

Reducing cancellations of planned operations

*A case study of improving the quality of care at a district
general hospital*

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Scientific environment

I have had a 3-year PhD grant from Sogn and Fjordane University College, and I have participated in the doctoral program in the Department of Public Health and Primary Health Care, University of Bergen.

My main advisor has been Oddbjørn Bukve (Professor in the Department of Social Science, Sogn and Fjordane University College). Additionally, I have had three co-supervisors: Kjell Haug (Professor in the Department of Public Health and Primary Health Care, University of Bergen), Aslak Bjarne Aslaksen (Head of the Department of Radiology, Haukeland University Hospital, and Associate Professor at the Institute of Surgical Sciences, University of Bergen), and Christian von Plessen (Chief Physician in the Department of Thoracic Medicine & Infectious Disease, Hillerød Hospital, Denmark, Associate Professor in the Faculty of Social Sciences, University of Stavanger, teacher at the University of Copenhagen, and IHI Boston Improvement Advisor).

I have participated in the social epidemiology research group in the Department of Public Health and Primary Health Care, University of Bergen, and the PhD forum at Sogn and Fjordane University College, Department of Social Science.

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List of abbreviations

IOM: Institute of Medicine

SPSS: Statistical Package for the Social Sciences

CI: Confidence interval

MUSIQ: Model for Understanding Success in Quality Improvement

ELO: Evidence in the learning organization

CAS: Complex adaptive systems

SECI: Socialization, Externalization, Combination, and Internalization

Abstract

Background

Cancellations of planned surgeries are a well-recognized quality problem in healthcare. They harm patients and waste resources, leading to increased healthcare costs and undermining patient-centered care that is one of the core values of healthcare. Previous research on interventions to reduce cancellations has mainly addressed earlier and improved preoperative assessment as means to reduce cancellations and assessed outcomes from a management perspective (i.e., by focusing on costs, length of stay, improved efficiency, and reduced postoperative complications).

Førde Hospital had experienced high cancellation rates and decided to redesign the clinical pathway for elective surgery to reduce cancellations, increase efficiency, and make care more patient-centered. In this dissertation, I use different perspectives to assess whether and how the interventions affected the quality of care. I also explore how contextual factors affected the outcomes and factors that contributed to sustained improvements.

Material and methods

Together with my advisors, I conducted a case study with quantitative and qualitative data. The case was Førde Hospital's project for redesigning their clinical pathway for elective surgery.

We interviewed employees to explore how the pathway was redesigned, the impact of contextual factors, and the factors that contributed to sustained improvements. To assess the effect of the interventions, we collected the number of planned, performed, and cancelled operations from the patient administrative system. We interviewed patients to study how they experienced the changes. We used Student's *t*-test to compare cancellation rates before and after the intervention and statistical process control to assess whether the improvements coincided with the interventions and whether the improvements were sustained. We performed a content analysis of the

interview data and related the findings to theoretical frameworks.

Findings

The mean cancellation rate was reduced from 8.5% to 4.9% (95% CI for mean reduction, 2.6-4.5; $p < 0.001$) after the interventions. The median number of operations performed per month increased from 323 to 378 ($p = 0.04$). The improvements coincided with the interventions and were sustained more than 2 years after the interventions. According to the patients, the pathway was changed in a way that responded to their wants and needs; thus, care became more patient-centered.

The expedient use of information technology and sufficient time to rework the clinical processes, together with the improvement strategy, were important contextual factors that influenced the success of the project. The core element of the strategy was improvement through the involvement of clinicians in changing the clinical system. Changes should equally address client quality, professional quality, and management quality. These overall objectives were further operationalized into clinical problems to which the clinicians could relate.

The clinicians improved their understanding of the clinical system and its interdependencies during the course of the improvement project. This new understanding contributed to sustained improvements by influencing important stages of the improvement process. It influenced how they inquired about the quality problems, how they developed interventions, and how they adapted interventions to their context.

Conclusion

The changes that were made to the pathway for elective surgery contributed to improvements in the quality of care. Care became more efficient, timely, and patient-centered. Clinicians' new understanding of their clinical system represented a new mental model that was shared at the organizational level. This new mental model induced changes in organizational behavior; hence, double-loop learning occurred.

Changes that originate from double-loop learning are more likely to be sustained because deeper structural elements are changed. The new understanding contributed to an enhancement of the clinicians' understanding of the underlying causes of cancellations and made them more able to plan and implement interventions in alignment with the complexity of the problems. Furthermore, the new understanding enhanced their ability to adapt interventions to their context. The improvement strategy provided the clinicians with a holistic framework for their approach to quality improvement. Hence, they were able to achieve synergy in their improvements by implementing a set of interventions that simultaneously improved efficiency and patient centeredness.

List of publications

Paper 1:

Hovlid, E., Bukve, O., Haug, K., Aslaksen, A., & von Plessen, C. (2012). A new pathway for elective surgery to reduce cancellation rates. *BMC Health Services Research*, 12(1), 154.

Paper 2:

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Paper 3:

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Contents

SCIENTIFIC ENVIRONMENT.....	2
ACKNOWLEDGEMENTS.....	3
LIST OF ABBREVIATIONS.....	5
ABSTRACT	6
LIST OF PUBLICATIONS.....	9
CONTENTS.....	10
1. INTRODUCTION	13
2. BACKGROUND.....	15
2.1 KNOWLEDGE STATUS AND KNOWLEDGE GAPS FOR RESEARCH ON CANCELLATIONS OF PLANNED SURGERIES	15
2.2 DESCRIPTION OF THE CASE	16
2.3 QUALITY IMPROVEMENT IN HEALTHCARE	17
2.4 HEALTHCARE QUALITY	20
2.4.1 <i>The use of perspectives to define healthcare quality</i>	20
2.4.2 <i>Generic definitions</i>	21
2.4.3 <i>Quality dimensions</i>	22
2.4.4 <i>An integrated quality concept</i>	23
2.5 KNOWLEDGE GAPS WITHIN RESEARCH ON QUALITY IMPROVEMENT	24
2.5.1 <i>Interventions</i>	24
2.5.2 <i>Contextual factors</i>	25
2.5.3 <i>Sustainability of improvements</i>	25
3. ANALYTIC FRAMEWORK AND OBJECTIVES.....	26
3.1 FRAMEWORK FOR ASSESSING THE EFFECTS OF INTERVENTIONS	27

3.2	FRAMEWORKS FOR EXPLORING THE EFFECT OF CONTEXTUAL FACTORS.....	27
3.3	FRAMEWORKS FOR EXPLORING THE SUSTAINABILITY OF IMPROVEMENTS	28
3.4	ANALYTIC MODEL AND RESEARCH QUESTIONS	32
4.	MATERIAL AND METHODS	33
4.1	CHOICE OF METHODS	33
4.2	COLLECTION AND ANALYSIS OF QUANTITATIVE DATA	34
4.3	DATA COLLECTION AND ANALYSIS OF QUALITATIVE DATA	36
4.3.1	<i>Interviews with employees</i>	36
4.3.2	<i>Interviews with patients</i>	36
4.3.3	<i>Analysis of qualitative data</i>	38
4.4	ETHICAL CONSIDERATIONS	39
4.5	LITERATURE REVIEW	40
4.6	METHODOLOGICAL CONSIDERATIONS AND LIMITATIONS	40
4.6.1	<i>Study design</i>	40
4.6.2	<i>Data collection</i>	42
4.6.3	<i>Data analysis</i>	44
5.	RESULTS.....	47
5.1	THE INTERVENTIONS	47
5.2	THE EFFECTS OF THE INTERVENTIONS	47
5.3	PATIENT EXPERIENCES WITH THE CHANGES	49
5.4	CONTEXTUAL FACTORS	51
5.5	FACTORS THAT CONTRIBUTED TO THE SUSTAINABILITY OF THE IMPROVEMENTS	53
6.	DISCUSSION.....	55
6.1	THE INTERVENTIONS	55
6.2	THE EFFECTS OF THE INTERVENTIONS	56

6.2.1	<i>Client perspective</i>	57
6.2.2	<i>The management perspective</i>	58
6.2.3	<i>The professional perspective</i>	59
6.2.4	<i>Integrated quality improvement</i>	60
6.3	HOW ELEMENTS OF THE INTERVENTIONS CONTRIBUTED TO THE OBSERVED EFFECTS.....	61
6.3.1	<i>Reasons for reduction of cancellation rates</i>	61
6.3.2	<i>Alternative explanations for the reduction of cancellation rates</i>	62
6.3.3	<i>Increase in operations performed</i>	64
6.3.4	<i>Patient-centered care</i>	65
6.4	CONTEXTUAL FACTORS	66
6.4.1	<i>External environment</i>	67
6.4.2	<i>Organization</i>	68
6.4.3	<i>Quality improvement teams</i>	69
6.4.4	<i>Quality improvement support and capacity</i>	70
6.4.5	<i>Microsystem</i>	71
6.4.6	<i>Relationship between contextual factors</i>	72
6.5	SUSTAINABILITY OF IMPROVEMENTS.....	73
6.6	RELEVANCE OF THE FINDINGS	77
7.	CONCLUSION	79
7.1	MAIN FINDINGS	79
7.2	FUTURE RESEARCH.....	81
8.	REFERENCES	83

1. Introduction

Cancellations of planned operations are a well-recognized quality problem within the surgical field of medicine. Cancellations harm patients and waste scarce resources, leading to increased healthcare costs [1-3].

The reasons for cancellations are many. Accordingly, the problem may be addressed many possible ways [2, 4]. Previous research has not fully captured this complexity. It has mostly addressed how cancellations can be reduced through earlier and improved preoperative assessment. Furthermore, the effects of interventions have mostly been evaluated from a management perspective by focusing on increased efficiency and not from the perspective of those who suffer from cancellations (i.e., the patients).

The cancellations of operations are a persistent problem [4]. The reason for this is likely associated with the fact that we need more knowledge about how various interventions can effectively contribute to a reduction of cancellations, how improvements can be sustained, and how successful improvements can be spread to new settings. The aim of this dissertation is to contribute knowledge about interventions that can reduce cancellations, the effect of such interventions, how contextual factors affect the improvements, and the factors that can contribute to sustained improvements.

The dissertation is based on a case study conducted at Førde Hospital. The hospital had experienced high cancellation rates and redesigned the pathway for elective surgery by implementing interventions to reduce cancellations. Through three papers, I studied the steps that Førde Hospital took to reduce cancellations and evaluated the outcomes from different perspectives using quantitative and qualitative data. More specifically, I studied which interventions Førde Hospital implemented to reduce cancellations (Paper 1), assessed the effects of the interventions (Paper 1), explored how patients experienced the changes (Paper 2), explored how contextual factors affected the change process (Papers 1 and 3), and explored the factors that

contributed to sustained improvements (Paper 3).

Sustaining improvements and spreading them from one setting to another is not only a challenge for the particular quality problem studied in this dissertation. It also applies to healthcare quality improvement in general [5-8]. Over the past decades, there have been numerous initiatives that sought to improve different aspects of the quality of care, such as patient safety, patient centeredness, and the effectiveness of care (i.e., care based on scientific knowledge) [7-9]. Despite these initiatives, progress in improving the quality of care has been slow and scattered [10-14]. The reason for this is likely associated with the fact that we have limited knowledge about what interventions we can implement to improve various aspects of the quality of care, how improvements can be sustained, and how successful improvements can be spread from one setting to another [5-8].

I present knowledge about interventions that can reduce cancellations and knowledge about the factors that can contribute to sustaining such improvements. Furthermore, I present knowledge about how contextual factors influence the change process, which in turn can facilitate the spread of improvements to new settings. Therefore, I suggest that findings from this case study are relevant to the quality problem, specifically the cancellations of planned operations. Knowledge about the influence of contextual factors on improvements and knowledge about the factors that contribute to sustained improvements do not have to be unique to one particular quality problem. I suggest that findings from this case study can also be relevant to healthcare quality improvement in general.

2. Background

2.1 Knowledge status and knowledge gaps for research on cancellations of planned surgeries

Cancellation rates vary in different settings, from less than 1% to as high as 23% [1, 15, 16]. The reasons for cancellations are complex because they are related to patients, organizational issues, and clinical staff [2, 4]. One major reason for cancellations is inadequate medical pre-assessment, suggesting that cancelled patients might not have received care that is consistent with the best medical evidence prior to surgery [1, 2]. Other common causes for cancellations are ineffective planning and coordination within the clinical units, list overruns (i.e., all of the scheduled operations are not completed within the specified time frame), and patients who do not show up for their scheduled appointments [2, 16-20]. The literature suggests that more than half of the cancellations could be avoided by redesigning work processes, improving planning and coordination, and performing earlier clinical pre-assessment of the patients [16, 18, 21].

Previous research on how to reduce cancellations has not fully captured the compound reasons for cancellations. It has mostly addressed how cancellations can be reduced through earlier and better clinical pre-assessment and improved surgery scheduling [4, 17, 22-28]. The effects of the interventions have been evaluated from both management and medical perspectives, focusing on costs, length of stay, improved efficiency, and reduced postoperative complications [17, 25, 27, 29-31]. Knowledge about the long-term effects of combined interventions that include more elements than solely improved preoperative medical assessment and scheduling is therefore sparse.

Cancellations of planned surgeries cannot be simply reduced to a quality problem regarding the inefficient use of resources. From a patient perspective, cancellations represent increased waiting times and potentially harmful delays. Patients tend to react negatively when their surgery is cancelled [3, 32], and the cancellation itself and

extra waiting time may even cause physical and emotional distress [33]. To my knowledge, the effect of combined interventions has previously not been explored from the perspective of patients, those who suffer the most from cancellations.

2.2 Description of the case

I conducted a case study at Førde Hospital to gain more knowledge about how compound interventions can contribute to a reduction of cancellations and the effects of such interventions on the quality of care. The hospital had experienced high cancellation rates. Resources within the involved departments were not optimally used, and patients had complained about waiting times and unclear information prior to surgery. The management, therefore, initiated an improvement project to reduce cancellations and make care more patient-centered.

Førde Hospital is a district general hospital located in a rural community of approximately 10,000 inhabitants. The hospital offers elective surgery within the following disciplines: general surgery, gynecology, orthopedics, ophthalmology, otolaryngology, and odontology. It has seven operating suites and 34 surgical beds. The local health authority also includes two smaller district hospitals. Altogether, the three hospitals serve a population of approximately 107,000. Norwegian patients have general health coverage through national state insurance, and most hospitals are publicly owned and run.

In 2007, the top management of the local health authority decided to work more systematically with quality improvement in general and developed a common strategy for conducting quality improvement projects. It was not based on any particular theoretical model but was mainly influenced by the Model of Improvement [34]. The core element of the strategy was to improve quality by changing the clinical system by involving frontline clinicians to improve clinical processes [35]. All of the projects were meant to have a broad approach to quality improvement by addressing professional quality, client quality, and management quality [36]. The management

also established a small administrative unit to support clinicians in their improvement efforts. Based on their systematic efforts to work with quality improvement, the hospital was selected in 2008 to serve as a pilot hospital for improvement work in the western health region of Norway.

In 2007, the health authority board decided to increase the number of day surgeries. Middle managers at Førde Hospital used the board's decision as leverage to initiate an improvement project aimed at redesigning the clinical pathway for elective surgery. The improvement project involved all of the surgical departments at Førde Hospital.

The redesign of the clinical pathway was the first project that was run in accordance with the health authorities' newly developed improvement strategy. Four improvement groups with the broad participation of clinicians were established to suggest how various parts of the clinical pathway could be improved. Patient advocacy groups were also invited to participate in the groups but declined the invitation. Actual patient cases were instead used to focus improvement efforts on how care could be made more patient-centered. The interventions were planned between September 2007 and March 2008.

2.3 Quality improvement in healthcare

The project at Førde Hospital sought to improve the quality of care and is thus an example of quality improvement in healthcare. No common agreement has been reached about the definition of this concept [37]. Therefore, I will elaborate on different elements of this concept that are relevant to my dissertation.

Batalden and Davidoff [38] proposed an equation that seeks to explain the process of quality improvement and the elements involved in it. The equation consists of five elements: (1) generalizable scientific evidence, (2) particular context awareness, (3) performance measurement, (4) knowledge about how to induce change, and (5)

execution of planned changes.



Figure 1. Equation illustrating how different knowledge systems combine to produce improvement (Reprinted with permission from BMJ Group).

The equation recognizes that generalizable scientific evidence (1) is the foundation for quality improvement and that improvement is context-dependent because evidence is always introduced in a particular context (2). Introducing generalizable scientific evidence (1) to a particular context (2) requires knowledge (4) about how evidence can be applied and adapted to the particular context. Improvement takes action, and the fifth element (5) represents “the knowledge needed for execution – what you need to know to make things happen” [38, p 2]. The effects of the changes on performance should be quantified by measurements (3) to demonstrate that the changes in fact led to improvement.

Generalizable scientific evidence is interchangeable with evidence-based medicine or practice, which has been defined as “the explicit use of the best available evidence to inform decisions about the care of individual patients” [39, p 139, 40]. The important link between quality improvement and evidence-based medicine was also recognized by Mainz et al., who defined quality improvement as “the activities and methods applied to improve the quality of health care within the limits of current available knowledge” [41, p 39]. Evidence-based medicine is a well-established ideal within clinical medicine [42]. During the past decade, the activities undertaken to improve the quality of care were advocated to also be evidence-based [39, 43]. Shortell et al. [43] introduced the concept of evidence-based management to describe this phenomenon. The essence of this concept is that the way evidence-based medicine is implemented into routine practice should be based on evidence.

The equation recognizes that improvement does not happen by itself. Change requires systematic efforts, often referred to as interventions, that are specifically aimed at improving the quality of care [39, 44, 45]. Advances in individual, professional knowledge have traditionally been the basis for improvements in healthcare [46]. In the early stages of systematic efforts to improve the quality of care, interventions typically targeted individual factors, such as personal knowledge and the way routines were followed [46, 47]. These measures alone, however, were not sufficient to effect substantial improvement in the quality of care [46].

The lack of progress may be partially explained by the increasing complexity of medical services [48, 49]. In a complex clinical system, the quality of care is more dependent on how the elements that constitute the system function as a whole and to a lesser degree on the skills of individuals within the system [35, 49]. Quality improvement, therefore, relies on changing the clinical system that delivers the care. Accordingly, interventions should target the interdependencies of the clinical system so that its performance as a whole can be improved [35, 39, 50, 51].

The effects of interventions vary in different settings, indicating that conditions besides the interventions themselves must influence the outcomes [12, 52]. These conditions are referred to as contextual factors [53, 54]. Contextual factors have been defined as everything apart from the intervention itself [53, 54]. The line between context and intervention is not always clear, making this definition less useful [52, 55]. Øvretveit et al. defined context as "...influences which interact with each other, and interact with the implementation process" [53, p 609]. This way of viewing context embraces the fact that contextual factors and interventions may influence each other. Furthermore, it recognizes that "many improvements are not discrete single before-after changes but facilitated evolution" [45, 52, p i18]. Quality improvement, therefore, is dependent on knowledge about how interventions can be adapted to fit different contexts and how contextual factors influence the implementation process and outcome of the interventions [56].

“All improvement is change, but not all change is improvement” [35, p 450].

Batalden and Davidoff [38] highlighted the need for performance measurements to demonstrate that the changes we make in fact improve the quality of care. The effects of interventions are assessed according to how they affect the quality of care. Before we can assess improvements in the quality of care, we need to understand what healthcare quality is and how it can be defined [57].

2.4 Healthcare quality

Healthcare quality cannot be reduced to one global indicator [58]. It is a complex concept that can be assessed from different legitimate perspectives, with no unified definition [57, 58]. Healthcare quality has been defined using different approaches, such as perspectives, generic definitions, and dimensions. Below I will elaborate on each of these.

2.4.1 The use of perspectives to define healthcare quality

Donabedian [57] played a major role in developing a theory about how healthcare quality can be defined and understood. He suggested that healthcare quality could be assessed according to three perspectives: absolutist, individualized, and social [59].

The absolutist perspective refers to treatment that is expected to achieve the best balance between health benefits and risks, judged from the perspective of the professionals and based on current available knowledge [59]. The individualized perspective is healthcare quality assessed from the perspective of the individual patient. According to Donabedian [59], the patient and not the professional is the best judge of his or her own welfare. Ideally, the practitioner only provides expert information that can support patients in making their own decisions [59]. Donabedian [59] argued that monetary cost should be included in a definition of healthcare quality because society as a whole in some way needs to control costs related to delivering care. Therefore, he introduced the social perspective. This perspective differs from

the individualized perspective because “...society may place different valuations on the health and welfare of different segments of the population” and because “...some forms of care are more highly valued at the social level than others because their benefits are felt by more people than just the individual who uses them” [59, p 15-16]. By acknowledging that society needs to control the total cost, Donabedian also drew attention to a moral dilemma that the practitioner faces, namely the cost of care provided for an individual patient vs. the cost of care at the population level [59].

Øvretveit [36] further developed the thinking about quality perspectives and distinguished between three perspectives: client quality, professional quality, and management quality. Øvretveit’s client and professional perspectives are congruent with Donabedian’s [59] individualized and absolutist perspectives. Compared with Donabedian’s social perspective, Øvretveit’s management perspective more strongly emphasizes a limit to how many resources society can expend on healthcare and that this limit is set by higher authorities. According to Øvretveit, management quality can be understood as “using the fewest resources to give patients what they want and need without waste errors or delay, and within higher level requirements” [60, p 90]. The quality of care judged from this perspective, therefore, strongly emphasizes the allocation of resources and optimal usage of these resources to provide the patients with the care that they need.

Moreover, Øvretveit’s [36] perspectives make a more distinct reference to the three major stakeholders in modern healthcare—the patients who receive the care, the professionals who provide it, and management—which can be understood as the system that plans, organizes, and allocates resources on behalf of society. I find that Øvretveit’s reference to the major stakeholders makes his perspectives intuitively understandable.

2.4.2 Generic definitions

Generic definitions of healthcare quality can be understood as an attempt to combine the different quality perspectives to articulate a condensed statement that

characterizes healthcare quality. One of the first, widely recognized and used generic definitions of healthcare quality was introduced by the IOM in 1990 [61, p 21, 62]:

“Quality of care is the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge.”

The IOM [63] has elaborated on the meaning of the different elements in this definition. *Health services* refer to a wide array of services that affect health provided by various professional groups in different settings (e.g., primary care and hospitals). The definition addresses the fact that quality is not identical to good outcomes because diseases can defeat the best efforts of health personnel. The term *likelihood* recognizes an unknown aspect of healthcare. Consistent with Donabedian [59], the definition includes care at both individual and population levels and states that care should be based on evidence [63].

The problem with generic definitions is the challenge of combining all legitimate perspectives into one condensed statement. Furthermore, the statement can be so condensed that it becomes too lofty to be useful for actually assessing the quality of care. The IOM’s definition, for instance, does not make an explicit reference to Øvretveit’s [36] management perspective and the dilemma raised by Donabedian about monetary costs [59]. According to the IOM’s definition, *health services* are to produce *desired outcomes*. The definition, however, is too condensed to operationalize what desired outcomes are, and it does not operationalize what the health services should be to achieve the desired outcomes.

