used a previously tested model that had been successful in QICs for the acute phase of AMI.[15-17] We used it to improve the long-term process of treating patients for the chronic diabetes disease. While it was possible to attract clinical teams to join and complete this diabetes QIC, it was less straightforward to achieve substantial performance improvement, measured as changes in risk factors and not as changes in processes. Yet, we did identify a number of success factors, and 2 of the 3 risk factors measured in this study improved over time. In contrast to previous studies of collaborative learning, which involved different approaches to improvement and showed variable results for DM care,[11,25-27] this study included patients with both type 1 and 2 DM in both IMDs and PCUs. We evaluated performance according to 3 key risk factors in the NDR and compared participating units with the rest of the country for more than 30 months, thus covering the vast majority of people treated for DM across Sweden. Few other studies of QIC have had such a long follow-up period and such broad national comparisons.[28] The intervention occurred between 2008 and 2009, with a long follow-up period, and the changes were informed by the existing guideline. The large trials ACCORD and ADVANCE[29,30] that were published in 2008 could not confirm a beneficial effect of intensive glucose control on macrovascular events. As a result, Swedish and international treatment guidelines recommended a more personalized treatment strategy that focused on intensive glucose control in patients with relatively short diabetes duration and without previous cardiovascular diseases and less strict control in high-risk patients. This has influenced the HbA_{1c} trend in Sweden and may partly explain our findings regarding impact on HbA_{1c} levels. Otherwise, there has not been any major change in guidelines during the follow-up period. Therefore, the fundamental research question remains: How and why might QICs work? Here, our results including success factors add to the evolving knowledge base.

Participating teams were included on the basis of voluntary self-selection on a first-come, first-served basis. The goal was 20 teams, but when 3 more teams wanted to participate, we decided to include them as well. More programs were later implemented to meet the needs of teams that wanted to participate. Therefore, the teams included in the study may not be representative of all service providers across the country. The baseline data showed, however, that QIC units started at a level of performance similar to that of the rest of the units in the NDR.

The QIC participants showed clinically significant performance improvement in blood pressure and LDL measurements compared with the rest of the country according to the NDR data, even if their patients in the aggregate did not reach the guideline targets (apart from systolic blood pressure for patients with type 1 DM, which remained below the target of 130 mm Hg; Figure 1). The large UK Prospective Diabetes Study[31] showed that several risk factors need to be addressed for patients with diabetes. This is mirrored by the 5-year risk model for both type 1 and 2 diabetes.[32,33] The risk model shows that several factors increase the risk of diabetic complications and cardiovascular disease within the next 5 years. In our study, LDL and blood pressure showed the most improvement. We argue that improvement of 2 of 3 risk factors is a good result, considering that the improvement work was carried out without any extra resources. The changes made by the teams concerned improved work practices and procedures. They sought to reach the treatment targets by more active treatment of their patients and improved clinical routines. Although the changes were very modest, the data indicate improvement in HbA_{1c} levels among patients with high values at baseline (Figure 2), as has been shown previously.[34]

HbA_{1c} levels deteriorated in the NDR population as a whole during the QIC, with the HbA_{1c} levels of patients of the QIC teams the same as those of the rest of the country. As noted earlier, there is an ongoing debate about HbA_{1c} targets and how low they should be. According to NDR data, average HbA_{1c} levels for both type 1 and 2 DM have been rising slowly in Sweden since 2007, until 2013 when there was a trend break in terms of HbA_{1c}, with improvement particularly among patients with high levels. Change in HbA_{1c} levels probably requires more patient interaction/education. Patients need to take a greater responsibility for their care,[35] which was not sufficiently tested as part of this QIC, even if many teams performed some actions in this area. Some teams did improve their patient population's aggregated HbA_{1c} level. Even if their improvements were limited, they point to teamwork, engaging the patient, and changing routines in taking care of patients as important for success.

The study was set in everyday care, not in settings selected on the basis of narrow criteria. The work was carried out by participating teams as part of their regular work. No dedicated funding was provided to the teams for participating in the QIC. The different themes of improvement activities mainly focused not only on changes in practice, guidelines, and improved teamwork but also on how to involve patients in their own care. No extra efforts were required of participating teams to collect data for the study; they already used the NDR as part of their regular clinical practice, although several teams improved their data registration and review practices as part of the QIC. Such a computerized system, to support frontline clinical process management and improvement work and at the same time provide data for aggregated annual reports and nationwide comparisons, is important for

achieving improvement.[5,25] The NDR, described as the most comprehensive electronic, population-based NDR in the world,[36] includes almost all units and DM patients in Sweden. The NDR provides teams and leaders with the opportunity to continuously monitor adherence to national guidelines for DM care and compare their performance with that of the rest of the country. A lack of quality indicator data has proven to be a limitation in many other studies of QI.[28,37] The NDR allowed us to assess and compare data on performance among both participating units and all non-QIC units in the NDR as a whole.

