# Impact of first-time hospital accreditation on recommended care, patient experiences and clinical outcomes

PhD dissertation

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## Dissertation papers

### Paper I

Bergholt MD, Falstie-Jensen AM, Hibbert P, Eysturoy BJ, Guttesen G, Róin T, Valentin JB, Braithwaite J, Plessen CV, and Johnsen SP. The association between first-time accreditation and the delivery of recommended care: a before and after study in the Faroe Islands.

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### Paper II

Bergholt MD, Falstie-Jensen AM, Valentin JB, Hibbert P, Braithwaite J, Johnsen SP, and Plessen CV. Patients experience more support, information and involvement after first-time hospital accreditation: a before and after study in the Faroe Islands.

Submitted

### Paper III

Bergholt MD, Plessen CV, Johnsen SP, Hibbert P, Braithwaite J, Valentin JB, and Falstie-Jensen AM. Shorter length of stay after first-time hospital accreditation: a national before and after study in the Faroe Islands.

In preparation

## List of abbreviations

**ACHS:** Australian Commission on Safety and Quality in Health Care

**ACI:** Accreditation Canada International Distinction Programme

**ACS:** American College of Surgeons

**ACS:** Acute coronary syndrome

**AMI:** Acute myocardial infarction

**AR:** Acute readmission

**CARF:** Commission on Accreditation of Rehabilitation Facilities

**CBAHI:** Saudi Central Board for Accreditation of Healthcare Institutions

**CI:** Confidence interval

**COPD:** Chronic obstructive pulmonary disease

**CPC:** Chest pain centre

**DDKM:** Danish Healthcare Quality Programme

**FÓLK:** Faroese Population Registry

**HR:** Hazard rate ratio

**HS:** Haemorrhagic stroke

**HSCT:** Haematopoietic stem-cell transplant

**IKAS:** Danish Institute for Quality and Accreditation in Healthcare

**IRR:** Inter-rater reability

**IS:** Ischaemic stroke

**JACKIE:** Joint Accreditation Committee for International Society for Cellular Therapy (ISCT) & European Society for Blood and Marrow Transplantation (EBMT)

**JCAHO:** Joint Commission on Accreditation of Healthcare Organizations

**JCI:** Joint Commission International

**JCT:** Joint Commission of Taiwan

**JSGO:** Japan Society of Gynecologic Oncology

**KOIHA:** Korean Institute for Healthcare Accreditation

**KTQ:** Cooperation for Transparency and Quality in Hospitals

**LOS:** Length of stay

**MBSAQIP:** Metabolic and Bariatric Surgery Accreditation and Quality Improvement programme

**MESH:** Medical Subject Headings

**MOHW:** Ministry of Health and Welfare

**MSQH:** Malaysian Society for Health Quality

**NSTEMI:** Non-ST segment elevation myocardial infarction

**OECD:** Organization for Economic Co-operation and Development

**OR:** Odds ratio

**pCC:** proCum Cert

**REDCap:** Research Electronic Data Capture

**RD:** Risk difference

**RKKP:** Danish Clinical Quality Registries

**RR:** Relative risk

**SCPC:** Society of Chest Pain Centres

**TIA:** Transient Ischemic Attack

**UHC:** United Healthcare

**VTE:** Venous thromboembolism

**WHO**: World Health Organization

**CONTENT**

# 1.0 INTRODUCTION

Over the past century, healthcare providers around the world have made considerable efforts to create a framework that ensures high-quality and safe care for patients. At the beginning of the 20th century, the Association of American Surgeons made the first attempts through standardisation of hospital care. This standardisation later became known as hospital accreditation [1]. In the 1960s, Donabedian contributed a model to analyze the quality of care delivered in healthcare and clarified the impact of structures and processes on the final outcome of the patient [2]. Later, evidence-based medicine was introduced as a movement in the early 1990s, which was instrumental in initiating the development of evidence-based clinical guidelines, thus improving the overall practice of medicine [3].

Despite positive changes over decades in healthcare, the use of accreditation as a way to improve the quality of care in hospitals have been subject to a great deal of criticism [4-6]. Healthcare professionals repeatedly questioned the model's ability to improve hospital performance and maintain a culture of quality for the benefit of patients. It has been argued that improvements in hospitals are most significant in relation to the period prior to the onsite survey (i.e., the external review) after which the effect (i.e., improvements in quality of care) reduces or fades out [7, 8], and that the major efforts being made to achieve accreditation lead to work overload at the expense of the patients [9, 10]. Furthermore, each round of accreditation is very expensive [11, 12] and evidence for the relationship between accreditation and measured outcomes is mixed and inconsistent due to various methodological limitations in the studies that have evaluated its impact [12-14].

Notwithstanding the great skepticism about its value, accreditation continues to be used on a voluntary and mandatory basis in more than 100 countries worldwide [15]. To obtain a better understanding of the impact of hospital accreditation, we conducted three before and after studies in conjunction with the first round of accreditation in the hospitals in the Faroe Islands. As they had never participated in systematic quality improvement activities before, including accreditation, we had the opportunity to conduct all of the studies based on a baseline.

Against this background, the overall aim of this dissertation was to examine the association between first-time hospital accreditation in the Faroe Islands and the delivery of recommended care, patient experiences and clinical outcomes including length of stay (LOS), acute readmission (AR), and 30-day mortality.

# 2.0 BACKGROUND

This chapter provides a brief introduction to quality in healthcare, accreditation of hospitals, and the challenges of evaluating the impact of accreditation. This chapter also provides information about the Faroe Islands and Faroese hospitals' path to becoming accredited for the first time. Finally, a literature review presents the existing literature on the impact of accreditation on recommended care, patient experiences and clinical outcomes.

## 2.1 Quality in healthcare

Due to ageing populations and rising costs, healthcare systems around the world are under constant pressure. Furthermore, unexplained and unjustified variations in the quality of patient care and clinical outcomes have emerged across health systems and challenged them further [16, 17]. Specifically, in Europe, Australia, and the United States, evidence has suggested that patients who are candidates for specific recommended care do not receive it or in some cases receive unnecessary or incorrect treatment [18-21]. Reducing unwarranted variations is essential for ensuring high quality of care, improving clinical outcomes, and reducing costs in healthcare systems.

According to the World Health Organization (WHO), the Organization for Economic Co-operation and Development (OECD), and the World Bank, quality in healthcare is defined by the extent to which healthcare services increase the likelihood that patients will achieve desired health outcomes consistent with current health professional evidence [22]. Hence, quality is not a static concept but something that is constantly changing as new knowledge arises. The WHO and OECD indicated seven elements which are essential to create and maintain high quality in healthcare [22]. First, care should be *effective*, which means ensuring that patients can receive a correct diagnosis and treatment that works at any time. Second, care must be *safe*, meaning that it does not cause any harm. Third, care must be *people-centred*, meaning that the wishes and values of patients are respected and decisions about care should always be made in collaboration with the patient and suited to his or her needs. The fourth and fifth elements are that care should be *equitable* and *timely*, meaning that it should be accessible and provided at the right time. Finally, the sixth and seventh elements are that care must be *integrated* and *efficient,* which require various health professionals to work together to improve patient care and also available resources to be used effectively to improve patient health. All seven elements are closely interrelated and interact in such a manner that each can hinder or facilitate a patient's course [22].

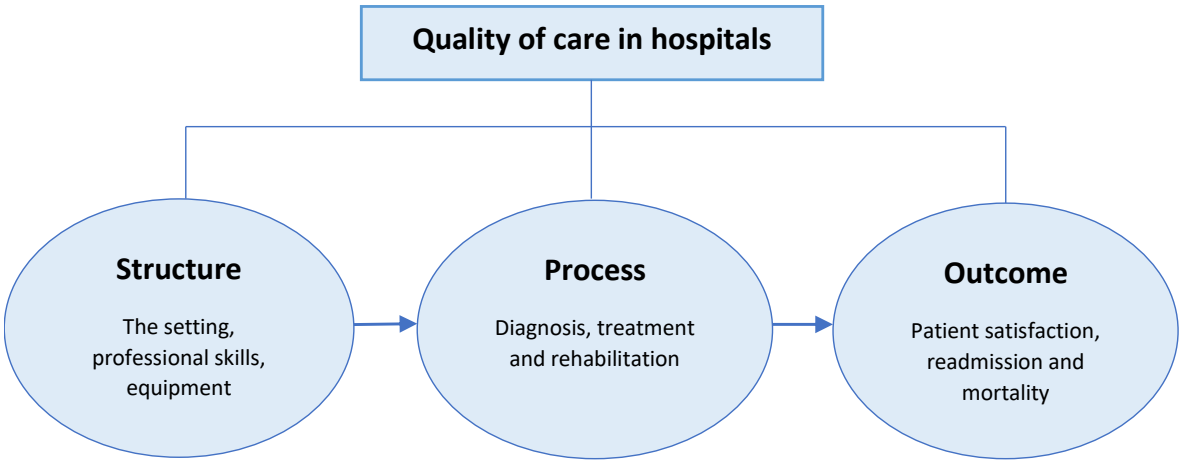
*2.1.1 The Donabedian model*

Donabedian's model of quality is a widely used approach for analysing quality in healthcare. The model consists of three dimensions, namely structure, process and outcome, which are all connected and affect quality in, for example hospitals. The connection between the three dimensions is outlined in Figure 1.