2.4.3 Quality dimensions

In their report *Crossing the Quality Chasm*, the IOM [51, p 5-6] operationalized desired outcomes and high-quality health services by introducing six aims that state that healthcare should be:

-
- *Safe*: avoiding injuries to patients from the care that is intended to help them.
 - *Effective*: providing services based on scientific knowledge to all who could benefit and refraining from providing services to those not likely to benefit (avoiding underuse and overuse, respectively).
 - *Patient-centered*: providing care that is respectful of and responsive to individual patient preferences, needs, and values and ensuring that patient values guide all clinical decisions.
 - *Timely*: reducing waits and sometimes harmful delays for both those who receive and those who give care.
 - *Efficient*: avoiding waste, including waste of equipment, supplies, ideas, and energy.
 - *Equitable*: providing care that does not vary in quality because of personal characteristics, such as gender, ethnicity, geographic location, and socioeconomic status.

Each of these six aims represents a dimension of healthcare performance. The six dimensions of the IOM aims are widely recognized and used for assessing the quality of care, and they are also the foundation for the Norwegian national strategy for quality improvement [64].

Additional quality dimensions have also been proposed (i.e., accessibility, competence, and continuity) [58, 65]. I argue that these dimensions are incorporated into the dimensions of the IOM. Competence can be understood as being part of effective care because competence is a prerequisite for delivering effective care, and continuity can be regarded as part of patient-centered care [66]. Accessibility can refer to physical, financial, and geographical access to care [58, 66], and it is captured by the IOM's *timely* and *equitable* care dimensions.

2.4.4 An integrated quality concept

The aforementioned quality dimensions incorporate all of Øvretveit's [36] quality perspectives. *Safe* and *effective* care makes reference to the professional perspective

because the professionals possess knowledge about what safe and effective care is. The client perspective is encompassed in the dimension that states that care should be *patient-centered* because only the patient can judge the extent to which care is patient-centered [67]. *Timely, efficient, and equitable* care makes reference to the management perspective, dealing with the effective use of resources and allocation of resources so that patients get care in a timely manner.

Although each quality dimension can be argued to have a primary relationship with one of Øvretveit's [36] quality perspectives, assessing each dimension from different perspectives is also possible. Timely care, for instance, can be assessed from the professional and client perspectives, in addition to the management perspective. Professionals have knowledge about how urgently care is needed, but their judgment may not be congruent with what the patient wants, illustrating that the perspectives may conflict with each another [36].

2.5 Knowledge gaps within research on quality improvement

Quality improvement is an immature research discipline [9, 68, 69], with a need to develop knowledge within a number of different fields, such as interventions, the impact of contextual factors, and the sustainability of improvements [9, 38, 45, 46, 53, 54, 68, 70-77]. Below I will elaborate on each of these fields.

2.5.1 Interventions

The quality of care is improved by changing the clinical system that delivers the care, and the clinical system can be changed by implementing interventions [35, 45, 78].

An important aim for research on quality improvement, therefore, is to identify interventions that can induce change and assess the effect of the interventions. In this dissertation, I provide knowledge about interventions that can contribute to the reduction of cancellations of planned operations.

As opposed to traditional medical research, in which interventions tend to involve few components that can be standardized, interventions that seek to change the clinical system are often multi-component and involve social change [69, 79]. To facilitate the spread of improvements, simply demonstrating that a particular intervention is effective is insufficient; we also need to explore how an intervention causes its effect and how contextual factors influence improvements [39, 54, 68].

2.5.2 Contextual factors

Contextual factors, such as resources, information technology, and leadership, can affect the improvement process [80]. Until now, most studies on quality improvement have been designed to evaluate the effects of the interventions [53, 54]. Few studies have used robust methods to report how contextual factors influence the outcomes [53, 54]. Research on contextual factors has also suffered from a lack of a common framework that assesses their impact [54, 55]. Hence, we have limited knowledge about how contextual factors affect improvements, and further research is needed into these matters.

2.5.3 Sustainability of improvements

Changes that improve the quality of care should be sustained. Improvements that are not sustained are a waste of resources. If the organization is unable to sustain new ways of working, then it may cause frustration and increase resistance to later initiatives to improve care [81].

Øvretveit defined sustainability as “sustained quality improvement is where either quality activities are continued, or improved results are maintained or exceeded. It often means both: continuing to use quality activities to maintain target results” [82, p 15]. This definition encompasses the sustainability of the interventions and outcome of the interventions. Interventions tend to be continuously adapted to the context and will consequently evolve over time [45, 53]. This adaptation process implies that elements of the original interventions might not warrant being sustained because they

are ineffective in a particular context [82]. Demonstrating sustained use of the intervention, therefore, is insufficient to demonstrate improved outcomes, and such a measure alone will not necessarily reflect sustainability. Hence, I will refer to sustainability as maintaining improved outcomes [82].

Few publications on quality improvement have reported the sustainability of changes [76, 77]. A systematic review of improvement projects in community health centers showed that many interventions performed well for a period of time and then waned [83]. Another systematic review that addressed research methods in healthcare quality improvement in general showed that the median follow-up time for interventions that sought to improve the quality of care was less than 1 year [73]. Research on sustainability has suffered from the lack of a widely used research paradigm with corresponding definitions and research questions [84]. Consequently, little is known about the factors that contribute to sustained improvements [9, 85, 86].

Most research on the sustainability of improvements in a healthcare setting has been performed in conjunction with public health programs [84, 87-89]. Such programs have much in common with quality improvement in a traditional medical setting. The program itself can be regarded as interchangeable with interventions [84]. Like quality improvements, the programs are implemented in complex social systems. They intend to improve outcomes for individuals, and they are context-dependent [87]. Previous research on public health programs, therefore, can be useful for exploring how improvements can be sustained.

3. Analytic framework and objectives

Theoretical frameworks can guide research on quality improvement because they can help us explore and understand the complex processes that are involved [79, 90, 91]. My dissertation addresses three domains in which theoretical frameworks can be useful for providing a deeper understanding: the effect of interventions, the impact of contextual factors on improvements, and the factors that contribute to the

sustainability of improvements.

3.1 Framework for assessing the effects of interventions

In this dissertation, I will assess the effects of the interventions with regard to a quality concept in which I combine different perspectives and dimensions. The advantage of using perspectives is that they refer to the main stakeholders in healthcare and as such are intuitively understandable and can readily be operationalized. Furthermore, one of the objectives of this dissertation is to explore patients' experiences with the changes, which corresponds with Øvretveit's client perspective [36]. In the previous section, I indicated that quality perspectives can be readily combined with quality dimensions. Such a combination will provide a more comprehensive concept of quality because the dimensions of quality more clearly operationalize what constitutes high-quality health services.

The quality of care can be assessed using quality indicators (i.e., measurable variables) that reflect the quality of care with respect to the various quality dimensions or subcategories of these [41, 65]. These quality indicators are typically related to Donabedian's [92] framework of structure, process, and outcome [93, 94]. Data that underlie these indicators should be congruent with the perspective from which the quality is assessed (i.e., to assess whether care is patient-centered, the data must be collected from patients because only the patient can judge whether the care is patient-centered) [36, 67]. The quantitative data in this case study included measurable variables, such as the cancellation rate and number of operations performed, which can serve as quality indicators.

3.2 Frameworks for exploring the effect of contextual factors

In recent years, a few frameworks for exploring and analyzing the effects of

contextual factors have been developed. Damschroder et al. [95] developed the Consolidated Framework for Implementation Research, which consists of five domains: intervention characteristics, outer setting, inner setting, characteristics of individuals, and the process of implementation. Three of these domains, inner and outer settings and the characteristics of individuals, can be considered aspects of context [54]. Taylor et al. [75] proposed a framework for analyzing contextual factors. In contrast to the framework developed by Damschroder et al. [95], which targets quality improvement in general, this framework specifically addresses contextual factors in relation to interventions to improve patient safety.

I use the Model for Understanding Success in Quality Improvement (MUSIQ) as a framework for systematizing and discussing the impact of contextual factors in this dissertation [80]. This is the most recently developed framework, and it captures most of the factors identified in the aforementioned frameworks. Furthermore, the MUSIQ is built around the different organizational levels that are typically involved in improvement work: organization, microsystem, and quality improvement team. The contextual factors are organized according to the level of their influence [80]. Another advantage of the MUSIQ framework is that it takes into account that contextual factors might influence each other [80].

Altogether, the MUSIQ identifies 25 categories of contextual factors that may influence the success of quality improvements. These 25 categories are structured around six main categories: external environment, organization, quality improvement support and capacity, microsystem, quality improvement team, and miscellaneous [80].

3.3 Frameworks for exploring the sustainability of improvements

The quality of care is improved by changing the clinical system, which in turn

requires a change in organizational behavior [35, 51]. Theories of organizational learning explain changes in organizational behavior. According to Argyris and Schön [96], learning is the translation of new knowledge into altered behavior that is replicable. To achieve improvement, an organization needs to alter its behavior, and the behavioral changes must be replicable to sustain the improvements. Sustained improvement can thus represent a case of organizational learning, and organizational learning frameworks can be suitable for exploring the factors that influence the sustainability of improvements.

Evidence in the Learning Organization (ELO) is a recently developed model that describes how healthcare organizations learn, create, and share knowledge about evidence-based practices and the systemic issues that facilitate or inhibit these learning processes [97]. This model is based on theories about organizational learning and is structured around four main themes: inquiring, deciding, relating, and interpreting. Clinicians need to inquire to identify a need to change and make decisions about how to facilitate change. Furthermore, the changes are to be implemented and integrated into an organization and must therefore be related to its particular context. To relate changes to their particular context, clinicians need to interpret and share their tacit knowledge.

The ELO model itself does not specifically elaborate on how new knowledge is created, how individual learning is transformed into organizational learning, or what organizational mechanisms are involved in the change process. These questions are important for exploring how an organization changes its behavior and performance. To better understand these processes, I include four of the theoretical frameworks that underlie the ELO model: Argyris' and Schön's [98] loop learning, Kim's [99] concept of organizational learning, Nonaka's [100] Socialization, Externalization, Combination, and Internalization (SECI) model, and the framework of Complex Adaptive Systems (CAS) [48]. These theoretical frameworks together can be useful for exploring the factors that contribute to sustained organizational changes. The concept of single- and double-loop learning explains the actual learning process in the

organization [98]. Kim's [99] model explains the transformation from individual to organizational learning through mental models. The SECI model explains how tacit knowledge is shared and how mental models are incorporated and shared at the organizational level [100]. The CAS framework elucidates what consequences interdependencies in a clinical system can have for organizational behavior and performance [101].

We have limited knowledge about the factors that affect the sustainability of improvements. Presently, few relevant frameworks have explicitly addressed this topic [77]. By reviewing the sustainability literature, I identified two models that are suitable for exploring the sustainability of improvements within healthcare: the Sustainability Model of the National Health Services (NHS) [102] and Gruen et al.'s [87] model for sustainability of public health programs. Although the model of Gruen et al. was developed for public health programs, it has been suggested that the model can also be useful for understanding how improvements in a traditional clinical setting can be sustained [103].

The NHS model was primarily intended as a diagnostic tool that can be used to predict the likelihood of the sustainability of an improvement project in the planning phase [102]. The model consists of 10 factors that are considered to be important for sustaining change: benefits beyond helping patients, credibility of evidence, adaptability, monitoring progress, infrastructure, fit with goals and culture, training and involvement, attitudes, senior leaders, and clinical leaders. The factors are grouped into three categories: process, organization, and staff. The NHS Sustainability Model was later supplemented by the NHS Sustainability Guide, which provides practical advice related to the 10 factors in the model.

As opposed to the NHS Sustainability Model that lists factors, the model of Gruen et al. [87] provides a dynamic representation of how various factors interact to promote sustainability. I found this model to be more useful for discussing the factors that influence sustainability. The model was developed on the basis of an extensive

literature review and incorporates three key components: program, health, and drivers (Figure 2) [87]. *Health* refers to the health concerns that the *program* addresses. These two components can be considered interchangeable with quality problems and interventions. *Drivers* represent the factors that influence the implementation and effectiveness of the program [87]. With regard to quality improvement, these three components are surrounded by context and resources.

The two-way arrows in the model indicate that the interactions between the three components are dynamic. Thus, improvements cannot be understood as a linear, sequential process that comprises the identification of the problem and implementation and adaptation of interventions. Furthermore, the model suggests three factors that influence the interaction between the three components: quality cycle, problem definition, and political economy.

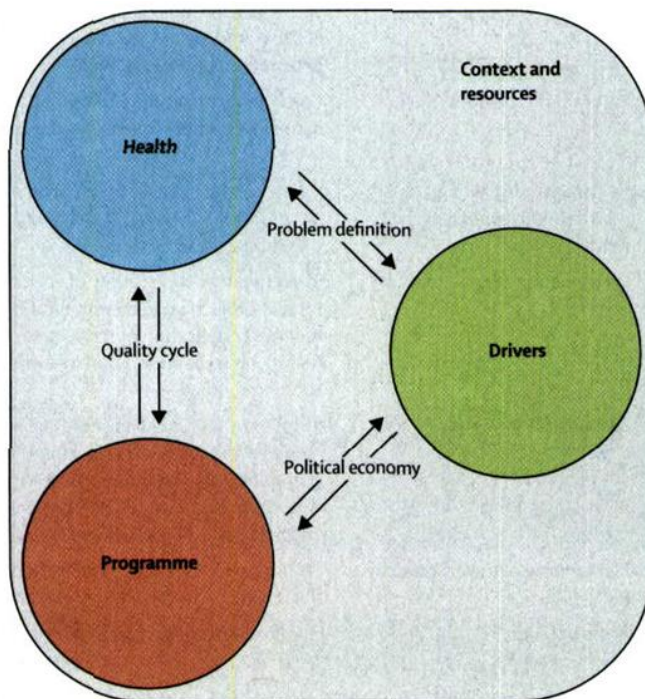


Figure 2. A model for sustainable health programs (Reprinted with permission from Elsevier).

3.4 Analytic model and research questions

Figure 3 is based on Donabedian's [92] structure, process, and outcome model and illustrates my analytical model. The interventions in the case study targeted structures and processes to improve outcomes. They were implemented in a particular context. The way contextual factors interacted with the interventions affected the change process. The figure also indicates that improvements should be sustained, and factors can contribute to this. The numbers in the figure refer to the following research questions:

1. What interventions did Førde Hospital implement to reduce cancellations?
2. What were the effects of these interventions?
3. How did the patients experience the changes?
4. How did contextual factors affect the change process?
5. What factors contributed to the sustainability of the improvements?

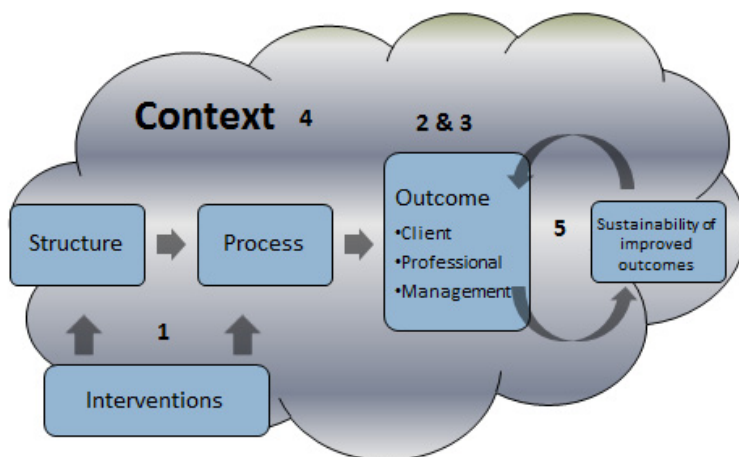


Figure 3. Analytical model.

4. Material and methods

4.1 Choice of methods

The interventions that were implemented at Førde Hospital contained several components that interacted with each another and with contextual factors to produce the outcomes. Furthermore, the interventions targeted a large group of people and different organizational levels. The interventions fulfill the criteria for complex interventions as defined by Craig et al. [104]. Consistent with the recommendations offered by Davidoff, our research questions were not limited to demonstrating the effect of the interventions. We also studied how contextual factors influenced the effects and factors that contributed to sustaining the improvements. Thus, we used a retrospective, observational case study design with multiple units of analysis that combined qualitative and quantitative data to explore our research questions [105-107]. We choose Førde Hospital as the case because it was potentially interesting based on their reputation of working systematically with quality improvement. Furthermore, we were given permission to collect qualitative and quantitative data, which included longitudinal outcome measures that enabled us to study the sustainability of improvements.

As recommended by Yin, we studied the case using different perspectives [108]. We took advantage of the flexibility offered by the case study design, in which one finding can provide directions for further data collection and analysis [108]. First, we explored what the hospital actually did to improve care and assessed the outcomes of the interventions (Paper 1). Second, we assessed how the patients experienced the outcomes of the interventions (Paper 2). Our analysis of these data enabled us to have a different perspective and use theoretical frameworks to explore how contextual factors influenced the change process and the sustainability of improvements (Papers 1 and 3).

We used qualitative data from interviews with employees and quantitative measures from the hospital's administrative system to study the interventions and assess their

effects. Because of limited knowledge about patients' experiences with interventions to reduce cancellations and because experiences are qualitative by nature, we used qualitative data to explore how patients perceived the outcomes of the interventions [109]. We used qualitative data from interviews with employees to explore how contextual factors influenced the outcomes and explore the factors that contributed to sustained improvements. Below I describe how we collected and analyzed the quantitative and qualitative data.

4.2 Collection and analysis of quantitative data

From the hospital's patient administrative system, we obtained the number of planned and performed operations and cancellations per month. Based on these numbers, we calculated the monthly cancellation rates. A planned operation that was cancelled within 24 h of the scheduled time was defined as a cancellation.

As recommended by Dexter et al. [110], we compared transformed cancellation rates before and after the interventions using a *t*-test because this method has been shown to be robust for comparing cancellation rates [110]. We transformed the monthly cancellation rates using Freeman-Turkey Double Arcsin Transformation and applied Student's *t*-test on the transformed rates using SPSS 18.0 software [110]. We used statistical process control to analyze whether changes in cancellation rates coincided with the interventions and whether improvements were sustained. The cancellation rate is nonconformance per unit (the number of cancelled operation divided by the total number of planned operations per month); therefore, we used a U-chart. We used the Mann-Whitney U test to compare scheduled and performed operations before and after the interventions because these numbers were not normally distributed.

Because cancellations varied by specialty, an increase in the number of operations performed after the interventions in a department with low cancellation rates could disproportionately affect the total number of cancellations at the hospital [4]. To

assess this effect, we calculated the expected number of cancellations for each department for the time period after the interventions (i.e., the product of pre-intervention cancellation rates and number of scheduled operations after the interventions for each department). Based on these numbers, we calculated the expected cancellation rate for the entire hospital for the time after the interventions (i.e., the sum of the expected number of cancellations for each department divided by the total number of scheduled operations).

We recorded the volume of elective surgeries, emergency surgeries, and consultations at outpatient clinics because an increase in the volume of one of these activities could affect the volume of any of the others. Data on emergency cases for the Department of Ophthalmology were incomplete and therefore excluded (it accounted for less than 1% of the total number of emergency cases). To compare the number of emergency cases before and after the intervention, we used the Mann-Whitney U test. To compare the number of consultations at the outpatient clinics, we used Student's *t*-test.

Changes in the ratio of capacity and demand could influence the cancellation rate [23]. We measured capacity as the number of hours available for surgery per week and number of full-time equivalents per year for the involved departments. Data on full-time equivalents were only available after January 2008 because the hospital changed its data system. We used the number of scheduled operations per month as a measure of demand.

The degree of utilization of the list of scheduled operations, particularly list overruns, can influence cancellation rates [17]. Consistent with Pandit et al. [17], we classified a list that finished $> 10\%$ after the scheduled end time as overrunning. Data about list overruns were only available for the time after the interventions. Finally, we recorded the number of cancellations per month caused by the hospital not being able to finish the scheduled list and used Student's *t*-test to compare this measure before and after the interventions.

4.3 Data collection and analysis of qualitative data

4.3.1 Interviews with employees

We interviewed employees to explore how the hospital redesigned the pathway for elective surgery, how contextual factors and the interventions influenced the outcomes, and how the improvements were sustained. Interviews were semi-structured and based on a guide. The guide was grounded in a literature review and administrative hospital documents that described the overall aim of the improvement project and mandate of the improvement teams. The documents were not subject to a formal document analysis. They were merely used as background information when developing the interview guide [105]. The questions in the guide covered the typical phases of an improvement project: local problem, setting, context, intended improvement, planning of interventions, implementation of interventions, outcomes, and efforts to sustain outcomes [78]. Questions about how the organization changed its behavior were based on the four themes of the ELO model, reflecting the tasks that an organization needs to address to create and share new knowledge [97].

We used purposive sampling. To cover a wide range of viewpoints, we recruited interviewees with different professional backgrounds (e.g., physicians, nurses, secretaries, and leaders) who worked in different departments that were involved in the clinical pathway that was changed [111]. Furthermore, the interviewees' degree of participation in the improvement work varied. Some had participated in planning the interventions, whereas others were not directly engaged in the work. I completed interviews with 20 employees during June and July 2010. Each respondent was interviewed once. Table 1 in Paper 2 presents the characteristics of the interviewees.

4.3.2 Interviews with patients

We collected qualitative data through interviews with patients to explore their experiences with the interventions aimed at reducing cancellations. To enhance data validity, we included patients from two hospitals, Hospital A and Hospital B [105]. These two hospitals belong to the same local health authority and share the same top

management. Hospital A is Førde Hospital, where the pathway was redesigned. Hospital B was used for comparison and is a local hospital with three operating suites and 14 surgical beds. It performs gynecological and orthopedic surgery. Initially, both hospitals had a similar clinical pathway for elective surgery and faced the same quality problems with their services for elective surgery. The management of the health authority, therefore, planned to redesign the pathways in both hospitals. For practical reasons, the plan was abandoned at Hospital B, which gave us the opportunity to compare patient experiences from the redesigned and original pathways, thereby relating the experiences to the interventions.

Clinicians at Hospitals A and B recruited 10 and 8 patients, respectively, to the study. They handed out an information letter that described the purpose of the study to patients who received their medical pre-assessment before surgery. Patients who wanted to participate in the study signed an informed consent form. This form was returned to me, and I contacted the patients by phone after they had completed their surgery to schedule the interviews.

The interviews were semi-structured and followed a guide with open-ended questions that were structured around the phases that patients went through to have their surgery performed: consultation at the outpatient clinic, the time spent waiting for surgery, and the stay in the hospital when surgery was performed. Before developing the guide, we reviewed the literature on patients' experiences with interventions to improve care [112-115]. The guide also included open-ended questions about how the patients experienced their care with regard to the interventions that had been implemented (e.g., new procedures for scheduling surgery and calling patients at home prior to surgery).

I completed telephone interviews with 18 patients (14 patients, two mothers, and two fathers) between January and March 2011. When the patients were less than 18 years of age, I interviewed one of their parents. One patient withdrew his/her consent to participate, and one interview was incomplete because of technical difficulties. Thus,

16 interviews were eligible for analysis (eight from Hospital A and eight from Hospital B). The characteristics of the interviewees are provided in Table 2 in Paper 2.