The present project has formed the foundation for a structured approach to continuous improvement connected to the use of an NQR. Considering the widespread use of QICs, deeper investigation is warranted to clarify what aspects of QICs work for whom, and why, in different contexts[13,19,38-40] and to ensure sustainability.[41,42] A more profound understanding could enhance improvement work that employs quality registers in Sweden and elsewhere.

Considering all of the collected material, we have evidence that structure in the program was important to the QIC for both AMI and DM. Moreover, the fact that the whole team focused on the same issue made it possible to share experiences. In the evaluation of each program, the opportunity to share ideas and the results of tested ideas was pointed out as very important and useful by the participants. The structure of the content in the QIC (eg, use of the PDSA wheel) also made it possible for teams to have structure and support in the change process. The difficult part turned out to be the application of new ideas and suggestions, which required active work at the participants' respective clinics. The results and lessons learned described in the final reports indicate that improvement work takes time. In contrast to the QIC for AMI,[15-17] the QIC for the chronic condition of diabetes was more challenging, because of the required long-term follow-up. HbA_{1c} levels in patients tend to increase with disease duration.[1,31] In this study, we followed the same patients during the whole QIC. In the AMI QIC, most changes focused on medication or clinical tests, whereas in the DM QIC, most of the changes required improved performance in terms of clinical indicators concerned with supporting patients both in self-care and in making lifestyle changes. This may be a bigger challenge that will take longer to address successfully. If so, this could help explain the differences in the impact of the AMI and DM QICs. Further work will need to address the challenges specific to chronic conditions such as DM.

The NDR did not enable teams to track process indicators, which likely would have helped them in guiding continuous improvement efforts. This is particularly challenging for a chronic condition such as DM, where practice changes may have an impact on outcomes far into the future. In our studies of the AMI QIC,[15-17] several process measures were available and amenable to improvement; for example, the proportion of patients who received angiotensin-converting enzyme inhibitors before discharge.

In this study, we were unable to link particular changes made by different teams to specific outcomes. Instead, we assessed changes in the 3 selected quality indicators associated with the QIC as a whole. Evaluations of the most successful PCU and IMD teams did, however, show that they had in common certain changes that they had applied.

While the effectiveness of improvement collaboratives has been questioned,[14,39] this study shows that this QIC enabled some teams to accomplish clinically meaningful improvement in DM care and their patients' risk status but that major impact was elusive. Further research is needed to further unpack the "black box" of improvement.[12,13] Still, the 7 actions promoting QIC success that emerged in this study and similar in other studies[43,44] can support teams and leaders who are planning new QICs.

CONCLUSION

Using the online NDR as a tool and measurement system in a QIC, the teams in this study significantly improved performance with respect to 2 national DM guideline targets among their patients compared with other units in the NDR. Our findings suggest that the QIC helped teams close the gap between ordinary clinical practice and evidence-based guidelines and contributed better care and better clinical outcomes. This should, in turn, yield better quality of life for people with DM. At the same time, the impact was limited regarding HbA_{1c} levels. This point to challenges in the improvement of care for patients with DM, with its substantial reliance on self-care, compared with care for patients with AMI, for whom more of the care is directly related to caregiver actions during hospitalization. At the same time, this study revealed general success factors that could be the foundation for QIC in different contexts.