Using knowledge in each of the dimensions, the model can be used to identify quality problems and organise healthcare services for the benefit of the patients [2]. The overall assumption is that a good structure, which includes the physical environment, staff competencies, and equipment, increases the probability of having a good process, which includes diagnosis, treatment, and prevention. The structure and process ultimately affect the patient's chances of a good outcome, which include having high patient satisfaction, and experiencing a shorter LOS, fewer ARs, and lower mortality [23] (Figure 1).

As accreditation in hospitals aims to strengthen the hospitals structures and its capacity to provide high quality of care, Donabedian's model can also be used as a tool to guide the understanding of hospital accreditation requirements and to monitor the hospitals progress throughout the accreditation process.

**Figure 1. A modified Donabedian model [2]**



## 2.2 What is accreditation?

Accreditation is a formal and independent review process for assessing how well an organisation meets established standards, with the aim being to improve patient safety and quality of care [24]. In some countries, especially some European countries, accreditation is mandatory as it is used as an extension of statutory licensing, although accreditation is usually a voluntary programme [25]. To become accredited, an organisation commits itself to implementing a set of predefined quality standards and to establishing a continuous quality improvement process, which will be evaluated in the context of the review process.

Conventionally, accreditation focused on organisational policies and procedures rather than on clinical activities. To adapt to increasingly complex healthcare systems, accreditation evolved during the 1980s and 1990s to include the principles of continuous quality improvement [26]. As a result of these changes, the surveyors (conducting the external evaluation process) were required to consider not only whether the organisation had developed and implemented recommended organisational and clinical guidelines, but also whether it had addressed any identified unsatisfactory outcomes [27].

Accreditation standards are developed by an independent accreditation organisation and are advocated as an important means of improving clinical practice and organizational performance [24]. All standards are based on the plan-do-study-act model ensuring continuous quality improvement [27, 28]. Moreover, the standards are generic and includes several indicators that represent a measurable variable used to monitor and evaluate quality [24]. Please see an example of a Faroese accreditation standard in Appendix 1.

To ensure that an organisation is prepared for accreditation, the date for the external review is usually announced 6–12 months in advance [24]. During the external review, also referred to as an onsite survey, a team of surveyors assesses whether the hospital is maintaining the minimum requirements for each standard and identifies opportunities for improvement to inspire continuous quality improvement [29]. To assess compliance, the surveyors interview staff, make observations, and review documents and medical records [30]. Finally, a report is handed to the accreditation board, which ultimately decides whether the organisation should be awarded full or partial accreditation or not be accredited. If the organisation is awarded partial accreditation, it will receive the opportunity to achieve fully accredited status by submitting evidence of improvements or by receiving a focused revisit, where standards with noncompliance are assessed again. Once an organisation has been accredited, the timing for reaccreditation varies between accreditation programmes. However, accreditation rounds are usually conducted at 3-year intervals with a mid-term visit at the halfway point.

## 2.3 The Faroe Islands

The Faroe Islands are a high-income nation [31] located in the North Atlantic. They are part of the Danish Kingdom but self-governing in many domains [32]. The Faroe Islands have the main responsibility for their own healthcare; however they are under the supervision of the Danish Health and Medicines Authority [33, 34]. Approximately 53,000 people live on the islands [35], the majority of whom live in the capital Torshavn. The Faroe Islands have three public hospitals and treatment is free of charge. The largest hospital is the National Hospital located in Torshavn, which has 29 specialties and a capacity of 120 inpatients. The other two hospitals are Klaksvik Hospital and Suderø Hospital. These hospitals cover the northern and southern parts of the Faroe Islands, respectively, and each has a department with accommodation for 22 medical and surgical patients [34, 36]. Faroese patients in need of specialised treatment can, based on cooperation agreements between Denmark and the Faroe Islands, access treatment at Danish hospitals [34, 37].

## 2.4 Accreditation in the Faroe Islands

### *2.4.1 The Faroese accreditation model*

The three Faroese hospitals are voluntarily accredited by the Danish Institute for Quality and Accreditation in Healthcare (IKAS) [29] using a modified second version of the Danish Healthcare Quality Programme (DDKM) [38]. IKAS is an independent Danish accreditation institution financed by private clients and public means. The institution was created in 2005 with the aim – through accreditation – of stimulating and inspiring organisations to engage in quality improvement activities and to reflect on their own practice for the benefit of their patients. In addition, the institution wanted to create better and more coherent patient pathways as well as prevent errors that might contribute to death or reduced quality of life [39].

The first and second versions of the DDKM were originally used for the mandatory accreditation of Danish public hospitals from 2010 to 2015. After 2015, public hospitals in Denmark abandoned accreditation. The programme does not specify a methodology for implementing the accreditation standards; thus, each hospital must assess the most appropriate implementation methods [39].

The changes to the original Danish DDKM that created the modified Faroese programme were made in cooperation with Faroese stake holders to meet the demands of Faroese legislation. However, changes were also made to address some of the challenges experienced in using the accreditation programme in Denmark. The original pre-hospital accreditation standards included in the Faroese DDKM were not used in the first round of accreditation. The final version consisted of 76 hospital standards.

*2.4.2 First-time accreditation in the Faroe Islands*

Planning for the first-time accreditation of Faroese hospitals was initiated in 2011 by the Faroese Ministry of Health. However, it was not until 2014 that the decision was made, and money was allocated in the Faroese Finance Act. In the same year, it was decided that IKAS would be responsible for the accreditation process. From 2011 to 2017, the Faroese hospitals prepared for accreditation. More details about this process are provided in the methodology section as well as in Figure 2.

All three hospitals underwent an external review in the same week in February 2017. As a result, Klaksvik hospital became fully accredited, whereas the National Hospital and Suderø Hospital became partially accredited. Both hospitals subsequently submitted additional documentation and underwent an interview, after which they became fully accredited in May (Suderø Hospital) and September (the National Hospital).

## 2.5 Challenges in evaluating the impact of accreditation

Even though accreditation in healthcare has been used for decades, evaluating its effects has proven difficult. The main factor that complicates assessments is the fact that accreditation is a complex intervention without a well-defined end point [13, 40, 41]. Furthermore, accreditation is not a single activity but rather a cluster of activities that are initiated when an organisation is preparing for and undergoes an accreditation round [25]. Moreover, there is no practical guidance on how or when to implement accreditation standards [40]; thus, each organisation, hospital, or department must interpret a programme [42]. Consequently, it becomes difficult to assess how and to what extent a process works as well as to identify which activities have influenced the outcomes. Additionally, if accreditation does not have the desired effect, it is not easy to determine the cause, since accreditation is also influenced by the context in which it is implemented [25, 42].

Participating in accreditation is usually a decision performed by policy makers; thus, researchers often do not have any impact on how or when the accreditation programme (i.e., the intervention) is implemented. Thus, it becomes a natural experiment receptive to bias and confounding [43]. However, randomised trials, stepped wedge designs [40] or comparative before and after studies [42] are strong designs that can produce solid evidence. In the Faroe Islands, it was not possible to perform a randomised controlled trial when first-time hospital accreditation was introduced in 2017 because no hospital could have served as a useful control. The hospitals vary greatly in size, patient composition, and treatment options. In addition, it was the intention of the Faroese health authorities that all three hospitals should be accredited simultaneously. However, as the Faroese hospitals had never participated in accreditation before, it was possible to establish a baseline and thus to investigate the impact of hospital accreditation using a comparable before and after study.