4.3.3 Analysis of qualitative data

We followed a similar approach when we analyzed the interviews with employees and patients, guided by three generic steps as described by Creswell [116]: preparing and organizing data, reducing data into themes through a process of coding and condensing, and representing the findings in figures, tables, and a discussion.

Analysis of employee interviews

First, we analyzed the employee interviews to understand how the pathway had been redesigned. We structured our data chronologically according to the various phases of the improvement project. We then performed a content analysis as described by Hsieh and Shannon [117].

In accordance with the knowledge we derived from the literature review, we developed a coding scheme based on the following categories: local context, need to improve, interventions, implementation, effects of interventions, and adaptation of interventions. I coded the interviews. By reflecting on the codes and interpreting the relationships between them, we reduced the data into themes and identified how the hospital had planned and implemented interventions to address the quality problems, the intended effects of the interventions, and the actual effects of the interventions. We compared quantitative measures with qualitative descriptions of the intended mechanism for change to enhance the rigor of our analysis.

We performed a content analysis of the interviews with the employees to explore how contextual factors affected the improvements [117]. The codes were derived from the data [117]. I coded the dataset. By reflecting on the codes, we identified common themes and related these themes to the entire improvement process that we had identified in our previous analysis [109]. These themes, in turn, were related and

categorized according to the MUSIQ framework [80].

To explore how the improvements were sustained, we performed a content analysis of the employee interviews using a coding scheme based on the main themes in the ELO model [97, 117]. I coded the dataset. During the analysis, I added new codes derived from the data [116]. Through an iterative process of coding, reflecting on the codes, and condensing, we identified common themes [109]. We interpreted the themes with regard to our theoretical frameworks and represented the relationship between the themes in Figure 1 in Paper 3 [116, 118].

Analysis of patient interviews

We performed a content analysis to explore how the patients experienced the interventions [117]. We developed a coding scheme that reflected the interventions that the hospital had implemented to improve the quality of care: earlier clinical pre-assessment, patient participation in scheduling surgery, telephone call to patients prior to surgery, and centralized preparation and discharge. I coded the interviews and identified passages where the patients described experiences related to these interventions. We compared patient experiences from the two hospitals to identify how the patient experiences were related to the actual interventions that were implemented to reduce cancellations. Through an iterative process of coding, reflecting on the codes, and condensing, we identified common themes for how the patients experienced the interventions [116].

4.4 Ethical considerations

The Western Department of the Regional Committee for Medical and Health Research Ethics in Norway deemed a full ethical review unnecessary because the study did not use sensitive patient data. The Norwegian Social Science Data Services reviewed ethical aspects related to collecting and handling data (i.e., voluntary participation based on informed consent, anonymity of informants, and data storage) and approved the study protocol. Employees and patients participated voluntarily,

based on informed, written consent, and could withdraw from the study at any time.

4.5 Literature review

Relevant literature for the dissertation was found by combining intuitive and formal search techniques. I searched PubMed and Google Scholar using various phrases, including “surgery cancellation,” “quality improvement,” “context,” “quality improvement sustainability,” “quality improvement research agenda,” and “quality improvement learning theory.” Articles identified through this search served as a starting point for intuitive approaches using their reference lists, related articles, and citing articles in PubMed. I also performed a manual search of the latest volumes of *BMJ Quality and Safety*. The final date for the literature search was April 30, 2012.

4.6 Methodological considerations and limitations

Below I discuss the methodological considerations and limitations of our case study and what steps we took to enhance the quality and credibility of our research [108]. I structured the discussion around the following three main themes: study design, data collection, and data analysis.

4.6.1 Study design

Choosing a design

Our case study was observational and retrospective. Such a design has the limitations of information bias and confounding. Therefore, we cannot prove causality between the interventions and the observed outcomes. According to Yin, a case study is a suitable design when “how and why questions are being asked about a contemporary set of events, over which the investigator has little or no control” [105, p 13].

Furthermore, a case study design is particularly suitable for exploring how context influences outcomes [108]. The research questions of this dissertation were related to

how and why questions about an ongoing process. The interventions were comprehensive, implemented in a complex organization, and evolved over time; therefore, we could not control what happened. Moreover, one of our purposes was to explore the effect of contextual factors, which renders a traditional experimental design that tries to exclude the influence of such factors less suitable [69]. A case study design makes long-term follow-up feasible and allowed us to combine quantitative and qualitative data to assess the outcomes of the interventions and sustainability of the improvements. An important aim for quality improvement research is to foster the spread of successful improvements by developing knowledge about how and why the interventions work in different settings. Case study research can contribute to such theory building [119]. Despite its limitations, we found a case study design appropriate for our purpose.

Operationalizing the case study

A case study should be operationalized using a model that enhances its reliability and validity [108]. Our case study had both exploratory and explanatory elements. Because we did not have detailed information about what the hospital had done to improve the quality of care and what the outcomes were up front, we could not operationalize the case study in a complete model before we began data collection. As we began to collect and analyze data, we operationalized the case study by developing a framework that described the interventions and how they contributed to improved care [108].

Alternative explanations of the observed effects are an important part of such a framework [108]. In our study, changes in the cancellation rates were a key finding because we used it as a measure to demonstrate organizational change and the sustainability of the improvements. Therefore, we devoted much effort to investigating alternative explanations for changes in this measure [105]. In this work, we took advantage of the flexibility provided by the case study design, in which the design, data collection, and analysis can be an iterative process. Based on feedback from reviewers and findings from the literature, we added alternative explanations to

our framework during the study period (e.g., how demand, operating capacity, and list overruns affect changes in cancellation rates).

4.6.2 Data collection

We responded to the challenge of information bias and confounding using multiple types of data from various sources in our case study to achieve data triangulation, thus enhancing the validity of our findings [105, 109]. Below I discuss the quality and credibility of the data that we used as case study evidence.

Quality of quantitative data

We collected a wide range of quantitative data that we used to assess the effects of the interventions and investigate alternative explanations for the observed effects. All of our quantitative data were routine data from the hospital's administrative systems. The advantage of this type of data is that it is readily available at low cost. Because the data are anonymous, data collection involves fewer ethical problems [120]. However, using routine data may also have some pitfalls [120].

Routine data might be originally collected for a different purpose, thereby decreasing validity. Our quantitative data were originally collected for the same purpose as they were used in our research (i.e., data about cancellations and planned operations were registered to monitor the cancellation rate). The only exception was our measure for surgery demand. The recommended way of measuring surgery demand is the number of minutes needed per week to perform operations on the referred patients [26]. Such a measure was not available. Instead, we used the number of planned operations per month. The hospital did not collect this information to monitor demand. Nonetheless, I argue that this measure reflects demand because if there is an increase in demand then more operations will be scheduled per month.

Routine data can be incomplete [120]. Parts of our data were incomplete. Data about emergency cases for the Department of Ophthalmology were incomplete for part of the study period and were therefore omitted. Based on the years for which data were

available, emergency cases from this department accounted for less than 1% of the total number of emergency cases, and omitting these data should not influence the overall outcomes. Because of changes in the hospital's computer system, information about full-time equivalents was only available after January 2008. Our calculation of the number of full-time equivalents before the interventions was based on data from January 2008. Therefore, the number may not be representative of the entire pre-intervention period. The mean number of full-time equivalents after the interventions was 280, compared with 279 before the interventions, indicating no increase during the post-intervention period. These quantitative data were also supported by qualitative data from the interviewees, in which employees told us that no substantial change in the number of full-time equivalents occurred during the study period. Therefore, I argue that the number of full-time equivalents unlikely increased after the interventions.

We have not specifically assessed the accuracy of our quantitative data. To do so, we would have had to match the data from the administrative system with their corresponding medical records to verify whether surgeries were, in fact, cancelled or performed. This procedure would pose an ethical problem because the data would no longer be anonymous. When balancing data accuracy with ethical problems, we decided to not apply for permission to match the data because our data were primarily recorded by the hospital for the same purpose as our research.

Case mix may represent a threat to the validity of routine data [120]. Individual characteristics of patients and their diseases might vary before and after the interventions. This difference, in turn, could affect the cancellation rates. We did not have access to data regarding individual diagnoses and disease characteristics and could not adjust for such an effect.

Quality of qualitative data

The sample size might influence the validity of qualitative data. I made case notes of the interviews with employees and patients and began analyzing the data before I had

completed the data collection. The analysis and data collection, therefore, were iterative processes. Based on the case notes and our analysis, we did not learn anything new from the last two to three interviews with employees and patients. Newly collected information was repetitious and confirmed our previous findings. I argue that we reached redundancy, and our data sample became saturated [109, 121, 122]. Thus, our sample size was sufficient for our purpose [109, 122].

A conclusion of saturation might be reached prematurely if the data sample is not representative [121]. We used purposive sampling when we collected qualitative data [111]. Our objective was to explore the organizational change process from different perspectives and the patients' experiences with the interventions to reduce cancellations. The degree of involvement in improvement work, profession, the department to which the individual belonged, experience, patient age, gender, and type of surgery might affect the information we wanted to collect. To capture a wide range of viewpoints, we interviewed employees from different professions (e.g., physicians, nurses, managers, project support personnel, and secretaries) with varying degrees of work experience. The degree of participation in the improvement work for those interviewed varied. Some were directly involved in the improvement groups, whereas others were not directly involved. For the patient interviews, we included patients who had experienced both the new and old pathways, and we included patients from different age groups who had gone through various types of surgical procedures. I argue that our sample of interviewees was sufficiently diverse to capture a wide range of experiences [111].

4.6.3 Data analysis

To enhance the reliability of the analysis, Yin recommended constructing a case study database and separating the case study evidence from the researchers' interpretations when the findings are presented [108]. We created a case study database by organizing our quantitative data in an SPSS file and our qualitative data in a HyperRESEARCH file. I present the case study findings in the results section and the interpretations of the findings in the discussion section to clearly distinguish

between them, thereby minimizing researcher bias [108, 111].

As indicated by Barbour [123], our purposive sampling procedure also had implications for how we analyzed our data. We compared and presented findings from clinicians with various degrees of involvement in the improvement process and likewise from patients who had experienced the pathway before and after the redesign. This analytic approach enhanced the validity of the analysis.

Patton suggested three types of triangulation that can enhance the reliability and validity of data analysis: method triangulation, analyst triangulation, and theory/perspective triangulation [109]. We used all of these types of triangulation in our case study.

By combining qualitative and quantitative methods in a complementary way, we achieved method triangulation, which enhanced the rigor of our analyses [106, 124]. When analyzing our quantitative data, we used different approaches. We used both parametric and nonparametric tests to compare cancellation rates and the number of operations performed before and after the interventions, which enabled us to quantify the improvements and calculate p values. Furthermore, we used statistical process control to assess whether the changes were sustained and whether reductions of the cancellation rates coincided with the interventions. By combining these methods, we found a significant decrease in the cancellation rates after the interventions. The changes coincided with the implementation of the interventions, and the changes were sustained. For our analysis of the qualitative data, we used different variations of content analysis with codes derived from the data and from frameworks defined from the literature.

We used different approaches to secure analyst triangulation. As recommended by Barbour [123], co-researchers were presented with excerpts of the dataset of employee interviews to validate the coding and quotations that we presented in the articles. One of the main purposes of the employee interviews was to get an overview

of the change process. To reduce errors, we asked three key respondents at the hospital to validate a narrative that described what the hospital had done to redesign the pathway for elective surgery [125]. Oddbjørn Bukve read the patient interviews and validated their coding.

We used various theoretical perspectives and frameworks in our analysis of the case. For example, we used theories of organizational learning to explore how the improvements were sustained and the MUSIQ framework to explore how contextual factors influenced the outcomes. We assessed improvements in the quality of care according to three quality perspectives [36, 80, 97]. Therefore, we secured theory triangulation in our analysis [109].

In summary, the main limitation of our study was that it was a retrospective, observational, single case study that was partially based on quantitative routine data. Despite this limitation, the design allowed us to learn from a successful case. By combining qualitative and quantitative data, we demonstrated that the quality of care was improved and explored how contextual factors influenced the improvements. Furthermore, the design and choice of data made a long observation time possible, which enabled us to study the sustainability of the improvements and factors that contributed to this. The way we used theoretical perspectives contributed to a deeper understanding of the findings and rendered theoretical generalizations possible.

5. Results

The presentation of the results is structured according to my five research questions.

5.1 The interventions

In Paper 1, we used data from employee interviews and found that Førde Hospital implemented the following interventions when redesigning the pathway for elective surgery:

- One common entry point for all referrals to elective surgery
- Earlier and improved clinical pre-assessment
- Patient participation in scheduling surgery
- Centralization of preparation and discharge of patients in one unit
- Telephone call to patients 2 days prior to surgery
- Computer-based system for scheduling operations for all departments

A detailed description of the pathway before and after the redesign and interventions is provided in Table 2 in Paper 1. The interventions were based on discussions in the improvement groups, recommendations in the literature, and a site visit to a hospital where cancellations were reduced. The interventions were implemented in March 2008.

5.2 The effects of the interventions

The mean cancellation rate was reduced from 8.5% to 4.9% (95% CI for mean reduction, 2.6-4.5; $p < 0.001$) after the interventions. The U-chart (Paper 1, Figure 1) demonstrated a sustained change in cancellation rates. The shift in the process coincided with the interventions at month 38. After the interventions, the cancellation rates were more stable, and all points (i.e., registration of monthly cancellation rates) were below the centerline. The median number of operations performed per month increased by 17 %, from 323 to 378, after the interventions ($p = 0.04$).

Our first paper also included qualitative data about the effects of the interventions obtained through interviews with the employees. In the redesigned pathway, the medical pre-assessment was performed well ahead of the surgery so that medical issues could be taken care of. The telephone call to patients prior to the surgery was useful for preventing cancellations caused by inter-current diseases among children scheduled for otolaryngology surgery. The division of labor between the surgeon and anesthesia personnel regarding medical pre-assessment was clarified, and the anesthesia personnel had laboratory results and the surgeon's commentary when they conducted their pre-assessment.

Through employee interviews, we collected qualitative data on how various parts of the interventions contributed to the observed effects. The main elements of the interventions that contributed to decreased cancellation rates were earlier medical pre-assessment, telephone calls to patients, patient participation in deciding the time for surgery, and a designated operating theater for emergency cases.

A new computer application integrated surgery planning across all of the departments and provided an overview of the total available capacity. Together with the new position of a capacity coordinator who oversaw the scheduling of surgery, the new computer application contributed to a better utilization of the surgery lists and an increase in the number of operations performed.

In our first paper, we also collected quantitative data to explore how factors other than the interventions could have affected the observed outcomes. The capacity to perform surgery, utilization of the surgery list, and activities other than elective surgery could affect the decrease in cancellation rates and increase in the number of operations performed.

The median number of scheduled operations per month increased from 373 to 400 after the interventions ($p = 0.04$). The capacity to perform surgery increased stepwise. It began at 270 h per week and reached a maximum of 338 h per week 3 months after

the interventions. It then decreased to 304 h per week and remained unchanged for the remainder of the study period. The number of full-time equivalents for the involved departments was 279 in January 2008. The mean number of full-time equivalents for the time period after the interventions was 280 (95% CI, 277-283).

Before the interventions, the mean number of total cancellations was 28.1 per month (95% CI, 24.7-31.5). Of these 28.1 cancellations, 4.2 were caused by the hospital being unable to finish the scheduled surgery lists as planned (95% CI, 3.1-5.4). After the interventions, this number decreased to 3.1 per month (95% CI, 2.1-4.1, $p = 0.147$). The proportions of overrunning surgery lists for the involved departments after the interventions were 1.2% for ophthalmology, 2.8% for ear, nose, and throat, 21.1% for gynecology, 22.2% for general surgery, and 27.7% for orthopedics.

The mean number of consultations at the outpatient clinics increased from 2722 to 3021 per month ($p = 0.006$). No change in the number of emergency cases per month was found after the interventions ($p > 0.999$). The mean number of cancellations per month caused by emergency cases having priority over elective surgery was 1.46 (95% CI, 0.8-2.1) before the interventions and 0.1 (95% CI, 0.1-0.4; $p < 0.001$) after the interventions.

The change in the distribution of the number of operations performed between the departments after the interventions could affect the overall cancellation rate for the hospital. The expected cancellation rate for the time after the interventions, calculated from pre-intervention cancellation rates and the number of scheduled operations after the interventions, was 8.2%.

5.3 Patient experiences with the changes

In Paper 2, we interviewed patients to explore how they experienced the effects of the interventions. Table 1 integrates the main changes in the pathway that affected the patients, the employees' intention with the changes, and the patients' experiences.

Table 1. Changes in pathway, employees' intentions with changes, and patients' experiences with the changes.

Old pathway	New pathway	Employees' intended effect with interventions	Patient experience with intervention
<p>Patients did not participate in deciding the time for their surgery.</p> <p>Patients left the consultation at the outpatient clinic without an appointment for surgery, and they were notified about the scheduled appointment for surgery in a letter.</p>	<p>Patients participated in deciding the time for surgery.</p> <p>Patients received their appointment at the consultation when the decision to perform surgery was made.</p>	<p>Reduce cancellations.</p> <p>Make care more patient-centered.</p>	<p>Patients valued participation in scheduling surgery because it allowed them to integrate the planned surgery into the way they live their lives.</p>
<p>No routine for calling patients prior to surgery.</p>	<p>Patients were called 2 days prior to surgery to ensure that they were ready for surgery.</p>	<p>Reduce cancellations.</p>	<p>For the patients, the phone call indicated that the hospital cared about their well-being and that the hospital was prepared to deal with their particular situation.</p>
<p>Preparation and discharge of patients took place at respective surgical departments.</p>	<p>Preparation and discharge of surgery patients was centralized in one location.</p>	<p>Use resources more effectively to make care more efficient.</p>	<p>Patients had to relate to fewer healthcare personnel, which contributed to a perception of safety.</p>

In Paper 2, we identified three themes related to how the patients experienced the new pathway: the importance of integrating surgery into the way patients live their lives, individualized preparation before hospital admission, and the importance of relating to fewer clinicians during a hospital stay. The clinicians thought that patient participation in deciding when surgery was to take place would be important and implemented a new way of scheduling patients. The patients who had participated in scheduling surgery valued their participation in the decision, whereas patients who had not participated in the decision expressed that doing so would have been important.

To remind the patients of their appointment and prevent cancellations caused by inter-current illness, Førde Hospital began calling patients 2 days prior to surgery to ensure that they were in good health and ready for surgery. Findings from the patient interviews indicated that the phone calls had an effect beyond preventing cancellations. The patients felt that the phone call demonstrated that the hospital cared about their well-being and that the hospital was prepared and ready for their particular situation.

To optimize resource utilization, Førde Hospital established a day surgery center and centralized preparation and discharge of patients at this facility. This centralization required patients at Førde Hospital to relate to fewer healthcare professionals during their stay at the hospital because they no longer went through the regular ward. Patients from both hospitals emphasized the importance of relating to few healthcare professionals during a hospital stay.

Data from the patient interviews indicate that Førde Hospital implemented interventions that changed care in a way that respected and responded to the patients' needs, thereby contributing to patient centeredness. Patient participation in scheduling surgery, for instance, allowed the patients to make choices that fit their particular situation and integrate surgery into the way they lived their lives.

5.4 Contextual factors

In Paper 1, we used data from employee interviews to identify contextual factors that influenced the observed outcomes.

The patients had complained about unclear information and waiting times. This input was used in the improvement process and gave direction to the improvement efforts, and contributed to a common understanding among employees that change was necessary.

The top management of the local healthcare authority decided to work more systematically with quality improvement in general and developed a common strategy for conducting quality improvement projects. The core aim of the strategy was to involve frontline professionals in detecting systemic problems and subsequently improve the corresponding clinical processes. The top management emphasized the system perspective in the improvement efforts by stating that all of the improvement projects were meant to address professional, patient, and management quality.

In accordance with the improvement strategy, a wide range of frontline professionals from different departments and with different professional backgrounds participated in improvement groups that planned and developed the interventions. These project groups received guidance and support from a small administrative unit about practical tools and improvement techniques. The project groups communicated regularly with each other and the involved departments. Through regular meetings with healthcare personnel who were affected by the change process, leaders and project groups received feedback on the proposed actions.

The interventions included changes in structural elements of the clinical system (i.e., a new day surgery center and new computer application for scheduling operations). The structural changes affected the clinical processes, and clinicians were allowed sufficient time to actually rework the corresponding clinical processes.

Middle managers played an important role in implementing and adapting the interventions. Through their presence and participation in the daily work processes, they served as role models, monitored the degree of implementation of the interventions, and received feedback from clinicians on the need to adapt the interventions to the local context.

Førde Hospital introduced a computer-based system for scheduling surgery. It contributed to the integration of surgery planning across departments and provided

the necessary overview that allowed patients to participate in scheduling surgery. The way information technology was introduced contributed to an emphasis on the system perspective in the improvement efforts.

5.5 Factors that contributed to the sustainability of the improvements

In our third paper, we used data from employee interviews at Førde Hospital to identify factors that contributed to sustained improvements. Our analysis of the interviews was guided by theoretical organizational learning frameworks.

During the course of the improvement project, clinicians developed a revised understanding of their clinical system and its interdependencies. They became increasingly aware of how different elements of their clinical system needed to interact to improve overall performance and how they contributed to this improvement themselves through their own work. The new understanding emerged from a process in which clinicians shared information about their regular work activities and reflected on this information in relation to how the clinical system as a whole could be improved.

The new understanding represented a change in the clinicians' mental model of their clinical system. When the clinicians collectively reflected on this new model in the improvement groups, this information was shared and incorporated at the organizational level. The new mental model induced changes in organizational behavior. A new mental model that is shared at an organizational level and induces changes in organizational behavior implies that double-loop organizational learning has occurred.

Double loop-learning that was based on the new understanding of the clinical system contributed to sustained improvements by influencing the improvement process in

three important ways: systemic problems that clinicians had been unaware of earlier were detected and could be addressed, work processes were changed with regard to what was appropriate from a system perspective, and the clinicians' ability to adapt to the interventions was improved.

6. Discussion

I structure the discussion around the five research questions. First, I present the interventions and discuss the connections between them and the quality problem. Second, I discuss the effects of the interventions, structured according to Øvretveit's [36] three quality perspectives. My third research question about how the patients experienced the changes corresponds to Øvretveit's client perspective, and I will discuss the second and third research questions together. In this discussion, I also include a section about how various elements of the interventions might have contributed to the observed effects and relate this to previous research. Third, I discuss how contextual factors influenced the change process. Fourth, I discuss the factors that might have contributed to sustained improvements. Finally, I discuss the implications of my findings.

6.1 The interventions

The reasons for cancellations are complex because they are related to patients, organizational issues, and clinical staff [1, 2]. Cancellations occur because the clinical system performs suboptimally (e.g., poor scheduling, inadequate medical pre-assessment, and facility short-comings) [17, 22, 25, 27, 29, 30]. To reduce cancelations, the clinical system should be changed. The interventions should target the various reasons for cancellations, thereby contributing to changing the clinical system.

Førde Hospital redesigned the pathway for elective surgery by implementing interventions that contained several elements. The main components of the interventions were earlier and improved clinical pre-assessment, patient participation in selecting the date for surgery, centralization of preparation and discharge of patients in one unit, a telephone call to patients 2 days prior to surgery, and a common computer-based system for scheduling operations for all departments. Patient participation in scheduling surgery and the telephone call were measures that

targeted patient-related reasons for cancellations. Earlier and improved pre-assessment targeted reasons related to the clinical staff. The new computer system targeted reasons related to organizational issues and planning. Together, these interventions targeted various reasons for cancellations and contributed to a change in the clinical system.