REFERENCES

1. The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. The Diabetes Control and Complications Trial Research Group. *N Engl J Med*. 1993;329(14):977-986.
2. Quality and efficiency in Swedish Health Care—regional comparisons 2012. http://webbutik.skl.se/sv/artiklar/quality-and-efficiency-in-swedish-health-care-regional-comparisons-2012.html. Published 2013. Accessed May 21, 2013.
3. Nationella Kvalitetsregister. Quality Registries in Sweden. http://www.kvalitetsregister.se/sekundarnavigering/inenglish.4.f647a59141ef67b4342a3c.html. Published 2014. Accessed May 15, 2014.
4. Langley GJ, Moen R, Nolan KM, Nolan TW, Norman CL, Provost LP. *The Improvement Guide: A Practical Approach to Enhancing Organizational Performance*. 2nd ed. San Francisco, CA: Jossey-Bass; 2009.
5. James B. Information system concepts for quality measurement. *Med Care*. 2003;41(1)(suppl):I71-I79.
6. Gudbjornsdottir S, Cederholm J, Nilsson PM, Eliasson B, The National Diabetes Register in Sweden: an implementation of the St. Vincent Declaration for Quality Improvement in Diabetes Care. *Diabetes Care*. 2003;26(4):1270-1276.
7. Swedish National Diabetes Registry (Nationella Diabetes Registret). Annual report 2013 [Årsrapport. 2013 års Resultat]. https://ndr.nu/pdf/Annual_Report_NDR_2013.pdf. Published 2014. Accessed June 14, 2014.