## 2.6 Literature review

This section reviews the current literature on hospital accreditation and its impact on recommended care, patient experiences, LOS, AR and mortality.

### *2.6.1 Search strategy*

A search strategy was undertaken to identify studies that have examined the association between hospital accreditation and patient-related outcomes, including recommended care, patient experiences, LOS, AR, and 30-day mortality. Initially, all searches were conducted using the PubMed database, and subsequent searches were extended to include the Embase and CINAHL databases. The literature search covered studies published up until June 2021 and included five search strings related to the outcomes of interest.
All search strategies in the PubMed database included Medical Subject Headings [MeSH] to limit the search result to studies that addressed the specific topic. If only a few studies appeared using [MeSH] terms, the search was expanded by combining [MeSH] terms with [All Fields] terms, which do not rely on subject terms, thus expanding the search results significantly. All searches were restricted to studies published in either English or the Scandinavian languages. Studies that addressed education related to accreditation were excluded from the searches using 'Not' 'Education [All fields]'. Searches in Embase and CINAHL only included [All Fields] terms.
The terms accreditation [MeSH], hospital [MeSH], hospital accreditation [All Fields], external quality assessment [All Fields], non-accredited hospitals [All fields], unaccredited hospitals [All fields], accredited hospitals [All fields], pre–post accreditation [All Fields], and before and after accreditation [All Fields] were used in combination using AND and OR with the following five outcomes of interest: (1) recommended care [All Fields], process performance measures [MeSH], quality of care [MeSH], and patient outcomes [All Fields]; (2) patient experiences [All Fields] and patient satisfaction [MeSH]; (3) length of stay [All fields]; (4) acute readmission [All fields], readmission [All fields], and patient readmission [All fields]; and (5) 30-day mortality [All fields] and mortality [All fields]. To ensure that no studies were missed, snowball sampling was applied using the reference list from the identified studies. Overall, 2853 abstracts were screened and finally 50 studies were found to be relevant and thus included in the review.

*2.6.2 Accreditation and recommended care*

The literature search on the association between accreditation and recommended care identified 11 studies, of which 10 were follow-up studies based on data from registers [44-52] or medical records [7]. The last study had a cross-sectional design [53] (Table 1). The association was predominantly investigated by comparing accredited hospitals with nonaccredited hospitals [48-53] or comparing hospitals before and after the introduction of accreditation [7]. The four most recent studies examined the impact of accreditation by comparing specific time periods in relation to an accreditation process [46, 47] or by comparing fully and partially accredited hospitals [44, 45]. The studies examined accreditation according to one [7, 44-47, 49-53] or two accreditation programmes [48] in Denmark [44-48], the United States [49-53] or Abu Dhabi [7]. A total of 4–39 processes of care were used to assess compliance with recommended care. Some studies examined the association in relation to a single clinical condition (acute myocardial infarction [AMI] or cancer) [49, 51, 52], whereas others included several clinical conditions [7, 44-48, 50, 53]. One study included all available patients without further defining the specific disease areas [7].

The oldest study by Chen et al. included patients aged over 65 years with AMI. The study found that patients treated at accredited hospitals were more likely than those treated at nonaccredited hospitals to receive all five disease-specific processes of care [52]. Similar results were found in another study that included eight processes of care [51]. In a cross-sectional study from the United States, treatment in accredited hospitals was also associated with more recommended care, although accredited hospitals only outperformed nonaccredited hospitals in 4 of the 16 processes of care that were included [53]. These findings correspond with the findings of Merkow et al. and Schmaltz el al. [49, 50]. Both studies found larger improvements in accredited hospitals but some processes of care did not differ between accredited and nonaccredited hospitals [49, 50].

By contrast, a Danish follow-up study that included 21 processes of care found that the probability of receiving an individual process of care was greater among patients in nonaccredited hospitals. No difference was observed among the included hospitals in the probability of receiving all processes of care during hospitalisation [48]. The study by Devkaran et al. was the only one to investigate the association by comparing outcomes in the same hospital before and after the introduction of accreditation. The study results revealed an inconsistent association as accreditation was associated with improvements, deteriorations, or no impact [7]. In two studies from 2016 and 2017 [46, 47], Bogh et al. compared the periods before, during, and after accreditation among Danish public hospitals. In the 2016 study, compliance with processes of care that did not meet target values before accreditation was associated with an overall positive change during accreditation, but the difference levelled off after accreditation. No difference was found among processes of care at a satisfactory level before the introduction of accreditation [47]. In Bogh et al.'s 2017 study, most of the included processes of care were positively affected by accreditation during preparation for the accreditation period. However, during the actual accreditation, processes of care were either negatively or

not affected by accreditation. After accreditation, only processes of care related to heart failure were found to exhibit a positive change in trends [46]. Finally, Falstie-Jensen et al. compared fully and partially accredited hospitals in two studies. They revealed that patients treated at fully accredited hospitals after the first cycle of mandatory accreditation in Denmark were more likely to receive recommended care during hospitalisation than patients treated at partially accredited hospitals [45]. However, consecutive cycles of hospital accreditation in Denmark were not associated with more recommended care [44].

In general, adjustment for differences between hospitals [46, 47, 50, 51], clustering at hospital level [44, 45, 48, 49], and variations between seasons [7, 44, 47] were only accounted for in some of the included studies. Furthermore, the exposure (accreditation) was only sparsely [7, 51, 53] or not described at all [49, 50] in some studies.

In summary, the included studies indicated a trend towards the delivery of more recommended care when patients are treated in accredited hospitals. However, due to the inconsistency between the reported results, which may be due to the use of different accreditation programmes and process performance measures, no firm conclusions could be drawn (Table 1).

*Table 1. Identified studies on the association between accreditation and recommended care*