Changing the clinical system can be viewed as organizational learning [96]. Organizational learning is manifested through new organizational routines, and the effects of these changes can be measured [126, 127]. Cancellations are caused by a system that performs suboptimally, and organizational changes will consequently be reflected in changes in the cancellation rates. The cancellation rates, therefore, can be used as a measure for the effect of the organizational changes. One of my main findings, which will be discussed further in the next section, is that the cancellation rates were reduced. The change in this performance measure indicates that organizational behavior was altered. Accordingly, and consistent with the recommendations of Berwick [35], I suggest that the interventions that were implemented at Førde Hospital contributed to changes in the clinical system.

6.2 The effects of the interventions

The main findings from our three papers were that the interventions contributed to a reduction of cancellations, increased the number of operations performed per month, and made care more patient-centered. The U-chart demonstrated that the improvements coincided with the interventions and that the improvements were sustained for 2 years after the interventions. The fact that all of the registrations of monthly cancellation rates in the U-charts after the interventions were below the center line is a strong indicator of a shift in the process [128].

The way these findings can be understood as improvements in the quality of care is dependent on the concept of quality that is used for assessment [36, 59]. I will relate the improvements to Øvretveit's three perspectives on quality (i.e., client,

professional, and management quality) and the IOM's dimensions of high-quality services [36, 51].

6.2.1 Client perspective

According to Øvretveit, client quality is “what clients want from the service individually and as a population” [36, p 4]. Øvretveit emphasized that client quality is more than client satisfaction; “it is a global and enduring attitude towards a service, built up from repeated satisfaction over time, rather than a judgment about the service in relation to a recent specific transaction” [36, p 29]. The attitude to which Øvretveit refers should be the foundation when clinicians plan, develop, and deliver health services. In essence, this attitude is also the core element of the IOM's aim of delivering patient-centered care [51].

Decreased cancellation rates indicates that client quality improved. Cancellations imply annoying and potentially harmful delays for the patients [3, 32, 33]. When Førde Hospital reduced their cancellations, fewer patients experienced delays. Consistent with the aims of the IOM, care became timelier. The cancellation rates can also be regarded as an indicator of patients' access to care. A decrease in the cancellation rates implies that the patients' access to care improved.

The pathway for elective surgery became more patient-centered after the changes. Data from the interviews with patients showed that they valued the service after the changes and that the services were changed in a way that responded to their needs. In the new pathway, the patients participated in scheduling surgery, received a telephone call from the hospital prior to surgery, and could relate to fewer healthcare professionals during their stay. The changes were consistent with the core principals of patient centeredness, implying that the care provider has services that respect and respond to patients' wants, needs, and preferences [129]. In accordance with the IOM's aims, the interventions contributed to patient centeredness [51].

Data from the patient interviews indicated that the interventions changed care in a

way that contributed to a perception of safety. In the redesigned pathway, the preparation for surgery and discharge was centralized in one location for all of the patients. As opposed to the old pathway, the patients did not enter the regular ward in the redesigned pathway. This change implied that the patients had to relate to fewer healthcare professionals. The statements from the patients illustrated that a reduction of the number of contacts was important because this made it easier for them to know whom they were relating to at any given point, and such knowledge even contributed to a perception of safety. Our finding is consistent with the findings of Mira et al., who found that “knowing what type of professional one was dealing with at any given time” was a strong predictor of patient satisfaction in surgery [130, p 536].

6.2.2 The management perspective

According to Øvretveit [60], management quality reflects providing care that the patients need by using the fewest resources at the lowest cost. This perspective corresponds to the IOM’s [51] dimension of providing efficient care.

High cancellation rates imply that a hospital wastes resources by maintaining capacity that is not utilized optimally [17]. Reducing cancellation rates does not necessarily imply that care becomes more efficient. The reason for this is that the spare capacity that is created by reducing cancellations is related to costs and structures that are fixed in a short time perspective, such as the number of beds and the number of employees. Marshall and Øvretveit [131] introduced the concept of *theoretical saving* to describe this phenomenon, and they suggested that such savings can be released in a *second cash change* by cutting back on the number of beds, redeploying staff, or increasing productivity.

In our case, a sustained decrease in the cancellation rates was found after the interventions. Decreased cancellation rates represent a theoretical saving that can be released through structural cutbacks or increased productivity [131]. The number of operations per month increased after the interventions. Hence, Førde Hospital released the theoretical saving caused by the reduction of cancellation rates through

increasing the number of operations performed.

The increase in the number of operations performed per month exceeded what can be explained by releasing the theoretical saving caused by a reduction of the cancellation rates. The number of patients referred to Førde Hospital increased after the interventions. The hospital managed to handle the increased inflow of patients without a corresponding increase in resources. The number of full-time equivalents was unchanged after the interventions, and the operating capacity, measured as the available minutes per month, decreased. The findings, therefore, indicate that the interventions contributed to increased productivity. The combination of decreased cancellation rates and an increased number of operations performed is an indicator of improved quality of care assessed from a management perspective and according to the IOM's dimension of efficient care.

6.2.3 The professional perspective

Professional quality reflects “whether the service meets needs as defined by professionals, and whether it correctly carries out techniques and procedures which are believed to be necessary to meet client needs” [36, p 4]. It corresponds to the IOM's aims of delivering safe and effective care [51].

Quantitative outcome measures that explicitly demonstrate that care became safer or more effective after the changes were not available. A reduction of cancellation rates might indicate that the quality of care improved from a professional perspective. Inadequate medical pre-assessment is a major cause of cancellations [2, 29]. Patients whose surgeries are cancelled because of inadequate pre-assessment may not have received effective pre-operative care consistent with best evidence; it might also represent a safety problem for the patients [132]. Cancellations might cause harmful delays in treatment, and the extra time spent waiting can cause physical and mental distress for the patients [32, 33]. A reduced number of cancellations may indicate that fewer patients experienced inadequate care prior to their surgery and that care became safer and more consistent with what is considered effective care after the

interventions.

Our qualitative data also suggest that the quality of care improved from a professional perspective. Data from employee interviews showed that the division of labor and responsibility between the surgeon and anesthesia personnel regarding medical pre-assessment was clarified in the redesigned pathway. In the new pathway, anesthesia personnel had laboratory results and the surgeon's commentary when they did the pre-assessment. Furthermore, the assessment was performed well ahead of the scheduled surgery so that undiscovered medical issues could be addressed in time, thereby reducing the probability of a cancellation. The clinical practice for pre-operative care became more consistent, and communication among health personnel became more effective. Therefore, I argue that the interventions might have contributed to improved care with regard to safety and effectiveness. This is consistent with Kerridge who stated out that outcomes in pre-operative care depend on "...well-designed processes, consistent clinical practice and effective communication" [133, p 23].

6.2.4 Integrated quality improvement

Øvretveit [60] highlighted the importance of planning for integrated quality improvement, reflected by a unified improvement of care with regard to client, management, and professional quality. This can be difficult to achieve in real life because improvements from one perspective can be regarded as a quality reduction from another perspective. Typically, improvements from a management perspective that focus on cost reductions and increased efficiency can be considered negative from a client and professional perspective [134]. Øvretveit [60] stated that a common understanding of healthcare quality is a foundation for an organization's improvement efforts. The hospital's improvement strategy was the foundation for their improvement efforts. A core aim of this strategy was to improve the quality of care with respect to all three of Øvretveit's [36] quality perspectives. Our findings indicate that the clinicians managed to maintain a holistic approach in their improvement efforts, in which they planned and implemented a combination of

interventions that simultaneously improved care from all three perspectives.

6.3 How elements of the interventions contributed to the observed effects

The interventions were context-dependent and implemented in a dynamic, complex clinical system. The distinct effects of the various elements of the interventions, therefore, cannot be disentangled or quantified. Below I discuss how various elements of the interventions might have contributed to the observed effects and relate the findings to previous research. I structured the discussion around the three main effects: reduced number of cancellations, increased number of operations performed, and increased patient centeredness.

6.3.1 Reasons for reduction of cancellation rates

Earlier medical pre-assessment

In the redesigned pathway, medical assessment was done the same day as the decision to perform surgery was made, as opposed to the old pathway in which the assessment was done closer to surgery. In this way, medical issues that could interfere with surgery and cause a cancellation were detected in advance and could be dealt with, thereby avoiding cancellations. This findings is consistent with previous studies that demonstrated that early preoperative assessment can reduce cancellations [25, 27, 29, 30].

Telephone call

To remind the patients of their scheduled appointment and ensure that they were fit and ready, the hospital began calling the patients 2 days prior to surgery. Data from employee interviews indicated that this measure contributed to a reduction of cancellations. It was especially useful for preventing cancellations caused by inter-current diseases among children scheduled for otolaryngology surgery. Because the telephone call was made 2 days prior to the scheduled surgery, there was sufficient

time to reschedule a new patient if the patient could not keep the scheduled appointment. This is consistent with previous research in other settings that demonstrated that telephone reminders can reduce non-attendance [135, 136].

Patient participation in scheduling surgery

Allowing patients to select the time for surgery, giving them earlier notice of their surgery day, and sending reminders can reduce cancellations [16]. Involving patients in the scheduling of surgery may increase satisfaction with treatment decisions during the initial consultation, which is a strong predictor of whether a patient will attend the surgery [137]. In the redesigned pathway, the patients participated in planning the date of their surgery and received the actual date of the operation before they left the outpatient clinic. Data from the patient interviews showed that these measures were valued by the patients. Consistent with proposals in the literature, I suggest that patient participation in deciding the time for surgery contributed to the reduction of cancellations [16].

Emergency cases

Emergency cases have priority over elective surgery and may therefore cause cancellations. As part of the interventions, one operating theater was designated for emergencies. Cancellations caused by emergency cases were practically eliminated after the interventions. The number of emergency cases was the same before and after the interventions; thus, the reduction was not caused by an overall reduction of the number of emergency cases. Therefore, the designated day-time theater for emergency cases likely contributed to the reduction of the cancellation rates through fewer conflicts between elective and emergency surgeries. This finding is supported by previous studies that suggested the designation of day-time theaters for emergencies [26, 138].

6.3.2 Alternative explanations for the reduction of cancellation rates

The reduction of cancellation rates is a key finding in our case study because we used

it as an indicator of the effect of the interventions and indicator of sustained, organizational change. To enhance the validity of this finding, I will discuss how factors other than the interventions themselves might have influenced the cancellation rates [108].

Cancellation rates vary across specialties [4]. A disproportionate increase in the number of operations performed after the interventions in a department with low cancellation rates could contribute to a reduction of the overall cancellation rate for the hospital. I adjusted for this effect by calculating the expected cancellation rate after the interventions. This rate was 8.2%, whereas the observed rate before the interventions was 8.5%. A minor difference was found between the calculated and observed cancellation rates, indicating that a disproportionate increase may have contributed to the reduction of cancellations. The effect, however, was small and can only explain a small portion of the observed reduction of the cancellation rates.

A decrease in the pressure on surgical services can reduce cancellation rates [23]. Pressure on surgical services depends on the ratio between demand and capacity. The findings indicated an increase in demand after the interventions because the number of operations scheduled per month increased. Capacity measured as the number of hours available for surgery per week increased during the pre-intervention period, reached a maximum 3 months after the interventions, and then decreased. Capacity measured as the number of full-time equivalents was unchanged after the interventions. The pressure on surgical services increased after the interventions, indicating that the change in the ratio between demand and capacity unlikely contributed to the reduction of cancellations.

Overrunning the operating lists is a way of avoiding cancellations, thereby reducing cancellation rates [17]. An increased tendency to overrun operating lists after the interventions could have contributed to the observed reduction of the cancellation rates. Data on the percentage of overrunning operating lists was not available for the pre-intervention period. Before the interventions, 4.2 cancellations per month were

caused by the hospital not being able to finish the scheduled lists as planned. These cancellations could have been avoided by overrunning the lists [17]. After the interventions, a nonsignificant reduction of the number of cancellations per month was found, from 4.2 to 3.1 ($p = 0.147$), caused by the hospital not being able to finish the lists. If the hospital had increased the tendency to overrun operating lists to reduce cancellations, then we would have expected a significant decrease in the number of cancellations caused by the hospital not being able to finish the scheduled lists as planned. This finding indicates that the hospital did not reduce cancellations by increasing the tendency to overrun operating lists after the interventions.

6.3.3 Increase in operations performed

The increase in the operations performed exceeded what can be explained by the reduction of cancellation rates alone. More patients were referred to the hospital for elective surgery, mainly because of the closure of a local hospital in the region. An important point that we make in Paper 1 was that the hospital managed to handle the increased inflow of patients without a corresponding increase in capacity or resources. In fact, the surgery capacity decreased after the interventions, and the number of full-time equivalents remained the same. The increase in the number of operations performed also cannot be explained by a subsequent fall in consultations at the outpatient clinic because this number increased after the interventions. A likely explanation for the increase in the number of operations performed is that Førde Hospital managed to increase the efficiency of their operating lists [17].

The increase in efficiency indicates that spare capacity might have been available in the clinical system before it was changed. Before the interventions were implemented, 15% of the cancellations per month were caused by the staff being unable to finish the scheduled program as planned (4.2 of 28.1 cancellations per month). If the spare capacity was easily accessible and releasable, then cancelling operations because of this reason should be unnecessary. This finding indicates that the spare capacity was not easily accessible or releasable; instead, it was hidden in the structures and work processes of the entire pathway (e.g., the interval between each

operation was too long, and the match between operating capacity and staff was not optimal). I suggest that the hospital managed to make this spare capacity visible and releasable when they changed their clinical system, and the way they utilized information technology was important in this regard.

The hospital introduced a new computer application for surgery planning. Before it was introduced, each department scheduled operations separately. The new computer application integrated the scheduling of operations for all of the departments, and surgery slots were made available and visible up to 6 months in advance. This change was also a prerequisite for letting the patients choose when surgery was to occur. When waiting lists for surgery became transparent for the hospital as a whole, they could be taken into account when surgery slots were assigned between the departments, ensuring better utilization of the total capacity of the operating theaters and increasing the number of operations performed.

Information technology was used as a basis for the system perspective for improvement by changing the focus from individual departments to an integrated perspective for all of the surgical departments. To take full advantage of the opportunities offered by the new technology, the hospital also created a new position of capacity coordinator. This person was responsible for overseeing the scheduling process across the different departments, thereby contributing to maintaining a system perspective after the implementation process was over and ensuring that the spare capacity was in fact released.

6.3.4 Patient-centered care

Data from the patient interviews showed that elective surgery is more than simply dealing with an isolated health issue. It affects the way patients plan and live their lives and affects their social surroundings. Patient participation in deciding the date for surgery, combined with setting the appointment right away, was an improvement related to how the patients live their lives. It allowed them to make choices that fit their particular situation and integrate the planned surgery into their lives. The

hospital was able to change the clinical pathway so that their services better matched the needs of the patients [139, 140]. Patient participation in scheduling surgery is an improvement that is consistent with the intentions of patient-centered care [129].

In accordance with suggestions from the literature, the hospital called the patients 2 days prior to surgery to reduce cancellations [135, 136]. Data from the patient interviews showed that this telephone reminder had an effect beyond reducing cancellations. The patients stated that the phone call indicated that the hospital was prepared for their particular situation and cared about their well-being. The likely reason for the patients' experience was that the theme of the call was not strictly limited to reminding the patients of their surgery. Patients were also asked questions about their health status, and the patients' questions could be answered. The phone call enabled a dialog between the patient and hospital that addressed patient needs, thereby contributing to patient centeredness.

A common feature of the elements of the interventions was that they increased the predictability of care. Predictability of future care is considered an aspect of patient-centered care, which is known to be important for patients [141, 142]. In the redesigned pathway, the patients knew when surgery was to occur, immediately when the decision to perform surgery was made. Furthermore, the medical pre-assessment was completed after the decision to perform surgery was made, as opposed to the original pathway when it was done closer in time to the surgery. In the redesigned pathway, the patients knew that they were cleared for surgery the same day as the decision was made. Altogether, these measures contributed to making care more predictable for the patients and patient-centered.

6.4 Contextual factors

The MUSIQ framework has been recommended as a framework to structure knowledge about the role of contextual factors in quality improvement in healthcare. [80]. I structured the discussion about the impact of contextual factors around the

main categories in this framework: external environment, organization, quality improvement teams, quality improvement support and capacity, microsystem, and miscellaneous [80]. Table 2 provides an overview of the main categories in the MUSIQ framework and contextual factors that we identified in our case.

Table 2. Contextual factors that contributed to success.

Main categories in the MUSIQ framework	Contextual factors identified in our case
External environment	<ul style="list-style-type: none"> • Input from patients about quality problems • Cancellation rate as a national quality indicator
Organization	<ul style="list-style-type: none"> • Common belief that change was needed among hospital employees • Common improvement strategy that provided a foundation for the improvement work by emphasizing: <ul style="list-style-type: none"> ◦ involvement of frontline clinicians ◦ improvement by changing the clinical system • Understandable and acceptable problems
Quality improvement support and capacity	<ul style="list-style-type: none"> • Guidance about improvement techniques and project support for the improvement teams • Expedient use of information technology • Sufficient time to rework clinical processes
Microsystem	<ul style="list-style-type: none"> • Middle managers' role in following up and securing context-sensitive implementation of interventions • Adaptation of interventions based on feedback from frontline clinicians • Middle managers as role models who participate in daily work
Quality improvement team	<ul style="list-style-type: none"> • Participation from all of the relevant professional groups in improvement teams, including physicians • Communication and involvement of clinicians outside the improvement teams

6.4.1 External environment

Input from patients and external government regulations were external factors in our case. The overall aim of the hospital's improvement efforts was to reduce cancellations and make care more patient-centered. This aim was partially influenced by the external factors and is consistent with what is proposed in the MUSIQ

framework. These factors also worked as a trigger for change [80].

Norwegian healthcare is publicly financed, and most hospitals are owned and operated by the government. National authorities are an important stakeholder in quality improvement in healthcare. This influence is manifested through the national strategy for quality improvement, the appointment of Førde Hospital as a pilot facility for quality improvement work, and mandatory national quality indicators that all hospitals must report. The indicators are publicly available on the Internet, and one of the indicators is the cancellation rate. Altogether, these government regulations likely contributed by focusing on quality improvement work in general and the cancellations of operations in particular.

The hospital had received complaints from patients about the layout of the pathway for elective surgery. These complaints contributed to a common understanding throughout the organization that the pathway for elective surgery was not optimal from a patient perspective and needed to be changed. Input from patients served as a trigger for change and gave direction to what kind of interventions were needed, namely interventions that could contribute to making care more patient-centered.

6.4.2 Organization

Leadership engagement and strategy for improvement

We found that involvement from top management was an important contextual factor that contributed to success. The top management played a fundamental role in the improvement process through the general improvement strategy. The strategy ensured that the project was anchored with the top management, without compromising the professional entrepreneurship of middle managers and frontline professionals. The core aim of the strategy was to improve the quality of care by involving clinicians in changing the clinical system. The changes were to address professional, patient, and management quality [36]. By including all of these quality perspectives as a foundation for improvement, the top management operationalized what they meant by system improvement. Our finding about the importance of top management is in

accordance with previous research [54].

In our case, the overriding objective of the improvement strategy was further operationalized into understandable and manageable objectives (e.g., reducing cancellations and making the pathway more patient-centered). One common understanding throughout the organization was that the pathway for elective surgery needed to change. Consistent with Dixon-Woods et al. [81], I argue that the broad-based approach to quality improvement, which was further operationalized into clinical problems to which clinicians could relate, contributed to the clinicians' acceptance of the changes.

6.4.3 Quality improvement teams

No obvious or easy way to change the pathway for elective surgery was apparent, and four project groups were established to suggest how its various parts could be redesigned. These project groups can be regarded as equivalent to the quality improvement teams described in the MUSIQ framework.

In accordance with the improvement strategy, all of the relevant professional groups that constituted the clinical system were represented in the improvement teams, including physicians. The broad representation of participants ensured that all of the relevant parts of the clinical process were represented in the groups, thereby providing the necessary foundation for redesigning the clinical processes.

The members of the improvement groups interacted with one another and formed an informal network across departmental borders. The improvement groups also had continuous dialog with clinicians outside the groups through regular meetings. All of the clinicians were invited to provide feedback on proposed action items in the planning phase of the interventions. The open communication around the suggested measures to improve care contributed to acceptance of the proposed interventions and a better climate for implementation. This finding is consistent with Damschorder et al. [95], who suggested that networks and communication are important contextual

factors.

6.4.4 Quality improvement support and capacity

Information technology

The distinction between interventions and contextual factors is not clear [52, 55]. An illustrative example from our case was the way information technology was introduced and utilized. The computer application that was introduced for surgery planning can be regarded as an intervention. Moreover, the optimal use of information technology is a recognized contextual factor that influences the success of improvement projects [143]. The way that the computer application was introduced and utilized in our case was important for the success of the project, both for reducing cancellations and increasing the number of operations performed.

In our case, information technology underpinned the system perspective for improvement by providing an overview across departments. The new information technology alone did not solve any problem *per se*; it was merely a tool that opened new possibilities of doing things differently. To ensure that the opportunities provided by the new technology were in fact utilized, the management at the hospital created a new capacity coordinator position. This person had the mandate of overseeing the scheduling process across departments to ensure that the total capacity was utilized in an expedient way. The effect of the intervention was thus highly dependent on how it was introduced and adapted to the organizational context.

Resource availability

In our case, the top management made resources available to guide the improvement teams in relevant tools and techniques. Consistent with previous findings [144, 145], we found that guidance on basic improvement techniques, such as flow charts, was crucial for enabling the teams to redesign their processes.

Interventions at Førde Hospital targeted structural elements of the organization (e.g., a new day surgery center and new computer application) and work processes (e.g.,

earlier patient assessment, improved communication between staff, improved management, improved surgery planning, and patient participation). Structural changes can be a matter of management decisions. In our case, the top management changed the structures by deciding that a new computer application should be used for surgery planning. This structural change affected the corresponding processes (i.e., the new computer application affected the way surgery planning was conducted). As opposed to structural changes, procedural changes do not arise from management decisions alone. The management can give direction to how the clinical process should be changed, as they did in our case through the improvement strategy. The actual redesign and adaptation of the clinical process to structural changes, however, must be undertaken by the clinicians who own the process [140].

Changing processes can be time-consuming. An important learning point from our case was that the clinicians were allowed sufficient time to actually rework the processes after the structural changes, thereby securing a true change in the clinical system. This finding is in accordance with Damschroder et al. [95], who also indicated that sufficient time to redesign the processes is an important contextual factor in quality improvement.

6.4.5 Microsystem

Quality improvement leadership

The microsystem level is decisive in quality improvement work because the clinical processes that quality improvement seeks to change occur at this level [140]. Middle managers at the microsystem level are in charge of these processes, and they play an important role when it comes to implementing and adapting the interventions. At Førde Hospital, middle managers were in charge of implementing the interventions that had been devised in the project groups. The middle managers took part in the daily work processes, allowing them to continuously monitor the degree of implementation and receive feedback from frontline clinicians on the need to re-implement and adapt interventions to the local context. Feedback from frontline clinicians was considered more useful than the steering indicators, such as the

cancellation rate, because it was immediate and provided more insight into the underlying problems.