8. Eliasson B, Cederholm J, Nilsson P, Gudbjornsdottir S. The gap between guidelines and reality: type 2 diabetes in a National Diabetes Register 1996-2003. *Diabet Med*. 2005;22(10):1420-1426.
9. McGlynn EA, Asch SM, Adams J, et al. The quality of health care delivered to adults in the United States. *N Engl J Med*. 2003;348(26):2635-2645.
10. Stenestrand U, Lindback J, Wallentin L, Hospital therapy traditions influence long-term survival in patients with acute myocardial infarction. *Am Heart J*. 2005;149(1):82-90.
11. Landon BE, Hicks LS, O'Malley AJ, et al. Improving the management of chronic disease at community health centers. *N Engl J Med*. 2007;356(9):921-934.
12. Batalden PB, Davidoff F. What is "quality improvement" and how can it transform healthcare? *Qual Saf Health Care*. 2007;16(1):2-3.
13. Walshe K. Understanding what works—and why—in quality improvement: the need for theory-driven evaluation. *Int J Qual Health Care*. 2007;19(2):57-59.
14. de Silva D. *Improvement Collaboratives in Health Care, in Evidence Scan*. London, England: The Health Foundation; 2014:38.
15. Carlhed R, Bojestig M, Peterson A, et al. Improved clinical outcome after acute myocardial infarction in hospitals participating in a Swedish quality improvement initiative. *Circ Cardiovasc Qual Outcomes*. 2009;2(5):458-464.
16. Peterson A, Carlhed R, Lindahl B, et al. Improving guideline adherence through intensive quality improvement and the use of a National Quality Register in Sweden for acute myocardial infarction. *Qual Manag Health Care*. 2007;16(1):25-37.
17. Carlhed R, Bojestig M, Wallentin L, et al. Improved adherence to Swedish national guidelines for acute myocardial infarction: the Quality Improvement in Coronary Care (QUICC) study. *Am Heart J*. 2006;152(6):1175-1181.
18. Borg S, Palaszewski B, Gerdtham UG, Fredrik O, Roos P, Gudbjörnsdottir S. Patient-reported outcome measures and risk factors in a quality registry: a basis for more patient-centered diabetes care in Sweden. *Int J Environ Res Public Health*. 2014;11(12):12223-12246.
19. Kilo CM, A framework for collaborative improvement: lessons from the Institute for Healthcare Improvement's Breakthrough Series. *Qual Manag Health Care*. 1998;6(4):1-13.
20. Wilson T, Berwick DM, Cleary PD. What do collaborative improvement projects do? Experience from seven countries. *Jt Comm J Qual Saf*. 2003;29(2):85-93.
21. Deming WE. *Out of the Crisis*. Cambridge, MA: MIT Center for Advanced Engineering Study; 1986.
22. Yin R. *Case Study Research: Design and Methods*. 4th ed. Los Angeles, CA: Sage Publications; 2009.
23. Aagaard Nielsen K, Svensson LG. *Action Research and Interactive Research*. Maastricht, the Netherlands: Shaker Publishing; 2006.
24. Graneheim UH, Lundman B. Qualitative content analysis in nursing research: concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today*. 2004;24(2):105-112.
25. Chin MH, Cook S, Drum ML, et al. Improving diabetes care in Midwest community health centers with the health disparities collaborative. *Diabetes Care*. 2004;27(1):2-8.
26. Schouten LM, Hulscher ME, van Everdingen JJ, Huijsman R, Niessen LW, Grol RP. Short- and long-term effects of a quality improvement collaborative on diabetes management. *Implement Sci*. 2010;5:94.
27. Powers MA, Cuddihy RM, Bergenstal RM, Tompos P, Pearson J, Morgan B. Improving blood pressure control in individuals with diabetes: a quality improvement collaborative. *Jt Comm J Qual Patient Saf*. 2011;37(3):110-119.
28. Hulscher ME, Schouten LM, Grol RP, Buchan H, Determinants of success of quality improvement collaboratives: what does the literature show? *BMJ Qual Saf*. 2013;22(1):19-31.
29. Action to Control Cardiovascular Risk in Diabetes Study Group; Gerstein HC, Miller ME, et al. Effects of intensive glucose lowering in type 2 diabetes. *N Engl J Med*. 2008;358(24):2545-2559.
30. The ADVANCE Collaborative Group; Patel A, MacMahon S, et al. Intensive blood glucose control and vascular outcomes in patients with type 2 diabetes. *N Engl J Med*. 2008;358(24):2560-2572.
31. Effect of intensive blood-glucose control with metformin on complications in overweight patients with type 2 diabetes (UKPDS 34). UK Prospective Diabetes Study (UKPDS) Group. *Lancet*. 1998;352(9131):854-865.
32. Zethelius B, Eliasson B, Eeg-Olofsson K, et al. A new model for 5-year risk of cardiovascular disease in type 2 diabetes, from the Swedish National Diabetes Register (NDR). *Diabetes Res Clin Pract*. 2011;93(2):276-284.
33. Cederholm J, Eeg-Olofsson K, Eliasson B, Zethelius B, Gudbjornsdottir S. A new model for 5-year risk of cardiovascular disease in type 1 diabetes; from the Swedish National Diabetes Register (NDR). *Diabet Med*. 2011;28(10):1213-1220.
34. Tricco AC, Ivers NM, Grimshaw JM, et al. Effectiveness of quality improvement strategies on the management of diabetes: a systematic review and meta-analysis. *Lancet*. 2012;379(9833):2252-2261.
35. Thorpe CT, Fahey LE, Johnson H, Deshpande M, Thorpe JM, Fisher EB. Facilitating healthy coping in patients with diabetes: a systematic review. *Diabetes Educ*. 2013;39(1):33-52.
36. International Diabetes Federation Europe. *Diabetes—The Policy Puzzle Is Europe Making Progress?* 2nd ed. . http://www.fend.org/sites/default/files/Diabetes-Policy-Puzzle-3rd-ed-2011.pdf. Published 2011. Accessed September 5, 2012.
37. Thor J. *Getting Going on Getting Better: How Is Systematic Quality Improvement Established in a Healthcare Organization? Implications for Change Management Theory and Practice*. . Stockholm, Sweden: The Medical Management Center, Department of Learning, Informatics, Management and Ethics, Karolinska Institutet; 2007:66.
38. Dixon-Woods M, Bosk CL, Aveling EL, Goeschel CA, Pronovost PJ. Explaining Michigan: developing an ex post theory of a quality improvement program. *Milbank Q*. 2011;89(2):167-205.
39. Schouten LM, Hulscher ME, van Everdingen JJ, Huijsman R, Grol RP. Evidence for the impact of quality improvement collaboratives: systematic review. *BMJ*. 2008;336(7659):1491-1494.
40. Walshe K, Freeman T. Effectiveness of quality improvement: learning from evaluations. *Qual Saf Health Care*. 2002;11(1):85-87.
41. Parand A, Benn J, Burnett S, Pinto A, Vincent C. Strategies for sustaining a quality improvement collaborative and its patient safety gains. *Int J Qual Health Care*. 2012;24(4):380-390.
42. Carlhed R, Bellman C, Bojestig M, et al. Quality improvement in coronary care: analysis of sustainability and impact on adjacent clinical measures after a Swedish controlled, multicenter quality improvement collaborative. *J Am Heart Assoc*. 2012;1(4):e000737.
43. Brandrud AS, Schreiner A, Hjortdahl P, Helljesen GS, Nyen B, Nelson EC. Three success factors for continual improvement in healthcare: an analysis of the reports of improvement team members. *BMJ Qual Saf*. 2011;20(3):251-259.
44. Ovretveit J, Bate P, Cleary P, et al. Quality collaboratives: lessons from research. *Qual Saf Health Care*. 2002;11(4):345-351.