| Author and year | Design and setting | Population | Exposure and outcomes | Main results |
|---|---|---|---|---|
| **Falstie-Jensen et al, 2021 [44]** | ▪ Follow-up study<br>▪ Nov 2012–Nov 2015<br>▪ Comparing fully and partially accredited hospitals<br>▪ 26 public nonpsychiatric hospitals<br>▪ Denmark | ▪ 257,540 patient pathways<br>▪ Patients with stoke, chronic obstructive pulmonary disease (COPD), diabetes, heart failure, and hip fracture | ▪ Two cycles of accreditation by the Danish Healthcare Quality Programme (DDKM)<br>▪ 39 processes of care | ▪ Consecutive cycles of accreditation revealed no difference between fully and partially accredited hospitals in compliance with processes of care across all clinical conditions<br>▪ The second cycle of accreditation was associated across all clinical conditions with lower compliance with processes of care when patients were treated in partially accredited hospitals (individual care: odds ratio [OR] = 0.84; 95% confidence interval [CI]: 0.71; 0.99). No difference was found between fully and partially accredited hospitals in relation to patients receiving all recommended care (all-or-none score: OR = 0.78; 95% CI: 0.59; 1.03). |
| **Falstie-Jensen et al., 2017 [45]** | ▪ Follow-up study<br>▪ Nov 2009–Dec 2012<br>▪ Comparing fully and partially accredited hospitals<br>▪ 31 public nonpsychiatric hospitals<br>▪ Denmark | ▪ 215,937 patient pathways<br>▪ Patients with stroke, COPD, diabetes, femoral fracture, heart failure, and ulcers | ▪ Accreditation by the DDKM<br>▪ 48 processes of care | ▪ Across all clinical conditions, patients at fully accredited hospitals were more likely than patients at partially accredited ones to receive individual and all recommended care during hospitalisation: (individual care: OR = 1.20; 95% CI: 1.02; 1.58) and (all-or-none score: OR = 1.27; 95% CI: 1.02; 1.58). |
| **Bogh et al., 2017 [46]** | ▪ Follow-up study<br>▪ Nov 2008–Dec 2013<br>▪ Comparing time periods in relation to the accreditation process<br>▪ 25 public nonpsychiatric hospitals<br>▪ Denmark | ▪ Patients with stroke, heart failure, ulcers, diabetes, breast cancer, and lung cancer (no information on the number of patients) | ▪ Accreditation by the DDKM<br>▪ 43 processes of care | ▪ Prior to accreditation, all processes of care (except for those related to ulcers) were positively affected by preparation for accreditation in the "prior to accreditation" period.<br>▪ Processes of care related to heart failure, breast cancer, and diagnostics were negatively affected |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | by accreditation in the "during accreditation" period. Processes of care related to other conditions, types of care, and prophylaxis were unchanged.<br>▪ Only processes of care related to heart failure were associated with a positive change in trend post-accreditation (OR: 1.003; 95% CI: 1.000; 1.006).<br>▪ Hospital characteristics were not a predictor of the effectiveness of accreditation. |
| **Bogh et al., 2016 [47]** | ▪ Follow-up study<br>▪ Nov 2008–Dec 2013<br>▪ Comparing time periods in relation to the accreditation process<br>▪ 25 public nonpsychiatric hospitals<br>▪ Denmark | ▪ Patients with stroke, heart failure, ulcers, diabetes, breast cancer, and lung cancer (no information on the number of patients) | ▪ Accreditation by the DDKM<br>▪ 43 processes of care | ▪ Compliance with processes of care not meeting the target value for satisfactory care "prior to accreditation" was associated with an overall positive change in trend in the time period "during accreditation" (OR = 1.006 per week; 95% CI: 1.001; 1.011). The difference levelled off in the post-accreditation period (OR = 0.99; 95% CI: 0.984; 0.996).<br>▪ No significant difference existed in compliance when processes of care were at a satisfactory level prior to accreditation. |
| **Bogh et al., 2015 [48]** | ▪ Follow-up study<br>▪ 2004–2008<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 33 public nonpsychiatric hospitals<br>▪ Denmark | ▪ 27,274 patients with stroke, heart failure, bleeding ulcers, and perforated ulcer | ▪ Accreditation by the Joint Commission International (JCI) and Health Quality Service<br>▪ 21 processes of care | ▪ Opportunity-based composite score: Improvements were higher at nonaccredited hospitals: (acc. hospitals: 9.9%; 95% CI: 5.4; 14.4) vs. (non-acc. hospitals: 13.7%; 95% CI: 10.6; 16.8); (absolute difference = 3.8%; 95% CI: 0.8; 8.3).<br>▪ All-or-none score: No difference existed between accredited and nonaccredited hospitals: (acc. hospitals: 6.3%; 95% CI: −0.6; 13.2) vs. (non-acc: 9.4%; 95% CI: |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | 5.0; 13.9); (absolute difference = 3.2%; 95% CI: −3.6; 9.9)<br>▪ No difference at the clinical condition level. |
| **Devkaran et al., 2015 [7]** | ▪ Follow-up study<br>▪ 2009–2012<br>▪ Comparing a hospital before and after accreditation<br>▪ One hospital<br>▪ Abu Dhabi | ▪ All patients in a 150-bed hospital (no information on the number of patients) | ▪ Accreditation by the Joint Commission on Accreditation of Healthcare Organizations (JCAHO)<br>▪ 27 processes of care | ▪ Comparing before and after, accreditation was associated with a statistically significant improvement in two processes of care and negative change in 13 of the 27 processes of care.<br>▪ A total of 11 processes of care was unchanged after accreditation |
| **Merkow et al., 2014 [49]** | ▪ Follow-up study<br>▪ 2012<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 3563 cancer centres<br>▪ USA | ▪ Patients with cancer (no information on the number of patients) | ▪ Accreditation by the National Cancer Institute and Commission on Cancer<br>▪ Four processes of care | ▪ Treatment at accredited hospitals was associated with a decreased likelihood of poor performance in three of the four processes of care (antibiotic administration, VTE prophylaxis, and beta-blocker use). |
| **Schmaltz et al., 2011 [50]** | ▪ Follow-up study<br>▪ 2004 and 2008<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 3891 hospitals<br>▪ USA | ▪ Patients with AMI, heart failure, and pneumonia (no information on the number of patients) | ▪ Accreditation by the JCAHO<br>▪ 16 processes of care | ▪ Accredited hospitals improved their performance more than nonaccredited in 13 of 16 process performance measures.<br>▪ Overall composite score: Improvements were larger at acc. vs. non-acc. hospitals (16.1% vs. 12.0%). (Absolute difference: 4.2%; 95% CI: 3.2; 5.1).<br>▪ Accredited hospitals were more likely to have high overall performance (compliance) > 90%: Acc. hospitals 84% vs. non-acc. 69%. (Overall: OR = 2.32; 95% CI: 1.76; 3.06). |
| **Lutfiyya et al., 2009 [53]** | ▪ Cross-sectional study<br>▪ March 2006<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 730 rural critical access hospitals | ▪ 218,290 patients<br>▪ Patients with AMI, heart failure, pneumonia and surgical infection prevention | ▪ Accreditation by the JCAHO<br>▪ 16 processes of care | ▪ Accredited hospitals outperformed nonaccredited hospitals in 4 of 16 processes of care. No difference existed in the remaining 12 measures. A composite score showed that accredited hospitals were more likely than nonaccredited |

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| | ▪ 45 states<br>▪ USA | | | | to score in the top half for compliance with processes of care measures (Overall: OR = 1.39; 95% CI: 1.09; 1.76). |
| **Ross et al., 2008 [51]** | ▪ Follow-up study<br>▪ Jan–Dec 2005<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 3070 hospitals<br>▪ USA | ▪ 395,250 patients with AMI | ▪ Accreditation by the Society of Chest Pain Centers (SCPC)<br>▪ Eight processes of care | ▪ Patients at accredited hospitals were more likely to receive all processes of care:<br>Aspirin on arrival and at discharge (OR = 1.16; 95% CI: 1.09; 1.23) and (OR = 1.17; 95% CI: 1.11; 1.23). Beta blockers on arrival and at discharge: (OR = 1.13; 95% CI: 1.07; 1.18) and (OR = 1.13; 95% CI: 1.08; 1.19). Percutaneous coronary intervention (OR = 1.37; 95% CI: 1.29; 1.46). Fibrinolytics (OR = 1.30; 95% CI: 1.07; 1.59). Angiotensin-converting enzyme inhibitor (OR = 1.11; 95% CI: 1.05; 1.17). Smoking cessation counselling (OR = 1.54; 95% CI: 1.44; 1.65). |
| **Chen et al., 2003 [52]** | ▪ Follow-up study<br>▪ Jan 1994–Feb 1996<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 4,221 nongovernmental hospitals<br>▪ USA | ▪ 234,769 fee-for-service Medicare patients aged ≥ 65 years with clinically confirmed AMI | ▪ Accreditation by the JCAHO<br>▪ Five processes of care | ▪ Patients treated at accredited hospitals were more likely to receive all five processes of care. |

*2.6.3 Accreditation and patient experiences*

The literature search on the association between accreditation and patient experiences identified eight studies [54-61] that compared accredited and nonaccredited hospitals [54, 56, 58-61], hospitals more and less compliant with accreditation [57], and hospitals before and after the introduction of accreditation [55] (Table 2). The studies were conducted in Asia [54-58, 60] and Europe [59, 61] and published between 2010 and 2021. All studies except one were cross-sectional and studied the association using validated questionnaires. Most studies used patient satisfaction, measured on a 5- or 7-point Likert scale, as their primary outcome [54-58, 60], although some also used recommendation rate, which reflects overall patient satisfaction during hospitalisation, as their primary outcome [59, 61].

The most recent as well as the three oldest studies found no association between accreditation and patient experiences, as patients treated at either accredited or nonaccredited hospitals did not differ in level of satisfaction with care or recommendation rates [54, 59-61]. Similar results were found when comparing hospitals more and less compliant with accreditation standards [57]. By contrast, in a follow-up study that included patients before and after the introduction of accreditation, patients treated after accreditation were found to be more satisfied [55]. Likewise, in two studies from Saudi Arabia, treatment in accredited hospitals was associated with greater patient satisfaction [56, 58]; however, not all domains of care were rated higher in accredited hospitals because women in childbirth were more satisfied with the professionalism in the laboratories at nonaccredited hospitals [58].

In general, all studies used validated questionnaires, although documentation of the validation process in the preparation of a new questionnaire or changing of an old one was limited [56, 60]. Furthermore, more than half of the studies had a low response rate or did not report one [54, 57, 59-61], and many of the included studies distributed the questionnaires to patients after discharge [54, 55, 59, 61]. Moreover, differences in patient [54, 56, 58, 60, 61] and hospital characteristics [58, 60, 61] were not accounted for in some studies when comparisons were made. In addition, most studies were accredited by one programme but some used two or more [59, 61]. Information about the accreditation programmes was either limited [54, 56, 57, 59-61] or completely omitted [55, 58].