Data from our case study did not include quantitative measures on quality improvement culture or leader characteristics. Dixon-Woods et al. stated that having an organizational culture that is “supportive of personal and professional development” is important for success [81, p 5]. Qualitative data from employee interviews indicated that the middle managers contributed to creating a culture that supports quality improvement by leading by example. Consistent with Fixen et al. [56], they took actions to overcome resistance, re-implement changes, and secure the context-sensitive implementation and adaptation of changes.

6.4.6 Relationship between contextual factors

The MUSIQ framework suggests that leadership at the organizational level (i.e., top management) can influence contextual factors at the quality improvement team level and microsystem level [80]. Through the improvement strategy, the top management in our case provided a framework for how the processes at the microsystem level could be changed. With regard to the quality improvement team level, the strategy influenced team diversity by emphasizing the broad involvement of all of the relevant professional groups in the redesign process. Because the strategy provided a framework for changing clinical processes, it also influenced the work in the quality improvement teams.

Leadership from top management is recognized as a crucial factor for quality improvement success, but little is known about the specific actions that leadership should take and how these actions affect lower organizational levels, such as the microsystem and team levels [146]. We found that the strategy developed by the top management affected the microsystem and team levels. It provided a framework for improving the clinical system and emphasized involvement. By relating improvement to Øvretveit’s [36] three quality perspectives, the strategy contributed to the operationalization of quality improvement into understandable and acceptable terms

for the clinicians. Our findings provided indications of how actions from the top management influence lower organizational levels. Furthermore, our findings support the relationship between contextual factors that is presented in the MUSIQ framework [80].

6.5 Sustainability of improvements

Interventions that exhibit characteristics of complex adaptive systems have been shown to be associated with better outcomes [147]. To plan and implement such interventions, awareness is needed about the various elements of the system and interactions between them. Individuals in a system, however, tend to focus on their immediate surroundings and pay less attention to the behavior of the clinical system as a whole [148, 149]. Data from employee interviews in Paper 3 demonstrated the same kind of behavior at Førde Hospital before the project began.

In our third paper, we analyzed our findings in light of the organizational learning framework and found that clinicians revised their understanding of the clinical system and its interdependencies during the course of the improvement project. They became increasingly aware of how their own work contributed to overall system performance and how the elements in the clinical system ought to interact to enhance the performance of the system as a whole. This finding was consistent across professional borders and the finding did not vary with the degree of involvement in the improvement work. The interviewees gave examples of their understanding before the project began, how the project changed their understanding, and what consequences this change had. Despite the fact that the employees were only interviewed once, I assert that the statements from the employees indicated that their understanding of the clinical system was altered.

The improvement strategy was important for how this new understanding emerged. The participants in the project groups shared existing grass-roots knowledge and reflected on it [150]. The improvement strategy secured broad participation in the

groups so that the entire clinical system was represented. Furthermore, the strategy provided a context for interpreting the information that the clinicians shared, namely how the clinical system as a whole could be improved. When clinicians in the project groups shared information and reflected on it, new knowledge was created, including knowledge about how the various elements of the clinical system had to interact to improve the performance of the clinical system as a whole.

The new understanding of the clinical system represented a change in the mental model of the clinicians [99, 151]. According to Kim, “mental models represent a person’s view of the world, including explicit and implicit understanding” [99, p 39]. Through reflection in the improvement groups and communication with clinicians who did not participate in the groups, the mental model was shared and incorporated at the organizational level, thereby linking individual and organizational learning [99, 100]. Because this altered mental model induced changes in organizational behavior, double-loop learning occurred [96]. The hospital was able to change the clinical system through double-loop learning. According to learning theory, double-loop learning implies a change in deeper system properties, which again makes the sustainability of changes more likely.

Double-loop learning induced by the clinicians’ new understanding of their clinical system contributed to sustained improvements because it influenced the change process in three important ways: the clinicians’ ability to detect systemic problems increased, the clinical processes were changed with regard to what benefited the clinical system as a whole, and the clinicians’ ability to adapt interventions was improved. By relating these three areas to Gruen et al.’s [87] conceptual model for sustainability, we can achieve a deeper understanding of how the new understanding contributed to the sustainability of the changes.

The model of Gruen et al. [87] incorporates three components: the program (the intervention), the health concerns that the program is targeting (the quality problem), and the program drivers. In the model, these components are surrounded by context

and resources. The sustainability of improvements depends on how the components in the model interact [87]. Like the two-way arrows in the model indicate (Figure 2), interactions are dynamic; thus, quality improvement cannot be considered a linear, sequential process of problem identification, implementation of interventions, and adaptation of interventions. The process is dynamic and can go back and forth. The initial understanding of the quality problem can be modified during the course of the improvement process, which in turn can lead to new or adapted interventions.

According to Gruen et al. [87], the *problem definition* is the key factor for explaining the interaction between the *quality problem* and *drivers*. The new understanding of the clinical system influenced how clinicians inquired about the need to change. As clinicians' new understanding gradually emerged, they were able to detect systemic problems that they were not aware of previously. The clinicians' enhanced ability to detect systemic problems led to a better and deeper understanding of the underlying causes of the quality problems. The *problem definition*, therefore, became more comprehensive because it better reflected the complexity of the problem and its underlying causes.

The way pre-assessments were improved can serve as an example. The quality of pre-assessments partially depends on the information flow between the surgeon and anesthesia personnel and the time when it is done in relation to the scheduled surgery. One of the changes that was made to the pathway for elective surgery was that the pre-assessments were done earlier. Patients proceeded straight from the consultation with the surgeon to a drop-in anesthesia outpatient clinic for their pre-assessment. The anesthesia personnel needed a written transcript of what the surgeon dictated on audio tape during the consultation, and the time-frame for secretaries to transcribe the tape was limited. Furthermore, the secretaries would not know who proceeded to the drop-in anesthesia clinic for pre-assessment. This problem was detected in the improvement groups because the participants shared information and inquired about how the pathway as a whole could be improved. The problem was solved by having surgeons tag the audio tapes that contained commentaries about patients who

proceeded to pre-assessment and designating one secretary to transcribe them immediately.

Alignment in the *quality cycle* is the key factor for understanding the interaction between the *quality problem* and *interventions* [87]. The *quality cycle* can be understood as the process of planning and implementing interventions that seek to improve the quality problem, and the interventions need to be *aligned* with the quality problems. In our case, the clinicians' improved understanding enhanced their ability to design interventions that changed the clinical processes in a way that benefited the clinical system as a whole. The way the new computer application for surgery scheduling was utilized, combined with the designated person who coordinated the planning process between the departments, illustrates how clinicians maintained a system perspective in their improvement efforts. In our case, clinicians' understanding of the quality problem and its underlying causes was followed by interventions that addressed them adequately. This connection secured the needed alignment between the *quality problem* and *interventions* as suggested by Gruen et al. [87].

Gruen et al.'s model [87] recognizes that improvement is context-dependent, and adaptation of the interventions to the context is important for sustainability. The revised understanding of the system enhanced the clinicians' ability to adapt the interventions to the context because their understanding of the interaction between contextual factors and the elements of their system was improved. The way the hospital implemented earlier clinical assessment in the form of a drop-in anesthesia outpatient clinic at their day surgery center illustrates how they adapted interventions described in the literature to their particular context to promote the sustainability of the improvements.

Previous studies indicated that organizational learning in healthcare tends to be fragmented and consist of learning cycles that are not interconnected [127, 152, 153]. Tucker and Edmondson [154] found that single-loop learning was dominant when

nurses learned from mistakes, and they suggested that this type of learning can mask the underlying structural problems, thereby inhibiting double-loop learning. Contrary to the findings of Tucker and Edmondson, we found that clinicians managed to address underlying problems, thereby facilitating double-loop learning and interconnecting different learning cycles.

6.6 Relevance of the findings

I suggest that the findings from our case study are relevant to the reduction of cancellations of operations and healthcare quality improvement in general. The findings indicate that the interventions that were implemented in this case study can contribute to a reduction of cancellations, increase the efficiency of care, and make care more patient-centered. Previous studies assessed interventions to reduce cancellation rates from a management perspective, focusing on efficiency and reduced costs. Our findings add to current knowledge because we demonstrated that a compound set of interventions can improve the efficiency of care and simultaneously make care more patient-centered, and these improvements can be sustained. Furthermore, I provided contextual information about the hospital and explored how contextual factors influenced the change process. I suggest that the interventions that were implemented at Førde Hospital, with adaptations, can be implemented to reduce cancellations at other hospitals of similar size and complexity.

Our data indicate that patient participation in scheduling surgery and a telephone call prior to the operation were measures that contributed to making care more patient-centered, in addition to reducing cancellations. I suggest that these interventions can be adapted to improve patient centeredness in other clinical settings beyond surgery.

I suggest that the findings regarding contextual factors and the sustainability of improvements are relevant to healthcare quality improvement in general. Contextual factors, particularly the improvement strategy and the way it was operationalized, together with allowing clinicians enough time to redesign their clinical processes,

were important for the success in our case. I discussed these factors in relation to the MUSIQ framework, which addresses how contextual factors influence healthcare quality improvement in general [80]. I suggest that the contextual factors that we identified are relevant to other change processes beyond reducing cancellations.

We used a framework of organizational learning and found that the clinicians' understanding of their clinical system and its interdependencies was a factor that contributed to sustained improvements. Consistent with recommendations in the literature, we used a framework to develop a context-dependent theory, describing how the improved understanding of the clinical system contributed to sustained improvements [79, 90, 155]. Furthermore, I showed that this theory has relevance for explaining the interaction between the system components of Gruen et al.'s model [87], which addresses the sustainability of healthcare improvements in general. I suggest that clinicians' understanding of their clinical system is a factor that is relevant to sustaining other quality improvements initiatives beyond reducing cancellations.

7. Conclusion

7.1 Main findings

Førde Hospital redesigned the pathway for elective surgery. The main components of the interventions were earlier and improved clinical pre-assessment, patient participation in selecting the date for surgery, the centralization of preparation and discharge of patients in one unit, a telephone call to patients 2 days prior to surgery, and a common computer-based system for scheduling operations for all of the departments. These interventions contributed to the reduction of cancellation rates and increased the number of operations performed per month. No corresponding increase in operating capacity or the number of full-time equivalents was found. Hence, care became more efficient. Furthermore, the changes that were made to the pathway contributed to making care more patient-centered. The improvements were sustained over 2 years after the interventions.

The interventions were implemented in a complex social system. The distinct effects of the various elements of the interventions cannot be disentangled or quantified. The findings from our case suggest that earlier clinical pre-assessment, patient participation in deciding the date for surgery, and a designated operating theater for emergency cases contributed to the reduction of cancellation rates. Earlier pre-assessment implied that medical issues could be dealt with in advance of surgery, thereby avoiding cancellations. Patient participation in deciding the time for surgery can increase patient satisfaction and make a patient no-show less likely. Emergency cases have priority over elective surgery. By performing emergency surgery in one surgical theater, fewer conflicts between elective and emergency surgeries occurred, which could cause cancellations.

The way information technology was implemented appeared to be important for how the hospital increased their efficiency of the operating lists, thereby increasing the number of operations performed per month. A new computer system provided an overview of available surgery slots and integrated the surgery scheduling of all of the

surgical departments, thereby improving the scheduling of operations in the hospital as a whole. Furthermore, a designated person oversaw the scheduling process. The planning processes became more dynamic because waiting lists were taken into account when assigning surgery slots between the departments. Altogether, these measures ensured better utilization of the entire capacity of the operating theaters and contributed to an increased number of operations performed.

Patient participation in scheduling surgery contributed to making care more patient-centered. Surgery impacts a patient's social life. By participating in scheduling the time for surgery, the patients could make choices that fit their particular circumstances, thereby integrating the surgery into the way they live their lives. The interventions contributed to change care in a way that responded to patients' wants, needs, and preferences, thereby making it more patient-centered [129].

The hospital's improvement strategy and the way it was operationalized were important contextual factors that contributed to the success of the project. Its core element was the involvement of frontline clinicians in changing clinical processes. The changes should equally address all three of Øvretveit's [36] quality perspectives: client quality, professional quality, and management quality. The strategy provided a holistic framework for how the clinical system should be changed. The overall objectives in the strategy were operationalized into clinical problems to which the clinicians could relate, thereby contributing to the acceptance of change. The clinicians planned and implemented interventions that targeted all three quality perspectives. Our findings indicate that the computer-based system for scheduling surgery contributed to an increase in the efficiency of care from a management perspective. Earlier pre-assessment and improved communication between surgeons and anesthesia personnel contributed to improved care from a professional perspective. The involvement of patients in scheduling surgery contributed to patient centeredness and increased quality from a client perspective. The improvement strategy contributed to ensuring a broad and balanced perspective on how the clinical system needed to change. Changing a clinical system takes time, and another

important contextual factor was the fact that clinicians were allowed sufficient time to rework their clinical processes and implement the changes [95].

During the change process, the clinicians developed a new understanding of their clinical system and its interdependencies. This new understanding represented a change in their mental model that induced organizational change. Organizational change based on a new mental model represents double-loop learning, and changes that originate from this type of learning are more likely to be sustained because they involve changes in deeper system properties. The clinicians' new understanding of the system contributed to sustained improvements by influencing the change process in three important ways: systemic problems that clinicians had been unaware of earlier were detected and could be addressed, work processes were changed with regard to what was appropriate from a system perspective, and the clinicians' ability to adapt the interventions was improved. Consistent with Gruen et al.'s [87] sustainability model, the clinicians gained a more comprehensive understanding of the complexity of the underlying problems, and they could plan and implement the interventions accordingly.

7.2 Future research

The findings in this dissertation are based on a single case. More research is needed to validate the findings in other clinical settings and with other patient populations.

Cancellations of planned surgeries are a persistent quality problem, and more research is needed to identify effective interventions [4]. Previous studies mainly assessed interventions that sought to reduce cancellations from a management perspective by focusing on costs and the efficiency of care and had retrospective designs [17, 25, 27, 29, 30]. Few studies have addressed the relevance that cancellations may have for patient safety, the effectiveness of care, and patient centeredness [132]. I suggest that future studies should incorporate these perspectives. To better facilitate the spread of improvements, future studies should

devote more effort to exploring how the interventions cause their effects and how contextual factors influence implementation and outcomes [38, 54, 56, 69, 90, 156].

Quality improvement will often rely on changing the clinical system of care [35, 50]. Previous research indicated that knowledge about the clinical system is important for clinicians' ability to effectively change it [147]. Actors in a system, however, tend to focus on their immediate surroundings and often have a limited understanding of system interdependencies [148, 149]. I suggest that the way clinicians understand their clinical system is important for the improvement process and sustaining improvements. Doyle [157] advocated more research on how change in mental models affects behavior. Consistent with Doyle, I suggest that future studies should explore how clinicians can enhance their understanding of the clinical system and its interdependencies and how such changes can affect organizational behavior and improvements.

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RESEARCH ARTICLE

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A new pathway for elective surgery to reduce cancellation rates

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Abstract

Background: The cancellation of planned surgeries causes prolonged wait times, harm to patients, and is a waste of scarce resources. To reduce high cancellation rates in a Norwegian general hospital, the pathway for elective surgery was redesigned. The changes included earlier clinical assessment of patients, better planning and documentation systems, and increased involvement of patients in the scheduling of surgeries. This study evaluated the outcomes of this new pathway for elective surgery and explored which factors affected the outcomes.

Methods: We collected the number of planned operations, performed operations, and cancellations per month from the hospital's patient administrative system. We then used Student's *t*-test to analyze differences in cancellation rates (CRs) before and after interventions and a u-chart to analyze whether the improvements were sustained. We also conducted semi-structured interviews with employees of the hospital to explore the changes in the surgical pathway and the factors that facilitated these changes.

Results: The mean CR was reduced from 8.5% to 4.9% (95% CI for mean reduction 2.6-4.5, $p < 0.001$). The reduction in the CR was sustained over a period of 26 months after the interventions. The median number of operations performed per month increased by 17% ($p = 0.04$). A clear improvement strategy, involvement of frontline clinicians, introduction of an electronic scheduling system, and engagement of middle managers were important factors for the success of the interventions.

Conclusion: The redesign of the old clinical pathway contributed to a sustained reduction in cancellations and an increased number of performed operations.

Keywords: Quality improvement, Process redesign, Cancellation of surgery, and Health information technology

Background

Cancellation of planned surgeries is a known quality problem in healthcare that harms patients and wastes resources, leading to increased healthcare costs [1,2]. Cancellation rates (CRs) vary in different settings, from less than 1% to as high as 23% [1,3,4]. It has been suggested that more than half of cancellations can be avoided [4,5].

Reasons for cancellations are complex because they are related to patients, organizational issues, and clinical staff. The main reasons are patient no-shows, patients' medical conditions, overbooking of lists, and facility

shortcomings [1,2,4]. Redesigning work processes, improving management, and performing early clinical evaluation of patients have been suggested to reduce CRs [6]. Various studies have shown that improved and early preoperative assessment prior to surgery reduces CRs [7-10]. These studies have demonstrated a reduction in CRs that was primarily attributable to earlier and improved preoperative assessment. Nonetheless, a paucity of information exists regarding the long-term effects of combined interventions that include elements other than just improved medical preoperative assessment.

We studied a Norwegian district general hospital in a rural community of 10,000 inhabitants. The hospital has 7 operating suites, 34 surgical beds, and serves a population of 107,000. Within the area, there are also two smaller district hospitals. Healthcare in Norway is financed by the state and most hospitals are publicly owned. They are geographically organized as regional and local health

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authorities. Before the changes were made to the pathway for elective surgery, CRs were high and fluctuating, resources were not optimally used, patient information was unclear, and patients complained about the duration of time spent waiting for surgery outside the hospital.

In 2007, the board of the regional health authority decided to increase the number of day surgeries. Middle managers in the hospital used this decision as leverage to start an improvement project to redesign the entire pathway for elective surgery. At the same time, the top management of the local health authority decided to work more systematically with quality improvement in general, and developed a common strategy for conducting quality improvement projects. The strategy was not based on any particular theoretical model, although it was influenced by the Model of Improvement [11]. The aim was to involve frontline professionals in the detection of systemic problems and to improve clinical processes. All improvement projects were meant to address professional, patient, and management quality (resource utilization), as well as staff satisfaction [12]. A small administrative unit was established to support frontline professionals in running the improvement projects.

Often the follow-up times of studies on quality improvement are too short to demonstrate sustainability of changes [13]. Therefore, we used data over a five-year period. We describe how multifaceted interventions across different departments led to a sustained reduction of cancelled operations. Furthermore, we explore contextual factors and their importance for sustaining these improvements.

Methods

Planning of interventions

The project involved all of the surgical departments at Førde Hospital, including in- and outpatient ophthalmology, general surgery, gynecology, orthopedics, and ear, nose, and throat. Additionally, the hospital has a small odontology unit that accounted for less than 5% of the total operations.

Four different project groups were established to improve different aspects of the elective surgery pathway. Redesign of this pathway was the first project that was run in accordance with the new improvement strategy of the local health authority. Table 1 displays the main activities during the project period. A strong motivator for the leaders who initiated the project was to improve patient satisfaction. Patient advocacy groups were invited to take part in the project groups but declined to participate. Instead, actual patient cases were used to focus improvement efforts, and patient-centered interventions were a core idea in the redesign process [14,15].

The entire pathway for elective surgery was redesigned, focusing on earlier patient assessment, improved communication between staff, improved management, improved

Table 1 Main events during the project period

Time	Activity
June 2007	Decision by the board of the local health authority to increase the number of day surgeries
September 2007	Report from work group suggests measures to increase day surgeries in a new day-surgery center
Fall 2007	Decision by top management of the local health authority to work more systematically with quality improvement and develop a common strategy for conducting quality improvement projects Establishment of a small unit to support frontline professionals in running improvement projects
January 2008	Remodeling of premises for a day-surgery center
February 2008	Project groups redesign the pathway for elective surgery
March 3, 2008	Opening of day-surgery center and implementation of new clinical pathway
April 2008	Implementation of electronic system for scheduling and planning surgery
2008-2010	Follow-up and adaptation of interventions to sustain improvement

planning, and patient participation in the planning of their elective operations. Table 2 shows a description of the clinical pathway and a detailed description of the different intervention elements, including the intended improvements. Ideas for improvements stemmed from discussions in the project groups, recommendations in the literature, and a site visit to a hospital with low cancellation rates.

As part of the interventions, a new day-surgery center was designed within the existing premises. All patients met at this center before their elective operation, and all day-surgery patients were discharged from this center without admission to a surgical ward. A computer application was introduced during the project. It provided an overview of referrals, waiting lists, and surgery schedules in all departments. A new position, a capacity coordinator, was created with the mandate to plan and coordinate the surgery program across different departments 6 months ahead. The implementation of the new pathway began when the new day-surgery center was opened in March 2008.

Another project during the study period reduced turn-over time between operations by improving logistics and coordination between the facilities for preparation, surgery, and recovery. In addition, the durations of surgical procedures were continuously monitored to get a more realistic picture of the actual time used, thereby improving scheduling of surgery. Furthermore, one operating theatre was designated for emergency cases.

Study of the interventions

We collected qualitative and quantitative data from the hospital between April 2010 and February 2012. We obtained the number of planned and performed operations and cancellations per month from the hospital's

Table 2 Main steps of the pathway for elective surgery before and after redesign

Time period	Clinical pathway before intervention	Intervention	Intended improvement
Before consultation at outpatient clinic	Referrals for elective surgery were sent to various departments. Each surgical department had their own lists of patients who were waiting for a consultation and surgery.	One electronic reception for all referrals for elective surgery.	Waiting list transparent across departments. More unified handling of referrals.
Consultation at outpatient clinic	Patients cleared for surgery were sent home without an appointment for surgery and without a medical pre-assessment. Medical pre-assessment was done the day before surgery.	New routine that clarified the allocation of work between surgical and anesthesia personnel with regard to clinical pre-assessment of the patient. Patients participate in planning the date of surgery and obtain the actual appointment while at the outpatient clinic.	Earlier and improved medical pre-assessment is known to reduce cancellations. Patient participation in planning date for surgery may improve patient satisfaction. Early notice of date for surgery is suggested in the literature as a factor that might reduce no-shows.
Consultation at drop-in anesthesia outpatient clinic at day-surgery center	Not applicable	A new day-surgery center is created within the existing premises. Patients cleared for surgery proceed straight to the laboratory for blood sampling and medical pre-assessment at newly established drop-in anesthesia outpatient clinic at the day-surgery center. The surgeon's considerations are written immediately after the consultation so that anesthesia personnel have the preoperative information during the preoperative assessment.	Improved information flow between surgical and anesthesia personnel may improve the quality of the clinical process.
Preparing for surgery	Letter to patient with appointment for surgery. Patient had no influence on appointment time. Limited planning between different surgical departments. Each surgical department had their own surgery program that basically was a text file.	Patient receives phone call from hospital 2 days prior to surgery to ensure that he is fit and ready. One common electronic surgery planning system for all departments. Designated coordinator supervises the planning process between departments.	Patients get a reminder of their appointment, which can reduce cancellations due to no-shows. If the patient is temporarily ill, then there is time to call a new patient and avoid a cancellation. One common overview for all departments allows better coordination and planning and might lead to more operations per day. Cancellations caused by facility shortcomings, such as double-booking of the same equipment, may be reduced.
Surgery	Patient showed up for pre-assessment the same day or one day in advance of the planned surgery. Routines varied between departments.	All patients scheduled for elective surgery are received at the day-surgery center. New standardized routines are implemented for pre-surgery preparations.	Centralizing all surgery patients and standardizing routines may reduce variations in the clinical process and thereby improve quality.
After surgery	Patients discharged from different departments with different routines. Discharge letter was not always in hand when the patient left.	All day-surgery patients are discharged from the day-surgery center through new standardized routines. Discharge letter is written and given to the patient before discharge.	

patient administrative system, and then calculated the monthly CRs. A cancellation was defined as a planned operation that was cancelled within 24 hours of the scheduled time. We considered a decrease in monthly CRs and an increase in the number of performed operations to be an improvement.