In summary, the literature on accreditation and patient experiences was found to be sparse and revealed mixed results. Therefore, no definite conclusion on the association could be drawn (Table 2).

*Table 2. Identified studies on the association between accreditation and patient experiences*

| Author and year | Design and setting | Population | Exposure and outcomes | Main results |
|---|---|---|---|---|
| **Rahim et al., 2021 [54]** | ▪ Cross-sectional study<br>▪ 2018–2019<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 48 government hospitals<br>▪ Malaysia | ▪ 2019 patients | ▪ Accreditation by the Malaysian Society for Health Quality (MSQH)<br>▪ Patient satisfaction | ▪ No association existed between hospital accreditation and patient satisfaction (OR = 0.95; 95% CI: 0.77; 1.17); P = 0.63. |
| **Andres et al., 2019 [55]** | ▪ Follow-up study<br>▪ 2010–2012<br>▪ Comparing a hospital before and after accreditation<br>▪ One hospital<br>▪ Hong Kong | ▪ 3083 acute inpatients aged 18–80 years | ▪ Accreditation by the Australian Commission on Safety and Quality in Health Care (ACHS)<br>▪ Patient satisfaction (low score = high satisfaction) | ▪ Patients treated at the hospital after accreditation were more satisfied than patients before accreditation: Overall, summary score: 9 months before acc. = 41.9 (95% CI: 40.3; 43.4); 3 months after acc. = 34.1 (95% CI: 32.8; 35.4) and 9 months after acc: 29.1 (95% CI: 27.9; 30.3); P = 0.000. |
| **Aboshaiqah et al., 2016 [56]** | ▪ Cross-sectional<br>▪ Feb–Jun 2011<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ Eight hospitals<br>▪ Saudi Arabia | ▪ 1059 patients | ▪ Accreditation by the Saudi Central Board for Accreditation of Healthcare Institutions (CBAHI)<br>▪ Patient satisfaction | ▪ Patients at accredited hospitals were more satisfied with the quality of care than patients at nonaccredited hospitals; Overall quality of care: acc. hospitals: median score = 3.47 vs. non-acc. hospitals: median score = 3.35; effect size = −0.06; P = 0.044.<br>▪ Accredited hospitals outperformed nonaccredited ones on satisfaction with quality of care related to structure and outcome indicators. No difference existed in satisfaction in relation to the process-access and process-communication indicators. |
| **Haj-Ali et al., 2014 [57]** | ▪ Cross-sectional<br>▪ 2011<br>▪ Comparing hospitals more and less compliant with accreditation standards<br>▪ Six hospitals<br>▪ Lebanon | ▪ 279 patients aged 18–80 years | ▪ Accreditation by the national hospital accreditation system in Lebanon<br>▪ Patient satisfaction | ▪ Hospital classification (more or less compliant with accreditation standards) was not associated with patient satisfaction; P = 0.10.<br>▪ Only tangibility (e.g., physical structure and equipment) received better scores at hospitals with high compliance to accreditation standards; P < 0.01. No |

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| | | | | | differences existed among other dimensions of care. |
| **Al-Qahtani et al., 2012 [58]** | ▪ Cross-sectional study<br>▪ April–May 2011<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ Two hospitals<br>▪ Saudi Arabia | ▪ 420 in- and outpatients (women in childbirth) | ▪ Accreditation (no information)<br>▪ Patient satisfaction | ▪ Women in childbirth at the accredited hospital were more satisfied than women at the nonaccredited hospital in relation to five of six dimensions of healthcare services: Clinical care facilities: mean score at acc. 3.90 vs. non-acc: 3.43; General services: mean score at acc. 3.67 vs. non-acc: 3.49; Ultrasound: mean score at acc. 4.30 vs. non-acc: 4.09; Doctor professionalism: mean score at acc. 4.25 vs. non-acc: 4.23; Overall satisfaction: mean score at acc. 4.37 vs. non-acc: 4.16.<br>▪ Women in childbirth at nonaccredited hospitals were more satisfied with the professionalism of the laboratory: mean score at acc. = 4.08 vs. non. acc = 4.31. |
| **Sack et al., 2011 [59]** | ▪ Cross-sectional study<br>▪ Jan–May 2007<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 73 hospitals<br>▪ Germany | ▪ 37,000 patients | ▪ Accreditation by the Cooperation for Transparency and Quality in Hospitals (KTQ), proCum Cert (pCC) and DIN ISO<br>▪ Patient recommendation rate | ▪ No association existed between hospital accreditation and patient recommendation rates (OR = 0.98; 95% CI: 0.84; 1.13); P = 0.74. |
| **Hayati et al., 2010 [60]** | ▪ Cross-sectional study<br>▪ July–Nov 2005<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ Four government hospitals<br>▪ Malaysia | ▪ 300 patients at medical and surgical wards aged 18–70 years | ▪ Accreditation (no information)<br>▪ Patient satisfaction | ▪ No difference in satisfaction level between accredited and nonaccredited hospitals; P = 0.460. |
| **Sack et al., 2010 [61]** | ▪ Cross-sectional study<br>▪ 2007<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 25 hospitals<br>▪ Germany | ▪ 3,037 patients in the field of cardiology | ▪ Accreditation by the KTQ and pCC<br>▪ Patient recommendation rate | ▪ No difference existed between recommendation rates in accredited (65.6%; 95% CI: 63.4; 67.8%) and nonaccredited hospitals (65.8%; 95% CI: 63.1; 68.5); P = 0.887. |

*2.6.4 Accreditation and length of stay*

The literature search revealed 10 studies that examined the association between accreditation and LOS [62-71]. The association was mostly investigated by comparing accredited and nonaccredited hospitals [62, 69-71], although there were also studies that compared partially and fully accredited hospitals [65, 67] or the same hospitals before and after the introduction of accreditation [63, 66]. Finally, two studies included several comparators, namely a comparison of accredited and nonaccredited hospitals as well as one before and after accreditation [64, 68]. The vast majority of studies had large sample sizes based on register extractions from large databases, but Al-Sughayir et al. used medical records from psychiatric inpatients and thus included far fewer patients [66]. Almost half of the studies included patients treated in the United States. The remaining studies were conducted in South Korea, China, Qatar, Saudi Arabia, and Denmark. Most studies defined their outcome measure as LOS from admission to discharge or death, although some studies did not formally define their outcome measure [63, 64, 68, 69]. One study, which only included patients who had undergone surgery, defined LOS from index procedure to discharge [71]. All of the studies are listed in Table 3.

Accreditation was observed to have a positive impact on LOS in eight of 10 studies [63-69, 71], although the overall differences were modest. However, two studies from 2013 and 2021, which included patients with AMI or those who had undergone amputation, found no link between accreditation and LOS. However, both studies found an association between accreditation and other outcomes [62, 70]. Among all studies, only a few presented relative association measures [64, 65, 67] with 95% CIs [64, 65, 67, 71]. In general, studies did not adjust for disease severity and only a few accounted for cohabitant status [65, 67, 70], which could potentially affect LOS. Furthermore, most studies accounted for differences in patient characteristics but some did not adjust hospital characteristics [66, 68, 71]. Several of the studies focused on specific clinical conditions in a specialised setting [62-64, 66, 68-71], but some studies also excluded a large number of patients due to missing ID [69] and lack of discharge date [70]. Moreover, one study used several accreditation programmes as exposure [68], while others did not describe their use of accreditation at all [68-71]. Most studies compared hospitals without a baseline prior with before the introduction of accreditation.

In conclusion, 10 studies have been published on the relationship between accreditation and LOS. These studies offer some indication of an association between accreditation and LOS, although the lack of adjustment for potential confounding factors – including patient-related factors and hospital characteristics – made it difficult to draw any firm conclusions (Table 3).

*Table 3. Identified studies on the association between accreditation and length of stay*

| Author and year | Design and setting | Population | Exposure and outcomes | Main results |
|---|---|---|---|---|
| **Lee et al., 2021 [62]** | ▪ Follow-up study<br>▪ Jan 2010–Dec 2017<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 352 hospitals in South Korea | ▪ 80,262 patients with AMI | ▪ Accreditation by the Korea Institute for Healthcare Accreditation (KOIHA)<br>▪ LOS = number of days from admission to discharge or death | ▪ No statistical difference in LOS between patients treated in accredited hospitals (8.59 days ± 1.62) and nonaccredited hospitals (10.49 days ± 1.84). |
| **El-Menyar et al., 2020 [63]** | ▪ Follow-up study<br>▪ Jan 2010–Oct 2014 and Nov 2014–Dec 2018<br>▪ Comparing a trauma center before and after accreditation<br>▪ The Hamad Trauma Center at Hamad General Hospital in Qatar | ▪ 15,864 trauma patients | ▪ Accreditation by the Canada International Distinction program (ACI), and JCI<br>▪ LOS = not defined | ▪ A statistically significant reduction in LOS was found from before accreditation (five days; IQR 2-13) to after accreditation (four days; IQR 2-11); P = 0.001. |
| **Sun et al., 2020 [64]** | ▪ Follow-up study<br>▪ Jan 2013–Dec 2016<br>▪ Comparing nonaccredited (i.e., had not applied for accreditation) and accredited hospitals<br>▪ Comparing before, undergoing, and after hospital accreditation<br>▪ 746 hospitals in China | ▪ 798,008 patients with acute coronary syndrome (ACS) or AMI<br>▪ Patients admitted to hospitals on an emergency/urgent basis | ▪ Accreditation by the China Chest Pain Center (CPC) accreditation program<br>▪ LOS = not defined | ▪ When comparing before and after accreditation, treatment after accreditation was associated with a shorter LOS for ACS: OR = 0.89 (95% CI: 0.89; 0.90) and AMI: OR = 0.88 (95% CI: 0.87; 0.89).<br>▪ When comparing nonaccredited with accredited hospitals, treatment at accredited hospitals was associated with a shorter LOS for ACS: OR = 0.89 (95% CI: 0.84; 0.94) and AMI: OR = 0.91 (95% CI: 0.86; 0.96). |
| **Falstie-Jensen et al., 2018 [65]** | ▪ Follow-up study<br>▪ Nov 2012–Nov 2015<br>▪ Comparing hospitals with persistent low and high compliance with accreditation | ▪ 277,559 inpatients diagnosed with one of 80 diagnoses | ▪ Two cycles of accreditation with the DDKM<br>▪ LOS = number of days from admission to discharge or death | ▪ Mean LOS at highly compliant hospitals was 4.02 days (95% CI: 3.98; 4.06) vs. 4.49 days (95% CI: 4.45; 4.53) at hospitals with low compliance.<br>▪ Compared with highly compliant hospitals, admission to hospitals with low compliance in both cycles |

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| | ▪ Public nonpsychiatric hospitals in Denmark | | | | was associated with a higher risk of longer LOS (HR = 0.89, 95% CI: 0.82; 0.95). |
| **Al-Sughayir et al., 2016 [66]** | ▪ Follow-up study<br>▪ July 2009–June 2011 and July 2011–June 2012<br>▪ Comparing a hospital before and after accreditation<br>▪ Two mental health wards<br>▪ King Khalid University Hospital, Saudi Arabia | ▪ 359 psychiatric inpatients | ▪ Accreditation by the Accreditation Canada International<br>▪ LOS = number of days from admission to discharge or death | ▪ Significantly shorter mean LOS after accreditation (35.3 ± 18.5) compared with before accreditation (41.1 days ± 29.5); P = 0.026. |
| **Falstie-Jensen et al., 2015 [67]** | ▪ Follow-up study<br>▪ Nov 2009–Dec 2012<br>▪ Comparing partially and fully accredited hospitals<br>▪ 31 public nonpsychiatric hospitals in Denmark | ▪ 275,589 inpatients with one of 80 diagnosis | ▪ Accreditation by the first version of the DDKM<br>▪ LOS = number of days from admission to discharge or death | ▪ Mean LOS in fully accredited hospitals was 4.51 days (95% CI: 4.46; 4.57) and 4.54 days (95% CI: 4.50; 4.57) in partially accredited hospitals.<br>▪ Patients treated in fully accredited hospitals were more likely to be discharged before patients at partially accredited hospitals (HR = 1.07; 95% CI: 1.01; 1.14). |
| **Telem et al., 2015 [68]** | ▪ Follow-up study<br>▪ 2004–2010<br>▪ Comparing accredited and never accredited hospitals<br>▪ Comparing hospitals before and after accreditation<br>▪ Hospitals in New York, USA | ▪ 47,342 patients undergoing laparoscopic bariatric surgery | ▪ Accreditation by the American College of Surgeons (ACS) and the Metabolic and Bariatric Surgery Accreditation and Quality Improvement programme (MBSAQIP)<br>▪ Length of stay LOS = not defined | ▪ LOS was significantly lower in accredited (2.0 days) vs. never accredited hospitals (2.3 days); P < 0.001.<br>▪ Postoperative LOS was significantly shorter after accreditation vs. before accreditation (1.9 vs. 2.2 days; P < 0.0001). |
| **Morton et al., 2014 [69]** | ▪ Follow-up study<br>▪ 2010<br>▪ Comparing accredited and unaccredited hospitals<br>▪ 145 hospitals in the USA | ▪ 72,615 patients ≥ 18 years undergoing bariatric surgery | ▪ Accreditation by the MBSAQIP<br>▪ LOS = not defined | ▪ Mean LOS was significantly shorter at accredited hospitals (1.99 days ± 4.90) compared to unaccredited (2.25 days ± 11.0) P<0.0001. |

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| **Kurichi et al., 2013 [70]** | ▪ Follow-up study<br>▪ Oct 2002–Sep 2003<br>▪ Comparing accredited and nonaccredited rehabilitation centres<br>▪ 100 Veteran Affairs Medical Centres in the USA | ▪ 1536 patients with a new major lower extremity hip to ankle amputation | ▪ Accreditation by the Commission on Accreditation of Rehabilitation Facilities (CARF)<br>▪ LOS = number of days from admission to discharge | ▪ No difference in LOS between accredited and nonaccredited rehabilitation centres (no data provided) |
| **Nguyen et al., 2012 [71]** | ▪ Follow-up study<br>▪ Oct 2007–Dec 2009<br>▪ Comparing accredited and nonaccredited centres<br>▪ 214 centres with United Healthcare (UHC) membership in the USA | ▪ 35,284 patients undergoing bariatric surgery | ▪ Accreditation by the ACS<br>▪ LOS = from index procedure to hospital discharge | ▪ Mean LOS in accredited centres was significantly shorter (2.4 days ± 3.1) compared with that in nonaccredited centres (2.7 days ± 4.2).<br>▪ Mean difference was 0.3 days (95% CI: 0.16; 0.44; $P < 0.001$). |

*2.6.5 Accreditation and acute readmission*

The literature search identified four studies on the association between accreditation and AR (Table 4). The studies were all register-based follow-up studies [62, 65, 67, 71] and were published between 2012 and 2021 in South Korea, Denmark, and the United States. Common to them all was that AR was a secondary outcome and defined as readmission within 30 days of discharge. The largest study included 266,532 patients from 31 public hospitals in Denmark [67]. This study, together with another Danish study, compared fully and partially accredited hospitals [65]. The studies covered two rounds of accreditation in the Danish healthcare system and neither observed any difference in risk of readmission. The two studies from South Korea and the United States compared accredited and nonaccredited hospitals [62, 71]. Lee et al. included patients with AMI from South Korea and Nguyen et al. included patients undergoing bariatric surgery in the United States. No differences in risk of AR were observed in the two studies.

In general, the included studies were limited by not adjusting for disease severity, which may have implications for the risk of AR. The same applied to differences in hospital characteristics as only three studies adjusted for them [62, 65, 67]. One study did not include patients readmitted to hospitals other than the index hospital, which could potentially have biased the results [71]. Furthermore, half of the studies had completely omitted or described their accreditation programme to only a limited extent, making it difficult to assess the extent to which it could have influenced outcomes [62, 71].

In conclusion, the literature search revealed a limited number of studies on the impact of accreditation on AR. The included studies found no association (Table 4).