To compare CRs before and after the interventions we used the statistical method recommended by Dexter et al., since this method has been shown to be the most

robust for this purpose [16]. We calculated the CRs for each month, and transformed the CRs using the Freeman-Tukey double arcsine transformation, and then applied a Student's *t*-test on the transformed rates using SPSS 18.0 [16].

The numbers of scheduled and performed operations were not normally distributed; thus we analyzed the differences before and after the interventions with the Mann-Whitney *U* test.

The cancellation rate is nonconformance per unit, and we therefore used a u-chart to analyze whether changes in CRs coincided with the interventions and whether improvements were sustained [17].

Cancellations vary by specialty [18]. The number of performed operations increased after the interventions. Thus, an increase in the number of performed operations at a department with low CRs could disproportionately affect the total number of cancellations at the hospital. To assess this effect, we calculated the expected number of cancellations for each department for the time period after the interventions (i.e., the product of pre-intervention CRs and the number of scheduled operations after the interventions). We then calculated the expected cancellation rate at the hospital for the time after the interventions (i.e., the sum of the expected number of cancellations for each department divided by the total number of scheduled operations).

We recorded the volume of elective surgery, emergency surgery, and consultations at the outpatient clinics, because an increase in the volume of one of these activities could affect the volume of the others. The Department of Ophthalmology, which accounts for less than 1% of the total number of emergency cases, was excluded from the count of emergency cases because of incomplete data. CRs from the odontology unit were not available for the entire period, and it was excluded from our study. Moreover, we recorded the number of cancellations per month due to overriding emergency cases.

Changes in the ratio of capacity and demand could influence the cancellation rate [19]. We measured demand as scheduled operations per month and capacity as hours available for surgery per week and the number of full-time equivalents per year for the involved departments. Due to changes in the data system of the hospital, information about full-time equivalents was only available after January 2008.

Utilization of the list of scheduled operations, and in particular list over-runs, can influence CRs [19]. We recorded the proportion of list over-runs for each department. In line with Pandit et al. [19] a list finishing >10% after the scheduled end time was classified as over-running. Data for these calculations were only available for the time after the interventions. Finally, we recorded the number of cancellations per month caused by the hospital not being able to finish the scheduled list.

We interviewed a strategic sample of employees at the hospital ($n=20$) to understand how the pathway for elective surgery was redesigned and to identify factors that had contributed to sustained improvements. Interviewees had different professional backgrounds (i.e., physicians, nurses, secretaries, and leaders) and worked in different departments involved in the clinical pathway. The degree of interviewees' participation in the

improvement projects varied. Some had participated in the design of interventions in their project groups and others were not directly engaged in the interventions. The interviews were semi-structured and based on an interview guide that covered the following topics: local problem, setting, context, intended improvement, planning of interventions, implementation of interventions, outcomes, and efforts to sustain outcomes. The interviews were taped, transcribed, and transferred to HyperRESEARCH 2.8.3 software (ResearchWare, 2009) for coding. We developed an initial coding scheme from the themes in the interview guide, and codes were added as the data were analyzed [20]. We interpreted the relationship between the codes to identify distinctive elements of the interventions and factors that influenced success of the improvement process [21].

The protocol of the study was presented to the regional ethical review board, and a formal ethical review was not deemed necessary. The study was approved by the Norwegian Social Science Data Services. All the interviewees participated voluntarily based on informed consent, and could withdraw from the study at any time.

Results

The mean cancellation rate was reduced from 8.5% to 4.9% (95% CI for mean reduction 2.6-4.5, $p < 0.001$; Table 3). The u-chart demonstrates a sustained change in CRs that coincided with the interventions at month number 38 (see Figure 1). After the interventions, the CRs were more stable, and all points (registration of monthly CRs) were below the centerline.

The median number of performed operations per month increased by 17%, from 323 to 378, after the interventions ($p=0.04$; Table 3). The mean number of consultations at the outpatient clinics increased from 2722 to 3021 per month ($p=0.006$; Table 3). The number of emergency cases per month was the same before and after the interventions ($p < 0.001$; Table 3).

The median number of scheduled operations per month increased from 373 to 400 after the interventions ($p=0.04$). The capacity increased stepwise until three months after the interventions, from 270 hours per week to 338. At that point it decreased to 304 hours per week and afterwards remained unchanged for the rest of the study period. The number of full-time equivalents as of January 2008 was 279 for the involved departments. For the time period after the interventions the mean number of full-time equivalents was 280 (95% CI 277-283).

Before the interventions the mean number of cancellations caused by the hospital being unable to finish the scheduled surgery lists as planned was 4.2 per month (95% CI 3.1-5.4), and the mean number of total cancellations was 28.1 (95% CI 24.7-31.5). After the interventions the mean number of cancellations caused by the hospital being

Table 3 Comparison of outcome measures before and after the interventions

	Before changes (Jan 2005 – Feb 2008)	After changes (Mar 2008 – Apr 2010)	P-value (Difference between before and after changes)
Cancellation rate (mean % per month)	8.5	4.9	<0.001 ¹
Transformed cancellation rate ²	0.30	0.22	<0.001 ¹
Total number of scheduled operations (median per month)	373	400	0.04 ³
Total number of performed operations (median per month)	323	378	0.04 ²
323 378 0.04 ₃			
Emergency cases (median per month) 102 103 1.0 ₃	102	103	1.0 ²
(Based on time the time period Jan 2006 to Apr 2010)			
Number of consultation at outpatient clinic (mean per month)	2722	3021	0.006 ¹
(Based on the time period May 2006 to Apr 2010)			

¹ Student's *t*-test.

² Using the Freeman-Tukey double arcsine transformation.

³ Mann-Whitney *U* test.

unable to finish the scheduled surgery lists as planned was 3.1 (95% CI 2.1-4.1, $p = 0.147$). The proportion of over-running lists per department after the interventions was: ophthalmology 1.2%; ear, nose, and throat 2.8%; gynecology 21.1%; general surgery 22.2%; and orthopedics 27.7%.

The mean number of cancellations caused by emergency cases overriding elective surgery was 1.46 (95% CI 0.8-2.1) per month before and 0.1 (CI -0.1-0.4, $p < 0.001$) after the interventions. The expected cancellation rate for the time after the interventions, calculated from pre-intervention cancellation rates and the number of scheduled operations after the interventions, was 8.2%.

Through the analysis of the interviews we found that the following factors were important for the success of the project:

- Involvement of frontline professionals in redesigning processes across traditional department borders
- Combining professional entrepreneurship with support from staff with knowledge about improvement techniques
- Centralizing patient preparation and discharge at one location
- Use of computer application to improve planning and coordination of surgery programs across departments
- Middle managers role in securing context-sensitive implementation of interventions
- Adaptation of interventions based on feedback from frontline clinicians

Before the start of the project, the clinicians agreed that the pathway for elective surgery needed to be improved. However, they had no common understanding of exactly what the problem was or how it could be solved. The top management of the hospital strongly emphasized involving a wide range of frontline professionals from different departments in the project groups. The participants shared information about their everyday work situations and

mapped the current state of the pathway by drawing flow charts. The staff from the support unit provided the clinicians with structure and process data from the patient administrative system and guidance about improvement techniques. Through these processes bottlenecks and areas that needed improvement were detected.

All project groups communicated regularly with each other and with the involved departments. Through regular meetings with health personnel affected by the change process, leaders and project groups received feedback on the proposed actions.

The opening of the day-surgery center and the software for surgery planning catalyzed changes in the corresponding clinical processes because participants could no longer follow the old clinical pathway. According to the informants, the degree and speed of change in the clinical processes varied among departments. Despite the involvement of frontline personnel in the planning and decision phases, resistance to change was encountered during the implementation process. Letting patients choose the date for their surgery was especially difficult to implement. The presence of middle managers in the daily work processes allowed them to continuously monitor the degree of implementation and receive feedback on the need to adapt interventions to the local context. Their continued intervention was important to overcome resistance, re-implement changes, and secure context-sensitive implementation and adaptation of changes.

Discussion

Our study showed a sustained reduction of cancellations over 2 years and an increase in the number of performed operations after the redesign of the surgical pathway. Such a long observation period is rare in research on quality improvement, in which the median follow-up time of the dependent variable is usually less than 1 year [13]. Moreover, the degree of fluctuation of CRs was reduced.

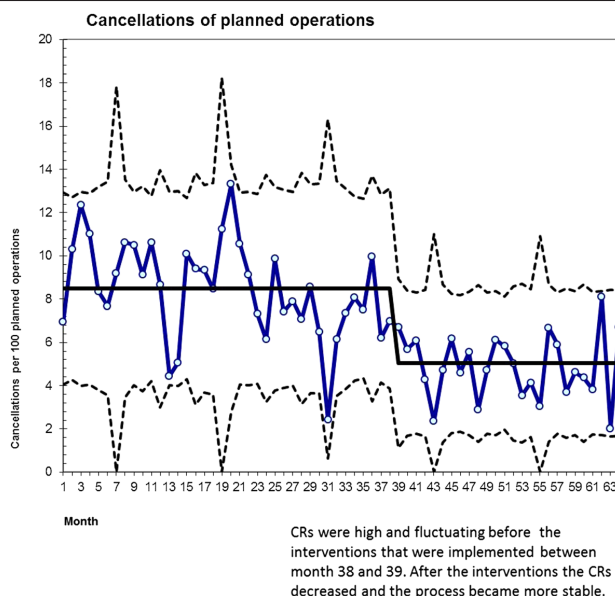


Figure 1 Monthly CRs at the hospital.

Causes of the reduction of CRs

The entire pathway for elective surgery, from referral to discharge, was redesigned. Changes were implemented across departmental borders, and frontline staff were broadly involved [22]. Improved management and surgery planning, redesign of work processes, training of staff, and early clinical evaluation have been suggested as strategies to reduce CRs [6]. At our hospital, all of these strategies were applied. The interventions included various elements that were linked to the local context. The distinct effects of the separate elements can therefore not be disentangled.

Sanjay et al. [4] suggest allowing patients to select the time for surgery to give them earlier notice of their operating day, and to send them a reminder. Involving patients in these ways can increase satisfaction with treatment decisions during the initial consultation, which is a strong predictor of whether a patient will attend the surgery [23]. In the new pathway, patients participated in planning the date of their surgery and received the actual date of the operation before they left the outpatient clinic. It is therefore likely that these measures contributed to reducing cancellations.

Early preoperative assessment has previously been shown to reduce CRs [7-10]. Van Klei et al. [8] showed that cancellations attributable to medical reasons decreased from 2.0% to 0.9% for patients who

had attended a pre-assessment clinic. Ferschl et al. [7] found a CR of 5.3% among patients who visited an anesthesia preoperative medicine clinic, in contrast to 13.0% for those who did not. Rai and Pandit [9] found that nurse-led pre-assessments in an elective surgical center reduced cancellations. O'Regan et al. [10] demonstrated that a process-oriented multidisciplinary approach for patients who undergo bypass surgery led to improved patient outcomes and lower CRs. Our findings are consistent with these studies.

Cancellations of elective surgery due to emergency cases were practically eliminated after the interventions. The number of emergency cases was the same before and after the interventions and can thus not explain this finding. It is most likely that the designated day-time theatre for emergency cases contributed to reducing CRs, which is supported by previous studies [24,25].

The increase in performed operations exceeded what can be explained by the reduction in CRs alone. More patients were referred to the hospital for elective surgery mainly because of the closure of a local hospital in the region. The number of performed operations increased after the interventions, while the capacity was reduced 3 months after the interventions. This finding indicates that the hospital managed to increase the efficiency of their operating lists [19].

Alternative explanations for the reduction of CRs

Since the CRs varied across specialties, the disproportional increase in scheduled operations among the surgical specialties could have contributed to reduced CRs after the interventions [18]. The calculated expected CR after the interventions for the hospital was 8.2%, while the observed rate before the interventions was 8.5%. The difference between the calculated and the observed CR indicates that a disproportional increase in scheduled operations may have contributed to the decrease in CRs after the interventions. The effect is, however, small, and can only explain a small portion of the observed reduction in CRs.

A reduction in emergency cases could have affected the CRs. However, the number of emergency cases per month was the same before and after the interventions, making this an unlikely explanation for the reduction in CRs. The increase in the number of performed operations was not caused by a subsequent fall in consultations at the outpatient clinic, as this number increased after the interventions.

Reduced pressure on the service could contribute to reduced CRs [26]. In our case the number of scheduled and performed operations increased. This increase indicates that there was a corresponding increase in demand. The capacity, measured as hours per week available for surgery, increased until 3 months after the interventions and then decreased, while the number of full-time equivalents remained unchanged after the interventions. Thus, the pressure on the service increased after the interventions, making it unlikely that change in the ratio between demand and capacity contributed to reduced cancellations.

An increased tendency to over-run operating lists after the interventions could have contributed to the observed reduction in CRs. Data about this were not available for the pre-intervention period. The proportion of over-running lists for the ophthalmology- and ear, nose, and throat departments was low after the interventions, at 1.2% and 2.8%, respectively. It is therefore unlikely that list over-runs at these departments increased after the interventions, thereby contributing to reduced CRs. For the three remaining departments, we cannot exclude the possibility that list over-runs increased after the interventions. Before the interventions, 4.2 cancellations per month were due to the fact that the hospital was not able to finish the scheduled surgery list as planned. These cancellations could have been avoided by over-running the lists [19]. However, there was no significant reduction of cancellations caused by the hospital not being able to finish the scheduled program after the interventions. This finding indicates that even if list over-runs may have increased after the interventions

it cannot be a strong factor for explaining the observed reduction in CRs.

Factors that contributed to sustained improvements

The redesign of the surgical pathway was embedded in the new strategies to improve the performance of the clinical system. This integration secured a solid foundation in the top management without compromising professional entrepreneurship of middle managers and frontline professionals. Consistent with earlier studies [27,28], we found that this strategy created a basis for improvement by providing guidance about tools and techniques that were important for the success of the project.

The improvement strategy was also important for securing a wide representation of clinical staff in the project groups and for setting the context for the project. In the strategy, the top management emphasized system improvement by equally addressing professional patient and management quality, as well as staff satisfaction. The inclusion of all these dimensions contributed to acceptance by clinicians and other staff, consistent with other studies [12,29].

Improvement groups interacted in an informal network across departments. This network continued after the project period. Frontline employees were engaged in suggesting adoptions and modifications of the interventions. The presence of the middle managers in the actual work processes allowed them to follow the implementation daily and adapt and re-implement changes when needed. The hospital increased the effectiveness of the interventions by adapting them to contextual changes, as indicated by Fixsen et al. [30]. This flexibility seems to be a key factor for sustaining the outcomes.

The optimal use of information technology contributes to the success of high-performing institutions [31]. In our case, the new software for planning surgery integrated the schedules of all the departments thereby improving the scheduling of operations for the whole hospital.

Moreover, the surgery coordinator supported scheduling of operations up to 6 months in advance by matching available slots for surgery and the expected duration of procedures based on previous experiences. The planning processes became more dynamic because waiting lists were taken into account when assigning slots for surgery. Altogether, these measures ensured a better utilization of the total capacity of the operating theatres.

CRs of approximately 5% in our study are still high compared to van Klei et al., [8] who reported a rate below 1%. Further improvements can probably be achieved by fully implementing the aforementioned changes. The process of scheduling surgery could likely be further improved by applying the approach described by Pandit

and Tavaré [32] using a formula to predict the likely duration of an operating list.

Limitations

An observational and retrospective study design has the limitation of information bias and confounding, and we cannot prove causality between interventions and the observed outcomes. The improvement project in our case is an example of complex, context-dependent interventions that evolved over time. Such projects are less suitable for strictly controlled, prospective, experimental study designs that could avoid these limitations [33]. Nonetheless, our design makes long-term follow-up feasible and allows us to learn from a successful case by combining qualitative and quantitative data and different analytical methods [34]. Therefore we found it appropriate to use the chosen design.

Our calculation of the number of full-time equivalents before the interventions was based upon data from January 2008, because prior data were not available. These data might not be representative of the pre-intervention period. However, the mean number of full-time equivalents after the interventions was 280 compared with 279 before the interventions, indicating no increase during the post-intervention period. This finding is also supported by data from the interviewees stating that there was no substantial change in the number of full-time equivalents during the study period.

We used the number of scheduled operations per month as a measure for demand. A more precise measure for demand would have been minutes of operating capacity needed per week, but data about this were not available [26]. However, we argue that the number of scheduled patients per month also reflects service demand. Since the number of scheduled patients increased after the interventions, while the capacity was reduced, it is likely that the pressure on the service increased.

In summary, the strength of our study is the long observation time with sustained improvements. Moreover, through our use of quantitative and qualitative methods, we were able to identify factors that contributed to the changes. By using statistical process control we could demonstrate a clear association between interventions and improvements. Data from interviews were consistent across departments and professional borders and did not reveal other organizational changes or quality improvement projects that could have influenced CRs. Finally, our findings are consistent with previous studies. The hospital in our study resembles other district hospitals and the interventions implemented here can likely be adapted to other hospitals of similar size and complexity.

Conclusion

The redesign of the pathway for elective surgery contributed to a sustained reduction in CRs and an increased number of performed operations. The improvement strategy sought to improve system performance through the involvement of frontline clinicians, use of information technology, and engagement of middle managers, all of which were important factors for the sustained reduction in cancellations of elective surgery.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

EH had full access to all the data in the study and takes responsibility for the integrity of the data and accuracy of the data analysis. EH, OB, and KH conceived and designed the study. EH acquired the data. EH, CVP, and ABA analyzed and interpreted the data. EH, CVP, ABA, and KH drafted the manuscript. EH, CVP, OB, and KH critically revised the manuscript for important intellectual content. EH and CVP provided statistical expertise. OB and EH obtained funding. CVP, ABA, OB, and KH supervised the study. All authors read and approved the final manuscript.

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Patient Experiences with Interventions to Reduce Surgery Cancellations: a Qualitative Study

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Abstract

Background

The cancellation of planned surgery harms patients, increases waiting times and wastes already scarce health resources. Previous studies have evaluated interventions to reduce cancellations from a medical and management perspective; these have focused on cost, length of stay, improved efficiency, and reduced post-operative complications. Literature is scarce concerning how patients experience such interventions. We studied the experiences of patients at a hospital where a pathway for elective surgery was successfully redesigned to reduce cancellations.

Methods

We conducted a comparative, qualitative case study by interviewing patients who had experienced the redesigned pathway, and patients who had experienced the pathway prior to redesign. We performed a content analysis of the interviews using a theoretically-based coding scheme. Through a process of coding and condensing, we identified themes of patient experience.

Results

We identified three common themes relating to how patients experienced the intervention effects: the importance of integrating surgery into the way they lived their lives, individualized preparation before hospital admission, and the importance of relationships with a minimum number of clinicians during their hospital stay.

Conclusions

The patients appreciated the effects of the interventions, which also had positive effects beyond simply reducing cancellations; they enabled patients to make choices that fitted their particular circumstances by integrating the surgery into their lives. Apart from improving surgical logistics, the interventions were also shown to contribute to increased patient-centered care.

Keywords

Quality improvement; surgery; cancellations; patient centered; qualitative

Background

The cancellation of planned surgeries is a well-recognized quality problem. High cancellation rates may indicate that scarce health resources are being used ineffectively, thereby increasing costs [1, 2]. Patients are directly affected by cancellations; they increase waiting times and may lead to harmful delays of operations [2, 3]. Further, the cancellation and the extra waiting time may cause patients physical and emotional distress [4].

Previous research has addressed how cancellations can be reduced through earlier and better clinical pre-assessment and improved surgical scheduling [5-11]. Interventions to reduce cancellations have been evaluated from a management and medical perspective; these have focused on cost, length of stay, improved efficiency, and reduced post-operative complications [8, 9, 11-14]. To our knowledge, the effects of interventions to reduce cancellations have not been explored from the perspective of those who are affected by them - the patients.

We have previously reported the case of a Norwegian district general hospital that redesigned its pathway for elective surgery and achieved a sustained reduction in cancellations [15, 16]. The purpose of the current study was to explore how patients experienced the changes that were implemented to reduce cancellations.

Method

Theoretical basis for interventions to reduce cancellations

Reducing cancellations is a complex task because its causes are related to patients, organizational issues and clinical staff [1, 17]. Common causes for cancellations are related to the patients' medical conditions, inadequate medical pre-assessment, overbooking of lists, facility shortcomings, and patient non-attendance [1, 8, 18-22]. Because the reasons for cancellations are multi-factorial, interventions to reduce cancellations need to target the complexity of the problem. The literature suggests that most cancellations can be avoided by redesigning work processes, improving planning and coordination, and performing earlier clinical pre-assessment of patients [18, 21, 23]. It has also been suggested that patients should be allowed to select their time of surgery, given earlier notice of their operating day, and sent a reminder of their appointment [21]. Involving patients in this way may even increase their satisfaction with treatment decisions during initial consultations, which is a strong predictor of attendance for surgery [24].

Design

We did not find relevant literature about patient experiences with interventions to reduce cancellations. Thus, we chose a qualitative design with semi-structured interviews which enabled us to explore the field [25]. Qualitative methods have also been advocated in outcome research because they are open to unexpected inputs [26].

We conducted a comparative case study and interviewed patients from two hospitals, A and B [27]. This design enabled us to compare experiences between hospitals. By using a

comparative method we could isolate the effects of the interventions and establish a probable relationship between the interventions and patient experiences.

Description of the case

Hospital A is a district general hospital where the pathway for elective surgery was redesigned. It has seven operating suites and 34 surgical beds. Hospital B, the comparison case, is a local hospital with three operating suites and 14 surgical beds. The two hospitals belong to the same local health authority and share the same senior management team. Initially, both hospitals had a similar clinical pathway for elective surgery and faced the same quality problems with their services. As a consequence, the health authority's management planned a redesign of the pathways at both hospitals. For practical reasons, the revised plan was abandoned at hospital B.

Hospital A redesigned its pathway by utilizing the following interventions: earlier clinical pre-assessment, improved information flow between surgeons and anesthesia personnel, patient participation in selecting their date for surgery, centralization of preparation and discharging of patients to a single unit, a telephone call to patients two days prior to surgery, and a common computer-based system for scheduling operations across all surgical departments [15]. Table 1 displays the main differences between the original and the redesigned pathways.