*Table 4. Identified studies on the association between accreditation and acute readmission*

| Author and year | Design and setting | Population | Exposure and outcomes | Main results |
|---|---|---|---|---|
| **Lee et al., 2021 [62]** | ▪ Follow-up study<br>▪ Jan 2010–Dec 2017<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 352 hospitals in South Korea | ▪ 80,262 patients with AMI | ▪ Accreditation by the KOIHA<br>▪ Readmissions with AMI within 30 days of discharge | ▪ The 30-day readmission rate was lower at nonaccredited hospitals (4.46%) compared with accredited hospitals (9.67%).<br>▪ Overall, no statistically significant difference existed in 30-day readmission risk (OR = 1.08, 95% CI: 0.973; 1.200). |
| **Falstie-Jensen et al., 2018 [65]** | ▪ Follow-up study<br>▪ Nov 2012–Nov 2015<br>▪ Comparing hospitals with two cycles of persistently low or high compliance with accreditation<br>▪ Public, nonpsychiatric, hospitals in Denmark | ▪ 277,559 inpatients with one of 80 diagnoses | ▪ Two cycles of accreditation with the DDKM<br>▪ All-cause acute readmissions within 30 days of discharge | ▪ 30-day readmissions were 14.2% (95% CI: 14.03; 14.42) at hospitals with persistently high compliance, and 13.12% (95% CI: 12.95; 13.29) at hospitals with persistently low compliance.<br>▪ Overall, no difference existed in risk of acute readmission (HR = 0.98, 95% CI: 0.90; 1.06). |
| **Falstie-Jensen et al., 2015 [67]** | ▪ Follow-up study<br>▪ Nov 2009–Dec 2012<br>▪ Comparing partially and fully accredited hospitals<br>▪ 31 public, nonpsychiatric hospitals in Denmark | ▪ 266,532 inpatients with one of 80 diagnosis | ▪ Accreditation by the first version of the DDKM<br>▪ All-cause acute readmission within 30 days of discharge | ▪ A total of 13.70% (95% CI: 13.45; 13.95) were readmitted from fully accredited hospitals and 12.72% (95% CI: 12.57; 12.86) from partially accredited hospitals.<br>▪ No difference existed in the risk of acute readmission (HR = 1.01, 95% CI: 0.92; 1.10). |
| **Nguyen et al., 2012 [71]** | ▪ Follow-up study<br>▪ Oct 2007–Dec 2009<br>▪ Comparing accredited and nonaccredited centres<br>▪ 214 centres with UHC membership, USA | ▪ 35,284 patients undergoing bariatric surgery | ▪ Accreditation by the ACS<br>▪ All-cause readmission to index hospital within 30 days of discharge after index procedure | ▪ A total of 2.4% were acutely readmitted from accredited hospitals and 3.1% from nonaccredited hospitals.<br>▪ No difference existed in relative risk for 30-day readmission (RR = 1.22, 95% CI: 0.98; 1.51; P = 0.072). |

*2.6.6 Accreditation and mortality*

The literature search on the association between accreditation and mortality identified 17 studies of which all were register-based follow-up studies [52, 62-65, 68, 69, 71-80] (Table 5). The majority of studies were conducted by comparing accredited and nonaccredited hospitals [52, 62, 69, 71, 75, 77, 78, 80], but comparisons were also made before and after accreditation [63, 72-74], between hospitals with different accreditation statuses [65, 76], and using several bases of comparison [64, 68, 79]. The association were predominantly studied in Asia [62-64, 72-75] and the United States [52, 68, 69, 71, 78, 80], but some studies were also conducted in Europe [65, 76, 77, 79]. Several different patient groups were included, of which most focused on patients with AMI [52, 62, 64, 72-74, 80]. Others included patients treated at hospitals in relation to bariatric surgery [68, 69, 71, 78], cancer [75, 77, 79], and trauma [63]. Two Danish studies included several different clinical conditions [65, 76]. Overall, the studies provided mixed results as most were in favour of accreditation [52, 62, 64, 65, 69, 71-78]; however, some studies found inconsistencies [63, 68, 79] and one study reported no association [80].

The impact of accreditation on mortality was measured using various approaches, including pre-hospital mortality, in-hospital mortality, 7-day in-hospital mortality, 30-day mortality, and overall mortality. Only one study did not formally define outcomes [69]. Gratwohl et al. included patients with haematopoietic stem-cell transplant, and therefore, they introduced a broader perspective on outcomes by including overall survival, disease-free survival, relapse-free survival, and nonrelapse mortality. The authors measured outcomes 3 years after introducing accreditation and almost all were in favour of accreditation with the exception of nonrelapse mortality, which exhibited no difference [79]. To determine the extent to which accreditation could affect mortality risk, El-Menyar et al. chose to expand the setting in which the association was studied. The authors included trauma patients and examined the risk from the accident site (pre-hospital mortality) and after arrival at the trauma centre (in-hospital mortality). The results were inconsistent as pre-hospital mortality was significantly higher after accreditation and in-hospital mortality was significantly lower in the accredited trauma centre [63]. Similar results were found in a study that included patients undergoing bariatric surgery. Comparing accredited and nonaccredited hospitals, the authors observed a reduction in short-term mortality (<30-day mortality) in accredited hospitals but no difference in long-term mortality (>30-day mortality) [68]. However, most studies reported findings that were all in favour of accreditation [52, 62, 64, 65, 69, 71-78]. Only one study – one of the earliest studies to compare accredited and nonaccredited hospitals – found no difference in risk of in-hospital mortality [80].

In general, patient- and hospital-related characteristics were addressed in various ways in the identified studies. Some studies applied different risk-models to standardised mortality [52, 71], whereas most adjusted for patient characteristics in multivariable regression models [62, 64, 65, 68, 69, 72, 73, 75-80] or used

propensity score matching [74]. Despite the fact that most authors considered patient characteristics, only a third accounted for disease severity [71, 74, 75, 77-79]. One study did not control for any patient characteristics [63]. In relation to hospital characteristics, differences between hospitals were controlled by adjusting [52, 62, 65, 72-74, 78] or controlling for within clustering in the analyses [65, 69, 76, 80]. Some studies also handled the differences through stratification [76, 77, 79] or propensity score matching [64]. A total of two studies did not account for differences between hospitals [68, 75]. Finally, only a few studies described their exposure (accreditation) in details [52, 65, 72, 76], and some studies included patients accredited by two or more different accreditation programmes during follow-up [63, 68, 73, 78]. Furthermore, numerous patients were excluded due to acute surgery [71], death within 24 hours of hospitalisation [80], or missing hospital identification number [69].

In summary, the included studies indicated a trend towards a lower risk of in-hospital mortality when patients are treated in accredited hospitals. However, no firm conclusion could be drawn due to the great diversity among the included studies (Table 5).

*Table 5. Identified studies on the association between accreditation and mortality*

| Author and year | Design and setting | Population | Exposure and outcomes | Main results |
|---|---|---|---|---|
| **Lee et al., 2021 [62]** | ▪ Follow-up study<br>▪ Jan 2010–Dec 2017<br>▪ Comparing accredited and nonaccredited hospitals<br>▪ 352 hospitals in South Korea | ▪ 80,262 patients with AMI | ▪ Accreditation by the KOIHA<br>▪ 30-day mortality | ▪ The 30-day mortality rate was significantly lower at accredited vs. nonaccredited hospitals (1.51% vs. 3.29%).<br>▪ Treatment in accredited hospitals was associated with lower mortality risk (OR = 0.845, 95% CI: 0.777; 0.929, P < 0.0001). |
| **Chun et al., 2020 [72]** | ▪ Follow-up study<br>▪ 2010–2017<br>▪ Comparing mortality in hospitals 3 years before and 3 years after accreditation<br>▪ 183 teaching hospitals in South Korea | ▪ 248,630 patients with AMI, ischaemic stroke (IS) and haemorrhagic stroke (HS) | ▪ Accreditation by the KOIHA<br>▪ 30-day mortality | ▪ The 30-day mortality rate was significantly lower among patients with AMI and cerebral stroke when treated at hospitals after accreditation (AMI: 7.34% vs. 6.15%), (IS: 4.64% vs. 3.80%), and (HS: 18.52% vs. 15.81%). |
| **Ko et al., 2020 [73]** | ▪ Follow-up study<br>▪ Jan 1997–Dec 2011<br>▪ Comparing hospitals before and after accreditation<br>▪ Comparing unaccredited hospitals (controls)<br>▪ 823 hospitals in Taiwan | ▪ 249,354 patients with AMI | ▪ Accreditation by the Ministry of Health and Welfare (MOHW) and The Joint Commission of Taiwan (JCT)<br>▪ In-hospital mortality | ▪ Significantly fewer deaths in hospitals after accreditation vs. before accreditation (13.9% vs 16.0%).<br>▪ No difference in unaccredited control hospitals before and after accreditation (21.6% vs. 21.8%).<br>▪ The in-hospital mortality risk was significantly lower in hospitals after accreditation (OR = 0.82, 95% CI: 0.79; 0.85, P < 0.001). |
| **El-Menyar et al., 2020 [63]** | ▪ Follow-up study<br>▪ Jan 2010–Oct 2014 and Nov 2014–Dec 2018<br>▪ Comparing a trauma center before and after accreditation<br>▪ The Hamad Trauma Center in Hamad General Hospital in Qatar | ▪ 15,864 trauma patients | ▪ Accreditation by ACI and JCI<br>▪ Overall mortality, pre-hospital mortality, and in-hospital mortality | ▪ Pre-hospital mortality was significantly higher after accreditation (before acc.: 41.3% vs. after acc.: 52.4%)<br>▪ In-hospital mortality was significantly lower after accreditation (before acc.: 58.5% vs. after acc.: 47.6%)<br>▪ Overall mortality was significantly higher after accreditation (before acc.: 7% vs. after acc: 9%); (P < 0.001) |