Table 1. Main differences in the pathway before and after redesign

Pathway before redesign	Pathway after redesign
Patients did not participate in deciding the time of their surgery	Patients participate in choosing the time of their surgery
Patients left the consultation at the out-patient clinic without an appointment for surgery and were notified later about the scheduled appointment for surgery via letter	Patients are given their appointment at the consultation when the decision to perform surgery is made
No routine process for calling patients prior to surgery	Patients are called two days prior to surgery to make sure they are ready for surgery
Preparation and discharge of patients took place within the surgical departments	Preparation and discharge of surgical patients is centralized to one location

Recruitment

Clinicians at hospitals A and B recruited patients for the study. They handed out an information letter describing the purpose of the study during the pre-surgical medical assessment. Patients who agreed to participate signed an informed consent form. The clinicians returned the form by mail and the first author called the patients after they had completed their surgery. As a result, we recruited 10 patients at hospital A and eight patients at hospital B.

Data collection

Between January and March 2011, the first author conducted semi-structured telephone interviews with patients who had undergone operations at hospitals A and B. For patients under 18 years of age, the first author interviewed a parent. We purposively sampled patients with different characteristics with regard to gender, age and type of surgery (day surgery/in-patient-stay) [28].

The interviews followed a guide with open-ended questions to explore the patients' experiences. The guide was based on a literature review about patient experiences of

interventions to improve care [29-32], the interventions implemented to reduce cancellations at hospital A and the different phases of elective surgery; the consultation at the out-patient clinic, the time spent waiting for surgery, and the hospital admission for surgery.

Participants

We completed interviews with 16 of the 18 patients (12 patients, 2 mothers and 2 fathers), eight from hospital A and eight from hospital B. One patient withdrew his/her consent to participate and one interview was not completed because of technical difficulties. Table 2 displays the characteristics of the interviewees.

Table 2. Interviewee Characteristics

Characteristic	Value	Number of patients
Age (yr)	<18	4
	18–40	2
	40–59	6
	>60	4
Sex	Men	9
	Women	7
Location	Intervention hospital	8
	Comparison hospital	8
Type of surgery	Day surgery	9
	Hospitalized	7

Analysis

We audio-taped the interviews, transcribed them verbatim, and transferred them to HyperRESEARCH 2.8.3 computer software (ResearchWare, Inc., 2009) for coding. We performed a content analysis using a direct approach, as described by Hsieh and Shannon [33]. Based on the theory about interventions to reduce cancellations, we developed a coding scheme to reflect the interventions implemented at hospital A, i.e. earlier clinical pre-assessment, patient participation in scheduling the surgery, telephone calls to patients prior to

surgery, and centralized preparation and discharge. The first author coded the interviews and identified passages where the patients described experiences related to these interventions.

The last author read all the interviews and validated the coding; the first and last authors then compared codes from the two hospitals. The aim was to identify how the patients' experiences were related to the interventions that reduced cancellations at hospital A. Using an iterative process of coding, then reflecting on the codes and condensing, the first and last authors identified common themes relating to how the patients had experienced these interventions [34].

The first author made consecutive case notes of the interviews. Furthermore, we started analyzing the data during the data collection. In doing so, the data collection and data analysis were iterative steps. From the case notes and our analysis, we observed that the last two interviews did not add any new information. Having reached data saturation, we concluded that the sample size was sufficient for the purpose of this study [25, 35, 36]. Saturation can be observed prematurely if a sample is not sufficiently diverse [35]. However, we interviewed patients of both genders, with different ages, and a range of operations types. As such, we believe that our sample was diverse enough to capture a wide range of experiences [28].

A professional bilingual translator translated the quotations in this article from Norwegian into English. Quotations were adapted from an oral style to a written format to enhance readability without changing the content of meaning [37].

Ethical considerations

Patients participated based on informed, written consent and could withdraw from the study at any time. The Western Department of the Regional Committee for Medical and Health Research Ethics in Norway deemed a full ethical review unnecessary because sensitive patient data were not included in the study. The study protocol was accepted by the Norwegian Social Science Data Services, which reviewed ethical aspects relating to the collection and handling of data (e.g. voluntary participation based on informed consent, anonymity of informants, and appropriate storage of data).

Results

We identified three common themes concerning how patients experienced the interventions. These included 1) the importance of integrating the surgery into the way they were living their lives; 2) individualized preparation before the hospital admission; 3) the importance of establishing relationships with a minimum number of clinicians during the hospital stay. We have structured the presentation of our findings around these themes and present patient quotes to illustrate how they experienced the changes.

Integrating surgery into the way patients were living their lives

Patients at hospital A originally received their surgical appointments by mail, after the out-patient clinic consultation when the decision to operate was made; as such they could not participate in its planning. This process was changed so that patients could choose the date of surgery and confirm the appointment during the actual pre-operative consultation. The patients reported that this option was important to them, because the elective surgery impacted on them and their social surroundings beyond the medical condition and its

treatment. Fundamentally, the surgery affected the way each patient planned and lived their lives. The active participation in deciding the date of surgery, in combination with agreeing the appointment in advance, allowed them to make choices to fit their particular circumstances. It allowed them to integrate the planned surgery into their lives. However, patients from hospital B who were not given this opportunity, expressed that they would have preferred to participate in scheduling their surgery, and pointed to the importance of knowing the actual date of surgery earlier on.

The following quotations illustrate this finding:

Interviewer (I): Did you have any influence over the scheduling of your surgery?

Patient (P) at hospital A: Yes, I did. And that was really good. I was due for a training period, and was able to work around that. I couldn't have made it work otherwise.

I: Did you have any influence over the scheduling of your surgery?

P at hospital B: No, but that would have been a great practical advantage, as it would have made it possible to schedule around work, school, and traveling to the hospital. It is important to be able to plan ahead.

Individualized preparation before hospital admission

At hospital B, patients received practical information about their forthcoming operation in the same letter that informed them about their operation date. The patients at hospital B reported that they were satisfied with the information they received prior to surgery. Patients at hospital A received the same type of information at their out-patient consultation when the decision to perform surgery was made. In addition, hospital A started calling patients two

days prior to surgery to make sure they were in good health and would keep their appointment. If patients were unable to attend their scheduled surgery, another patient was rescheduled, thereby avoiding a cancellation.

The phone calls also had beneficial effects beyond preventing cancellations. The phone call created a dialogue between the patient and the hospital. Patients could ask questions, staff were able to support their pre-operative preparation, and check if the patient had understood the information. Patients felt that the phone call demonstrated that the hospital cared about their well-being and was prepared and ready for their particular situation.

The following quotation illustrates these experiences:

P (Hospital A): It was a very positive thing. I felt that somebody cared about what was going to happen and that they were more on top of things than if they had just sent a letter.

Relating to fewer clinicians

To reduce cancellations arising from poor planning and a lack of coordination between departments, hospital A established a surgical center. Preparation and discharges of all patients were centralized to this facility to optimize resource utilization and to ensure improved planning and coordination. This centralization also resulted in patients relating to fewer health professionals during their admission, because they did not have to be admitted to a regular ward. Patients from both hospitals emphasized the importance of having relationships with a limited number of health professionals, because it contributed to continuity of care and made them feel safe.

P at hospital B: One thing I thought was really good, was that the same people were there when you came in and when you woke up again. I have had a number of surgeries over the years. On other occasions, I felt like I constantly had to relate to new people, and that was downright pathetic.

I: Why is meeting the same people the whole time a good thing?

P: I think it gives a sense of security. A person met you, knows about you, and follows your progress.

Discussion

Our main finding was that patients appreciated the effects of interventions that had been implemented to reduce cancellations. Interestingly, patients also described positive effects that the improvement team had not planned for, such as improved continuity of care and the personalized phone dialogue prior to surgery.

Patients appreciated the changes because they contributed to making care more patient-centered. Patient-centeredness is a core value of health care and one of the main characteristics of high quality health services [38]. It has been defined as “ . . . respecting and responding to patients’ wants, needs and preferences, so that patients can make choices in their care that best fit their individual circumstances” [38, 39]. Patient-centeredness is important in its own respect, but has also been associated with better clinical outcomes [40, 41]. In line with previous research, we found that patient participation in scheduling surgery and timely scheduling was important to patients [42, 43]. This change responded to patients’ wants, needs, and preferences and enabled them to make and adapt choices that fitted their individual circumstances, thus rendering the service more patient-centered.

Hospital A established telephone calls prior to surgery to reduce non-attendance, in line with published research about telephone reminders [44, 45]. For patients, the phone calls had additional effects in that they changed the information flow from a one way communication style (letter) to a personalized and interactive dialogue. Another effect that was not anticipated was related to the centralization of the preparation and discharge to the surgical center. Hospital A implemented this to improve coordination and efficiency. However, the patients valued this change because it reduced the number of different professionals they had to interact with.

Health care is currently facing the challenges of reducing costs and improving efficiency, while maintaining or improving quality [46, 47]. This challenge has stimulated an interest in relation to how quality improvement may increase efficiencies [48, 49]. Modern health care also needs to deliver care that is more patient-centered [38, 50, 51]. Improving efficiency and patient-centeredness is often considered to be contradictory, because interventions focusing solely on cost and efficiency can affect care in ways that health professionals and patients do not approve [52]. At hospital A, cancellations were reduced and the number of operations per month increased, while resources remained unchanged, thus indicating increased efficiencies [15]. From our interview findings we assert that the interventions at hospital A also contributed to increased patient satisfaction. Our findings indicate that interventions to reduce cancellations can be designed in ways that not only improve the logistics of surgical planning and efficiency, but can also make care more patient-centered.

Limitations and further research

We are unable to describe any potential negative effects from the interventions to reduce cancellations, because all the patients gave only positive feedback. We asked open-ended questions about their general experiences and covered all of the aspects within the trajectory of elective surgery. Also, our interview guide was informed by theory about reducing cancellations and patient experiences to improve overall care. Therefore, we suggest that the lack of negative cases in this research was not caused by the study methods that were used to collect data.

Interviews over the telephone may yield less information, because researchers have limited insight into and influence on, the interviewees' circumstances and reactions [53]. Further, face-to-face interviews were not feasible because of the long distances to travel in rural Norway. Also, we did not want to interview patients during the psychologically vulnerable phase immediately before or after their operation. However, the first author, who conducted all of the interviews, has extensive experience in communicating over the telephone with patients in the clinical setting, and has conducted previous studies using telephone interviews. Despite the inherent limitations of using telephone interviews, because of the author's previous experience, we are confident that we collected valid data to answer our study questions.

Patient experiences were reported consistently at hospital A where the changes occurred, and patients at hospital B who had not experienced the interventions, asked for the same types of interventions. Furthermore, the analytic framework used in this study was based upon accepted theory and our findings were aligned with the literature. Despite the limitations in

this study, we argue that valid data were collected to explore the patients' experiences of interventions to reduce cancellations.

Findings from this exploratory study need to be validated in larger studies. Such research could benefit from a prospective design and by using mixed methods. Patient participation in decisions about appointments and pre-admission telephone calls may have relevance for ambulatory care in general. Future studies should address patient experiences with these interventions in other settings. Further, patients who have valuable first-hand 'expertise' are not often directly involved in planning changes. More research is needed about how to effectively involve patients in developing patient-centered care models [31, 54].

Conclusions

Our findings indicate that patients appreciated the effects of interventions to reduce cancellations, because the interventions increased their autonomy by enabling choices that fitted with their particular circumstances. The interventions also had unanticipated consequences; the phone reminder created a personalized dialogue prior to surgery and centralization of surgical preparation and discharge processes contributed to continuity of care. Apart from improving surgical logistics, the interventions to reduce cancellations were also shown to contribute to increased patient-centered care.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

EH designed the study, collected the data, analyzed the data and drafted the manuscript. OB participated in the design of the study, the data analysis and helped to draft the manuscript. KH participated in the design of the study and helped to draft the manuscript. ABA participated in the design of the study and helped to draft the manuscript. CVP participated in the design of the study and helped to draft the manuscript. All authors read and approved the final manuscript.

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RESEARCH ARTICLE

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Sustainability of healthcare improvement: what can we learn from learning theory?

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Abstract

Background: Changes that improve the quality of health care should be sustained. Falling back to old, unsatisfactory ways of working is a waste of resources and can in the worst case increase resistance to later initiatives to improve care. Quality improvement relies on changing the clinical system yet factors that influence the sustainability of quality improvements are poorly understood. Theoretical frameworks can guide further research on the sustainability of quality improvements. Theories of organizational learning have contributed to a better understanding of organizational change in other contexts. To identify factors contributing to sustainability of improvements, we use learning theory to explore a case that had displayed sustained improvement.

Methods: Førde Hospital redesigned the pathway for elective surgery and achieved sustained reduction of cancellation rates. We used a qualitative case study design informed by theory to explore factors that contributed to sustain the improvements at Førde Hospital. The model Evidence in the Learning Organization describes how organizational learning contributes to change in healthcare institutions. This model constituted the framework for data collection and analysis. We interviewed a strategic sample of 20 employees. The in-depth interviews covered themes identified through our theoretical framework. Through a process of coding and condensing, we identified common themes that were interpreted in relation to our theoretical framework.

Results: Clinicians and leaders shared information about their everyday work and related this knowledge to how the entire clinical pathway could be improved. In this way they developed a revised and deeper understanding of their clinical system and its interdependencies. They became increasingly aware of how different elements needed to interact to enhance the performance and how their own efforts could contribute.

Conclusions: The improved understanding of the clinical system represented a change in mental models of employees that influenced how the organization changed its performance. By applying the framework of organizational learning, we learned that changes originating from a new mental model represent double-loop learning. In double-loop learning, deeper system properties are changed, and consequently changes are more likely to be sustained.

Keywords: Quality improvement, Organizational learning, Learning theory, Sustainability

Background

Quality improvements in health care that are not sustained are a waste of resources. Falling back to old, unsatisfactory ways of working can be frustrating and increase the resistance to later initiatives to improve care. Few publications have reported sustainability of

healthcare improvements. In a systematic review, the median follow-up time for interventions that sought to improve the quality of care was less than 1 year [1]. Consequently, little is known about the factors that contribute to the sustainability of improvements [2,3]. This makes such research sorely needed [4].

Over the past few decades, an understanding of healthcare quality as a system property has emerged [5-7]. Accordingly, the quality of health care primarily depends on the function of the system and to a lesser degree on the skills of individuals [5]. Changing the system is

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therefore the most effective route to improvement; i.e., an organization needs to change its way of operating to produce improved outcomes, and these changes must be maintained to sustain the improvements [5,8].

The sustainability of systemic change is poorly understood. Use of theoretical frameworks allows for an understanding of factors that contribute to sustainability [9,10]. In particular, theories of organizational learning explain crucial aspects of change in organizational behavior. Argyris and Schön [11] defined learning as the translation of new knowledge to altered behavior that is replicable. Quality improvement implies that an organization needs to alter its behavior, and that the behavioral changes must be replicable to sustain improvements. Sustained improvement after systemic change can thus represent a case of organizational learning. A framework of organizational learning can be used to explore the factors that influence the sustainability of improvements.

In this article, we use an organizational learning framework to explore a case that demonstrated sustained improvement. The case is Førde Hospital's project redesigning their pathway for elective surgery to reduce cancellations. Reasons for cancellations are complex and related to patients, organizational issues, and clinical staff [12,13]. Cancellations are caused by a clinical system performing sub-optimally, e.g., poor scheduling, inadequate medical pre-assessment, and facility shortcomings [14-19]. Reducing cancellations requires changes in the clinical system. Changing the clinical system requires organizational change through organizational learning [5]. Organizational learning becomes manifest through new organizational routines, and the effects of these new routines can be measured [20,21]. Organizational learning in our case should therefore be reflected in reduced cancellation rates. We have previously demonstrated how the redesign of the surgical pathway at Førde Hospital caused a significant reduction in cancellation rates from 8.5 % to 4.7 % that was sustained over 2 years [22]. The case is thus an example of sustained improvement through organizational learning, and it should be suitable for exploring factors contributing to sustain the improvements.

Methods

Context

Førde Hospital is a district general hospital in a small town in Norway, population 10,000. The hospital has 7 operating suites and 34 surgical beds. Like most hospitals in Norway, Førde Hospital is publicly owned and financed. The local health authority also includes two smaller local hospitals. Altogether, the three hospitals serve a population of approximately 107,000. All patients have full healthcare coverage through the national state insurance.

The cancellation of planned surgeries is a known problem in health care that affects patients, diminishes quality

of care, wastes resources, and increases healthcare costs. Complaints from patients and high cancellation rates indicated that the pathway for elective surgery was not optimal at Førde Hospital, and the hospital therefore set out to redesign the entire pathway. The project involved the surgical departments at the hospital (ophthalmology, general surgery, gynecology, orthopedics, and ear, nose, and throat). Altogether 280 full-time equivalents work in these departments.

Four different project groups with a total of 40 employees were formed. Each group was given a mandate to redesign parts of the pathway. The changes that were implemented included one common entry point for all referrals, earlier clinical patient assessment, improved information flow among staff members, patient participation in selecting the date for surgery, and improved coordination and scheduling of operations.

Theoretical framework

The Evidence in the Learning Organization (ELO) model describes how healthcare organizations *learn, create, and share knowledge about evidence-based practices and the system issues that facilitate or inhibit these learning processes* [23]. Therefore, we found that this model is appropriate as a framework for our analysis. The model is based on four main themes: *inquiring, deciding, relating, and interpreting*. Together, these themes *represent the process required for organizations to learn and share new knowledge more effectively* [23]:

1. Inquiring: Are members ready to inquire on behalf of teams/organizations to facilitate the loop learning processes?
 - a. Acquiring: Do they possess technical skills related to locating resources and communicating feedback about this inquiry (e.g., Information Technology training)?
 - b. Informing: Do they possess the cognitive skills (i.e., EBM skills) that support evidence-based decisions?
 - c. Transforming: Do they possess cognitive traits that facilitate behaviors for inquiry (e.g., internal learning motivation)?
2. Deciding: Are members and teams utilizing effective decision processes to integrate evidence into healthcare decisions?
 - a. Deliberating: Are they comparing and analyzing new working goals/strategies and structures/processes that will lead to better decisions (e.g., weighing alternative work procedures)?

- b. Decision-taking: Are they using appropriate decision methods/tools to support better decision-making (e.g., computer-assisted decision tools)?
 - c. Evaluating: Are they using adequate analytical methods (qualitative or quantitative) to measure outcomes of evidence-based decisions (e.g., adequate audit and feedback)?
3. Relating: Are members, teams, and organizations facilitating evidence-based practices through effective organizational communication and relationships?
- a. Sharing: Do the organizational communication structures and processes facilitate sharing knowledge (e.g., adequate information networks)?
 - b. Cooperating: Are teams available and functioning to facilitate efficient knowledge generation and evaluation (e.g., team composition and roles)?
 - c. Advocating: Is there adequate and sufficient leadership with effective motivational strategies to induce organizational cultural change toward learning (e.g., incentives, championing, leadership style, etc.)?
4. Interpreting: Are members and teams sensing the need for evidence-based practice innovations and explicitly describing their tacit knowledge?
- a. Judging: Are they properly evaluating judgments about the outcomes of decisions and needed practice changes (i.e., testing for epistemic gaps)?
 - b. Knowing: Are they building new models of shared understanding based on the results of evidence-based decision-making (i.e., interpreting/integrating with communities of practice)?
 - c. Formulating: Are they codifying this new knowledge (e.g., team-tested practice recommendations) for organizational consumption?

The ELO model itself does not specifically elaborate on how new knowledge is created, how individual learning is transformed to organizational learning, or what organizational mechanisms are involved in the change process. These questions are important for organizational learning. To better understand these processes, we included four of the theoretical frameworks that underlie the ELO model: Argyris' [24] loop learning, Kim's [25] concept of organizational learning, Nonaka's [26] *Socialization, Externalization, Combination, and*

Internalization (SECI) model, and the framework of complex adaptive systems (CAS) [27].

Together these frameworks help explore factors that sustain organizational changes. The concept of single- and double-loop learning explains the actual learning process in the organization [24]. Kim's [25] model explains the transformation from individual to organizational learning through mental models. The SECI model sheds light on how these mental models are incorporated and shared at the organizational level. The framework of CAS elucidates consequences interdependencies in a clinical system can have for organizational behavior and performance [28].

Loop learning

The concept of single- and double-loop learning explains the actual learning process in the ELO model [24]. In single-loop learning, a defect or mismatch between expected and observed outcomes is corrected, leaving the underlying theory for the action unchanged [24]. The feedback loop from the actual experience does not change the basic assumptions or decision-making rules that govern the action that corrected the defect. In double-loop learning, the detected defect is corrected, and the feedback loop from what is experienced during this process also changes the underlying theory or decision-making rules of the action that corrected the defect.

Double-loop learning can occur in organizations *when individuals inquire on behalf of the organization in such a way as to lead to change in the values of the organizational theory in use* [24]. In contrast to single-loop learning, double-loop learning changes the individuals' understanding of the fundamental *theories and values* that guide organizational behavior [24]. Double-loop learning is thus a deeper change than single loop-learning because it changes the underlying system that produces the current organizational behavior.

Organizational learning through changed mental models

Earlier models of organizational learning did not describe how individual members of an organization learn or how the organization learns. According to Kim [25], shared mental models can be viewed as the link between individual and organizational learning. *The cycles of individual learning affect learning at the organizational level through their influence on the organization's shared mental models.* When referring to mental models, Kim used Senge's [29] definition: *deeply held internal images of how the world works, which have a powerful influence on what we do because they also affect what we see.*

Kim's 1993 model also incorporates Argyris and Schön's concept of double-loop learning. *Organizational double-loop learning occurs when individual mental*

models become incorporated into the organization through shared mental models, which can then affect organizational action [25]. Argyris and Schön define organizational learning as the way people jointly construct maps [11]. These maps can be viewed as the mental models that are shared by the organization and compatible with the concept of the organizational theory in use [24].

The SECI model

Individual mental models can be viewed as tacit knowledge. According to Kim, making this tacit knowledge explicit is crucial to the development of new shared mental models in an organization [25]. The SECI model [26] explains how organizations dynamically share, create, and maintain knowledge. Knowledge is created through interactions between tacit and explicit knowledge through four modes of knowledge conversation: *socialization, externalization, combination, and internalization* [30]. Thus, the SECI model can help understand how individual mental models can be turned into shared mental models in the organization because it explains how tacit knowledge can be made explicit and shared in an organization. The model has been extended by introducing the concept of *ba* [30]. *Ba* can be defined as *a shared context in which knowledge is shared, created, and utilized* [30]. This shared context is important because it affects what kind of knowledge is shared and how the knowledge that is created is utilized.

Complex adaptive systems

In line with the increasing complexity of healthcare services, traditional organizational models have exhibited shortcomings, especially in explaining how change occurs. New ways of looking at healthcare organizations have evolved. The literature has advocated use of the CAS framework to explore change processes in health care [31-33]. As opposed to traditional organizational models, CAS explores organizational change by directing attention to the interdependency of the different organizational elements and not towards the elements themselves [28]. CAS can thus help us understand the importance of the relationships and patterns of actions between individuals in a clinical system [34]. These relationships are dynamic, non-linear, and evolve with time. Small changes in one part of the system can lead to huge consequences in a different part [34]. Changes in mental models at an organizational level may influence the relationships and patterns of actions between individuals in the clinical system. We used CAS to better understand the connection between clinicians' change in mental models and their revised understanding of interdependencies in the clinical system, and how this new understanding affected organizational behavior.

Design

Given the scarce knowledge on sustainability of health-care improvements, the character of our study is explorative. Thus we used a qualitative case study design grounded in the theoretical framework of learning theory [35]. Our case is the redesign of the clinical pathway for elective surgery at Førde Hospital.

Data collection

We used purposive sampling to explore the organizational changes at the hospital [36]. Our focus was on organizational rather than the individual perspectives. Thus we included informants with different roles in the hospital. With assistance from the hospital administration, we recruited informants with different professional backgrounds and work experience as well as varying degrees of involvement in the improvement project.

Case study evidence initially consisted of administrative documents. These documents described the overall aim of the improvement project and the mandate of the improvement groups at Førde Hospital. We did not conduct a formal document analysis, but the documents provided us with background information for the interviews.

One of the authors (EH) conducted all interviews during June and July 2010. Seventeen of the interviews were conducted face to face, and three on the telephone. The length of the interviews varied between 20 to 70 minutes. Each respondent was interviewed once. EH wrote case notes for each interview. Our purpose was to maximize information [37,38]. Based on the case notes, the last few interviews did not add any new substantial information. Thus, we reached redundancy, and our sample size was sufficient for the purposes of the study [37,38].

EH conducted in-depth interviews. Based on our theoretical framework, he asked questions having to do with the following themes: identification of a need to change, planning the change, actions taken to induce change, outcomes of change, and adaptations of interventions. He used open-ended questions, e.g., How did the interviewees realize that they needed to change? What did they do to induce changes? How did this change affect their work? At the beginning of the interviews he collected demographic data (gender, profession, degree of involvement in improvement work, leader responsibilities, and years of work experience at the hospital). We grouped the degree of involvement in improvement work in employees who participated in the project groups, i.e., those directly involved in planning and execution, and employees who did not participate in the project groups but whose daily work was affected by the changes.

Analysis

We analyzed the interviews in the three steps described by Creswell [39]: preparing and organizing, reducing

into themes through a process of coding and condensing, and representing in a figure and a discussion. We taped the interviews, transcribed them verbatim, and transferred them to HyperRESEARCH 2.8.3 computer software (Research Ware, 2009) for coding. We developed an initial coding scheme based on the main themes in the ELO model. EH coded the entire data set. During the analysis new codes were added based on the data [39]. Through an iterative process of coding, reflecting on the codes, and condensing, we identified common themes [37]. We interpreted the themes with regard to our theoretical frameworks and represented the relationship between the themes in Figure 1 [39,40].

As recommended by Barbour, [41] the other authors validated excerpts of the data set to validate the coding and the quotations that we present to illustrate our findings. To enhance the rigor of our analysis, three key respondents validated a narrative of how interventions were planned and implemented in the hospital [38,42]. We adapted the quotations, without changing the meaning, to enhance readability and maintain confidentiality [40]. A professional translator translated the quotations presented in this article into written English.

Ethical considerations

The Western Department of the Regional Committee for Medical and Health Research Ethics in

Norway deemed a full ethical review unnecessary because the study did not use sensitive patient data. The study protocol was accepted by the Norwegian Social Science Data Services, which reviewed ethical aspects related to collecting and handling data (voluntary participation based on informed consent, anonymity of informants, and presence of appropriate data storage protocols).

Results

We interviewed 20 employees with different professional backgrounds and varying degrees of involvement in the improvement work. Characteristics of the interviewees are provided in Table 1.

We structure the presentation of our findings around the four main themes of the ELO model. Where relevant, we present representative quotations from the interviews to illustrate our findings.

Inquiring

Complaints from patients and high cancellation rates indicated that the pathway for elective surgery was not optimal. At the beginning of the project, there was a unified understanding that the pathway needed to be improved. Four multidisciplinary project groups were formed to suggest a redesign of different parts of the pathway. The inquiry was initiated in these groups, and clinicians outside the groups were involved through regular meetings and dialogue.

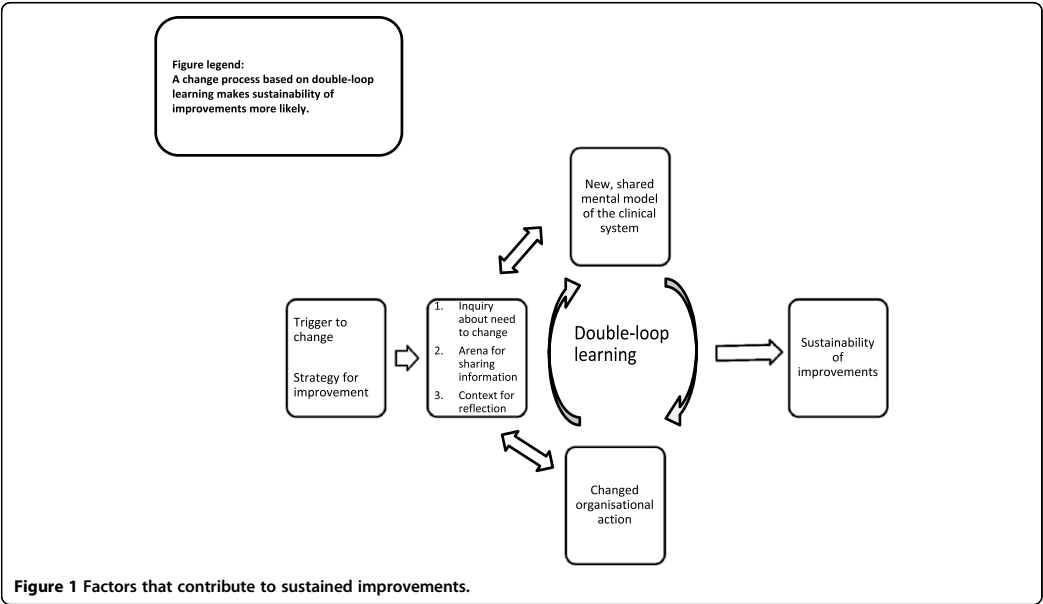


Table 1 Characteristics of the interviewees

Professional group	Number of informants	Participated in improvement groups	Not directly engaged in improvement work	Leaders	Gender (female/male)	Years of work experience at Hospital	
						<5	>10
Physician	9	4	5	4	1/8	1	4
Nurse	7	5	2	3	5/2	3	3
Secretary	2	0	2	1	2/0	1	1
Administrators (project support)	2	2	0	1	2/0	1	1
Total number	20	11	9	9	20	6	8

Within the organization, there was a desire to try to improve the flow of patients.

Middle manager in project group.

There were lots of information meetings along the way. People were supposed to make suggestions; they could write suggestions on pieces of paper, which were posted on the wall. They could say what they thought about the various stages in the process.

Physician not in project group.

The health authority had developed a common platform and strategy for conducting improvement projects. The focus was on detecting systemic problems through equally addressing the four perspectives: professional, patient, and management quality (resource utilization), and staff satisfaction. The balanced approach among these four quality dimensions contributed to making the project understandable and increased acceptance among frontline clinicians.

The project groups mapped the current state of the clinical system and then began inquiring about how the system ought to work in the future and what changes needed to be made. Necessary process data were extracted from the patient administrative system. The project groups received guidance about improvement techniques. They used simple tools, such as Post-It Notes, to visualize the clinical pathway.

You may have really good project support, but if you don't have really good ideas, good staff, creative staff, then all you'll get are minor adjustments or copies of what others do.

Staff member offering support in project group.

Cases of patients were used in the inquiry process to emphasize the patient experience in the pathway. Moreover, the team used ideas from a site visit to a hospital that was considered to have a better practice. Interventions suggested in the literature were also used. The inquiry was a stepwise process influenced by activities in the relating and interpreting phases of the model. New knowledge created in these phases revealed new areas of inquiry.

Deciding

The project combined top-down and bottom-up approaches. The improvement strategy secured a sound foundation with the top management, whereas the frontline professionals were left with sufficient room to find new ways to redesign their own work processes. The project groups suggested interventions and tried to build a consensus for their suggestions through the involvement of and dialogue with clinicians outside the groups.

Staff from the support unit provided the groups with structure and process data from the patient administrative system that served as the groundwork for their decisions.

Middle managers in the project groups mostly decided themselves which interventions to implement. Interventions in the project were in accordance with published evidence (e.g., earlier patient assessment, involvement of patient in decisions for scheduling operations, and calling the patient 2 days prior to surgery).

Those with expertise in project and improvement measures took part throughout the preliminary investigation stage and knew exactly what had been done before, what had been decided, and what the plans for the future were.

Middle manager in project group.

Additionally, the *deciding* phase was a stepwise process influenced by the new knowledge created in the *relating* and *interpreting* phases of the model. This new knowledge provided a new perspective and new areas of inquiry, which again could lead to new decisions. The middle managers participated in the actual clinical processes that were affected by the interventions, thereby instantly learning about the effects of their decisions. This feedback was considered more valuable than measurements such as cancellation rates because it was direct and without delay. Sometimes this feedback revealed a need to revise previous decisions.

Implementation was time-consuming and difficult because of resistance in the organization. Consistent follow-up by middle managers over an extended time was necessary to actually implement the decisions that were made. Through their participation in daily work, middle managers exemplified the new ways of working and demonstrated the importance of following new routines.

I've learned that involving the relevant staff is not enough. Unfortunately, we need those enthusiasts, too. This has not been a success only because of involvement, Post-It Notes, and conclusions. If that were the case, we would not have progressed a single step. And that is something I think that improvement theorists need to take more seriously: that is, that the project itself is only one per cent, or ten per cent. Ninety per cent is the consistent follow-up. And that is generally extremely unpleasant.

Middle manager in project group.

Relating

The meetings in the project groups were the most important arena for sharing and reflecting on information. The strategy of the top management was to include all of the

professional groups that participated in the work process; thus, they convened interdisciplinary project groups. In these groups, frontline clinicians shared information, reflected on it, and related it to their own work and the clinical pathway as one whole to detect areas for improvement. Through this process, tacit knowledge was made explicit and shared.

Reflection and communication was not confined to the project groups. Through the active involvement of clinicians outside the project groups, new knowledge was spread and shared throughout the organization.

You got to sit in a group with the doctor, the nurse, the director, and the porter and look at all the problems. It's not only about my challenges in dealing with a patient scheduled for an operation in an hour. There is actually an entire surrounding complex that has to work.

Middle manager in project group.

Interpreting

In accordance with the improvement strategy, the reflections by the project groups were set in the context of how the entire pathway could be improved. Considering this context enabled a new understanding of the clinical system to emerge. Clinicians realized that their former work processes had been fragmented and that they had lacked an understanding of how the hospital worked as a whole. Gradually, the focus shifted from their small, familiar part of the patient flow to how all of the various elements needed to interact to improve overall system performance.

Furthermore, individual clinicians reflected on how their own work contributed to the pathway and began to realize how dependent they were on each other and how crucial everybody's contribution was for an optimal pathway. Through this reflection, the organization improved its understanding of the clinical system and its interdependencies.

You see more than your own little task, and you see how you can become a bottleneck for others' tasks without even knowing it. I think that getting to see the whole process and to see that you actually are one link in a long chain helps people to see things more holistically.

Staff member offering support in project group.

The way it used to be, in many areas the big picture fell apart; work was so fragmented.

Physician in project group.

Each separate section had its own books with patients needing surgery, and everybody tried to plan their operation schedules on the basis of these. But there

was no coordination; nothing brought things together in terms of the resources available on the ward as a whole.

Nurse in project group.

The new understanding of the clinical system changed the mental model. Moreover, it was codified into altered individual and organizational behavior. New organizational routines were created and implemented, in which the new system perspective was taken into account. For example, before the intervention the different surgery departments managed their own scheduling of operations, with no coordination among the departments. As part of the intervention, a new computer application was introduced for scheduling surgery across all surgical departments. This made waiting lists and schedules transparent across departments. Furthermore, a capacity coordinator position was created that was empowered to coordinate planning across the departments. Scheduling surgery also became more dynamic because waiting lists were considered when slots for surgery were assigned among departments.

The most important thing, I think we've learned is that it was very easy to sit and just look at your own sphere when working out procedures and general standards for patient scheduling. When we all sat down together and tried to create something, it required a mental readjustment so that we had to think, "This isn't just about my area; it also affects others."

Physician in project group.

We [anesthesiology and surgery] have probably become closer; yes, we have. It isn't uncommon that we now are in touch at the early stages to discuss a patient's medical problem. Then, together, we work out a plan for preparing for the operation.

Physician not in project group.

The improved system awareness influenced the inquiry and decision processes. As staff members became aware of the complexity of their clinical processes and their understanding of the interdependencies of the various elements grew, they discovered new problems and possible solutions.

When the head got a look at the clinic waiting lists, it became clear that there was a whole ocean of things that needed to be tackled. And these are things that we didn't know about before, because the system hadn't been transparent.

Middle manager in project group.

Now we see the big picture with regard to the operation schedule, and this means that we now

discover ahead of time if two patients are scheduled for procedures that require the same instruments and thus re-sterilization. This used to cause unnecessary waits.

Nurse in project group.

Clinicians were involved in modifying and adapting the interventions to the context. Their new understanding of the clinical system influenced how this was done. With the new understanding, effects of the interventions were evaluated and adapted according to how the entire clinical pathway was thought should work.

Then we had to have a discussion about what we meant by "urgent," what kind of things really are urgent, and what kinds of things it makes no sense to mark as "urgent." So it took some time to get that as good as it could be.

Secretary not in project group.

Discussion

We begin by discussing our findings with regard to the theoretical framework and proceed to relate our findings to previous studies. We conclude with implications for quality improvement in health care.

A new understanding of the clinical system and double-loop learning

By structuring and analyzing our data according to the four themes of the ELO model, we were able to construct a representation of how the learning process unfolded. Furthermore, our theoretical frameworks helped us identify factors that contributed to sustain the improvements.

Our findings demonstrate that employees at the hospital developed a revised and deeper understanding of their clinical system and its interdependencies during the course of the improvement project. This new understanding had implications for organizational behavior. We consider this a key finding because it indicates a change in clinicians' mental model of their clinical system that influenced organizational action.

This new understanding emerged from a dynamic process in which clinicians shared information, reflected on it, and related it to their everyday work situation. Consistent with the extended SECI model, including *ba* [26,30], individual tacit knowledge was made explicit and interpreted in a new shared context. This shared context was provided by the hospital leadership. Specifically this context involved how the various elements of the clinical pathway needed to interact to enhance the performance of the clinical system as a whole. Through this process of sharing and reflection among individuals across professional groups and departments, the

employees' new model of the clinical system was transformed into a mental model that was shared by the organization [25]. As pointed out by Kim [25], a changed mental model that is shared at the organizational level can serve as a foundation for double-loop organizational learning if it affects organizational action [24].

Individuals in a system tend to focus on their immediate surroundings and pay less attention to the functioning of the clinical system as a whole [43,44]. We observed the same kind of behavior at Førde Hospital before the project started. During the project clinicians shared and reflected on information with regard to how the performance of the clinical system as a whole could be improved. In line with the CAS framework we observed that clinicians revised their understanding of the clinical system as they acquired a better understanding of its interdependencies [43]. Clinicians' improved understanding of the interdependencies in the clinical system affected three important stages of the change process: inquiry about what to change, change of organizational routines, and adaptations of interventions to the context.

As clinicians gradually improved their understanding of the clinical system and its interdependencies, they became able to detect system problems they previously had been unaware of. Failures prone to transitions between clinical entities were revealed as these transitions were evaluated from a new perspective, i.e., the clinical system as a whole. Furthermore, the new understanding led to a deeper and more precise understanding of the underlying causes of the quality problems.

Organizational learning becomes manifest through new or modified organizational routines [20]. In our case, clinical practice was altered as a consequence of a new understanding of the clinical system and its interdependencies. At the individual and group levels, physicians began cooperating in a new way that benefited the patients. At an organizational level, to offer one example, the hospital improved the scheduling and coordination of surgery by doing this across departments as opposed to department-wise as was done before the project. The new routine contributed to reducing cancellations and increasing the number of operations performed. Furthermore, remarks by the physicians demonstrated that their better understanding of the system of care facilitated the development of new organizational procedures in general.

Frontline employees were engaged in suggesting adaptations and modifications of the interventions. The improved understanding of the system increased the employees' awareness of the interaction between context and interventions and improved their ability to adapt interventions to specific situations. Moreover, the hospital increased the effectiveness of changes by fitting them to a constantly changing context in a way pointed out by Fixsen et al. [45].

Consistent with Berwick [5], improvements in our case were made by changing the clinical system. During this process, clinicians developed a deeper understanding of their clinical system and its interdependencies. This was transformed into a shared mental model at the organizational level. The shared mental model affected organizational action, indicating that double-loop organizational learning occurred [24]. According to our theoretical framework, organizational change that involves double-loop learning is more likely to be sustained because it alters the deeper, structural, and cultural properties of systems. The fact that the hospital was able to facilitate and induce systemic change through double-loop learning appeared to be important for understanding how improvements were sustained. In our case, important stages in the process of changing the system were based on double-loop learning: inquiry about the need to change, change of clinical practice, and adaptations of interventions.

Our findings in relation to earlier studies

An understanding of an organization as a system is a prerequisite for organizational learning [29]. The performance of a system is far more dependent on how the elements work together than on how each element performs separately [46]. According to Batalden and Davidoff [47], knowledge about *processes* and *patterns* is a prerequisite for improving the performance of a clinical system (i.e., knowledge about how clinicians interact to deliver the actual care that patients need). However, many health professionals are *process illiterate*, partially owing to the challenges of recognizing and understanding causal implications of their actions in a system [44,48]. In our case, clinicians improved quality by focusing on interdependencies, i.e., the way clinicians cooperated in their clinical processes to deliver care. By doing so, clinicians' understanding of the implications of their actions grew, deepening their understanding of the clinical system.

Previous studies indicated that organizational learning in health care is fragmented (i.e., consisting of many learning cycles that are not interconnected) [21,49,50]. Contrary to our findings, Tucker and Edmondson [51]

found that single-loop learning was dominant when nurses learned from mistakes. They suggested that this type of learning may mask the underlying structural problems of the system that could have been detected and corrected by double-loop learning. In our case, the hospital leaders were able to address underlying systemic problems through the dynamic process of inquiry, information sharing, and reflection, thereby facilitating double-loop learning.

Consistent with earlier studies [6,52], we found that multidisciplinary teams of professionals, combined with knowledge about improvement, was an important success factor in our case study. The staff that supported the project groups helped to structure an arena for reflection and sharing information. Furthermore, their guidance and assistance in mapping and visualizing the clinical system, along with their role in keeping track of decisions, were important for maintaining a system perspective during the inquiry process.

Perseverance from middle managers, who led the implementation process through their clinical work, was a key driver in overcoming resistance and implementing change. Consistent with previous findings, middle managers built and demonstrated knowledge about the clinical system through their work and leadership, thereby facilitating the spread of the new mental model [53,54]. By doing so, they maintained double-loop learning at the organizational level.

Implications for quality improvement in health care

We report here that clinicians revised their understanding of their clinical system and developed a new mental model. The mental model was then shared by the organization and influenced the inquiry process, clinical practice, and the way interventions were adapted. These steps are illustrated in Figure 1. The improvement strategy triggered clinicians to inquire about their system and opened an arena for information sharing and for relating these activities to the context of the whole clinical system. These combined activities improved clinicians' understanding of their clinical system. The process was circular as the new understanding influenced the actions that had induced it.

Our case demonstrates that clinicians' understanding of their clinical system can be improved, partially

Table 2 Implications for quality improvement in health care

Leadership action	Desired change for organization
Create a multidisciplinary arena for sharing information	Revised and deeper understanding of the clinical system that is shared by the organization
Provide a system context for interpreting shared information	
Provide guidance to clinicians about improvement knowledge	
Design and implement new organizational routines based on the new understanding of the clinical system	Change the system based on double-loop organizational learning
Facilitate continuous information sharing and reflection	Spread the new mental model in the organization
Modify and adapt interventions based on the new understanding of the clinical system	Sustained improvement

depending on how a project is planned and conducted. The hospital's general strategy for improvement influenced how this new understanding emerged. A fundamental part of the strategy was to provide an arena and structured approach for sharing information and involving frontline professionals in the inquiry about systemic problems by equally addressing patient, professional, and administrative quality [55]. By providing clinicians with an arena for sharing information and a context for reflecting on the shared information, the leadership facilitated the process that led to a revised understanding of the clinical system. We therefore suggest that it may be possible to influence clinicians' understanding of their clinical system by paying close attention to how improvement work is planned and conducted. Table 2 summarizes and suggests implications of our findings for quality improvement work in health care.

Limitations, relevance, and further research

The retrospective study design has inherent limitations such as information bias and confounding; thus, we cannot prove causality between interventions and outcomes. However, combining a retrospective design with a theory-driven analysis allowed us to learn from a successful case by exploring how and why the improvement efforts worked and were sustained [9,10,56]. Retrospective interview data may be influenced by what respondents remember and how they emphasize various parts of their experiences. In our case, the respondents independently described how the improvement process changed their understanding of the clinical system and their own roles in this system. This finding was consistent across professional groups, regardless of the degree of involvement in the improvement work, thus increasing the credibility and trustworthiness of our analyses [37]. The rigor of our analyses was also enhanced by our use of complementary theoretical perspectives [57].

Our study is based on a single case that cannot be directly generalized. However, lack of sustainability of healthcare interventions is a substantial and ubiquitous problem [58,59]. The literature suggests that an incomplete understanding of the clinical system is not unique to our case; our findings are consistent with the literature and previous empirical findings [47,50]. In line with recommendations in the literature, we used theoretical perspectives to generate a middle-range theory, or context-dependent theory, which describes how clinicians' increased understanding of their clinical system contributes to sustainability [9,10,60]. Despite the inherent limitations of a retrospective case study, we suggest that our theory may help hospitals to increase the sustainability of improvements.

Our study may also open a new line of research into sustainability of improvements. Future studies should address

factors that improve individuals' understanding of clinical systems, changes of mental models, sharing of mental models, and how these models affect organizational behavior [61]. A better understanding of these factors might eventually increase the sustainability of healthcare improvements.

Conclusion

Our case study demonstrated that the clinicians developed a new understanding of their clinical system and its interdependencies. We suggest that the management can facilitate this kind of change by focusing on how frontline clinicians are involved in sharing and reflecting on information with regard to how the clinical system as a whole can be improved. The new understanding of the clinical system represented a change in mental models of employees that influenced how the organization changed its performance. Changes originating from a new mental model represent double-loop learning. In double-loop learning, deeper system properties are changed, and consequently improvements are more likely to be sustained.

Competing interests

The authors have no competing interests.

Authors' contributions

EH designed the study, collected the data, analyzed the data and drafted the manuscript. OB participated in the design of the study, the analysis of data and helped to draft the manuscript. KH participated in the design of the study and helped to draft the manuscript. ABA participated in the design of the study and helped to draft the manuscript. CVP participated in the design of the study, the analysis of the data and helped to draft the manuscript. All authors read and approved the final manuscript.

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