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| **Sun et al., 2020 [64]** | ▪ Follow-up study<br>▪ Jan 2013–Dec 2016<br>▪ Comparing non-accredited (had not applied for accreditation) and accredited hospitals<br>▪ Comparing before, undergoing, and after hospital accreditation<br>▪ 746 hospitals in China | ▪ 798,008 patients with ACS or AMI<br>▪ Patients admitted to hospitals on an emergency/urgent basis | ▪ Accreditation by the China CPC accreditation programme<br>▪ In-hospital mortality | ▪ Compared with nonaccredited hospitals, in-hospital mortality was significantly lower for patients in accredited hospitals for ACS: OR = 0.70, 95% CI: 0.53; 0.93) and AMI: OR = 0.67, 95% CI: 0.51; 0.88).<br>▪ Compared with before accreditation, treatment in hospitals after accreditation was associated with a lower risk of in-hospital mortality for ACS: OR = 0.90, 95% CI: 0.84; 0.97), and AMI: OR = 0.90, 95% CI: 0.83; 0.97). |
| **Fan et al., 2019 [74]** | ▪ Follow-up study<br>▪ Nov 2014–June 2017<br>▪ Comparing hospitals before and after accreditation<br>▪ 40 hospitals in China | ▪ 15,344 patients with AMI | ▪ Accreditation by the SCPC<br>▪ All-cause 7-day mortality | ▪ All-cause 7-day mortality was significantly lower after accreditation vs. before (1.1% vs. 1.6%, P = 0.016).<br>▪ Being treated after accreditation was associated with a significantly decreased risk of all-cause 7-day mortality (HR = 0.71, 95% CI: 0.51; 0.99, P = 0.042). |
| **Falstie-Jensen et al., 2018 [65]** | ▪ Follow-up study<br>▪ Nov 2012 – Nov 2015<br>▪ Comparing hospitals with persistent high and low compliance with accreditation<br>▪ Public, non-psychiatric hospitals in Denmark | ▪ 277,559 inpatients diagnosed with one of 80 primary diagnoses | ▪ Two cycles of accreditation with the DDKM<br>▪ All-cause 30-day mortality | ▪ The mortality rate was 3.95% at hospitals with persistently high compliance with accreditation and 4.39% at hospitals with persistently low compliance.<br>▪ Inpatients had a higher risk of dying within 30 days of admission when treated in hospitals with persistently low compliance (OR = 1.26, 95% CI: 1.11; 1.43). |
| **Mikami et al., 2017 [75]** | ▪ Follow-up study<br>▪ 2006–2009<br>▪ Comparing accredited and nonaccredited institutions<br>▪ 244 institutions in Japan | ▪ 14,185 women with cervical cancer | ▪ Accreditation by the Japan Society of Gynecologic Oncology (JSGO)<br>▪ Overall survival and 5-years survival rates | ▪ Fewer women died at the accredited institutions (26.7%) compared with the nonaccredited ones (31.3%); P < 0.001.<br>▪ A lower 5-year overall mortality risk was found at accredited institutions compared with nonaccredited ones (HR = 0.843, 95% CI: 0.784; 0.905). |

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| **Falstie-Jensen et al., 2015 [76]** | ▪ Follow-up study<br>▪ Nov 2009–Dec 2012<br>▪ Comparing partially and fully accredited hospitals<br>▪ Public, nonpsychiatric hospitals in Denmark | ▪ 276,980 inpatients diagnosed with one of 80 diagnoses | ▪ Accreditation by the first version of the DDKM<br>▪ 30-day mortality | ▪ The mortality rate was 4.14% at fully accredited hospitals vs. 4.28% at partially accredited ones.<br>▪ A lower risk of 30-day mortality was found for patients treated at fully accredited hospitals (OR = 0.83, 95% CI: 0.72; 0.96). |
| **Telem et al., 2015 [68]** | ▪ Follow-up study<br>▪ 2004–2010<br>▪ Comparing never accredited and accredited hospitals<br>▪ Comparing unaccredited and accredited hospitals<br>▪ Comparing hospitals before and after accreditation<br>▪ Hospitals in New York, USA | ▪ 47,342 patients undergoing laparoscopic bariatric surgery | ▪ Accreditation by the ACS and the MBSAQIP<br>▪ All-cause short-term (<30 days) and long-term (>30 days) mortality calculated from surgery to death or date of last follow-up | ▪ Short-term mortality was lower in accredited hospitals (never acc. = 0.16% vs. acc. = 0.06%, P = 0.009), (un-acc. = 0.1% vs. acc. = 0.05%, P = 0.049).<br>▪ No difference in long-term mortality, mean follow-up 5.4 years: never acc. vs. acc.: (HR = 1.2, 95% CI: 0.96; 1.5, P = 0.01), un-acc. vs. acc. (HR = 0.89, CI: 0.72; 1.06, P = 0.18).<br>▪ No difference in short-term mortality between before and after acc.: (0.08% vs. 0.05%, P = 0.19) and long-term mortality before vs. after acc.: (HR = 0.93, CI: 0.76; 1.13, P = 0.45). |
| **Gratwohl et al., 2014 [77]** | ▪ Follow-up study<br>▪ Jan 1999–Jan 2006<br>▪ Comparing accredited and nonaccredited centres<br>▪ 585 transplant centres in Europe | ▪ 107,904 patients with hematopoietic stem-cell transplant (HSCT) | ▪ Accreditation by the JACIE<br>▪ Overall survival, nonrelapse mortality | ▪ The overall mortality rate decreased by 5.3% pr. year at accredited centres and by 3.5% per year at nonaccredited centres.<br>▪ The difference in speed was in favour of the accredited centres. Overall survival: (HR = 0.83, 95% CI: 0.71; 0.97). |
| **Morton et al., 2014 [69]** | ▪ Follow-up study<br>▪ 2010<br>▪ Comparing accredited and unaccredited hospitals<br>▪ 145 hospitals in the USA | ▪ 72,615 patients aged ≥ 18 years undergoing bariatric surgery | ▪ Accreditation by the MBSAQIP<br>▪ Mortality (no definition) | ▪ Incidence of mortality was higher at unaccredited hospitals than at accredited hospitals (0.15% vs. 0.07%, P=0.019)<br>▪ Higher risk of in-hospital mortality among patients treated at unaccredited hospitals: (OR = 2.26, 95% CI: 1.24; 4.10, P = 0.07) |
| **Gebhart et al., 2014 [78]** | ▪ Follow-up study<br>▪ 2008–2010 | ▪ 277,068 patients undergoing bariatric surgery for the | ▪ Accreditation by the MBSAQIP | ▪ In-hospital mortality was significantly lower at accredited centres vs. nonaccredited (0.08% vs. 0.19%). |

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| | ▪ Comparing accredited and nonaccredited centres<br>▪ 474 centres in the USA | treatment of morbid obesity | ▪ In-hospital mortality defined as a death occurring within the index surgical admission | ▪ Compared to accredited centres, nonaccredited centres were associated with a higher risk of in-hospital mortality (OR = 3.14, 95% CI: 1.6; 6.2, P < 0.001). |
| **Nguyen et al., 2012 [71]** | ▪ Follow-up study<br>▪ Oct 2007–Dec 2009<br>▪ Comparing accredited and non-accredited centres<br>▪ 214 centres with UHC membership in USA | ▪ Patients undergoing bariatric surgery<br>▪ 35,284 patients | ▪ Accreditation by the ACS<br>▪ In-hospital mortality | ▪ Compared to accredited centres, non-accredited centres were associated with a 3.5-fold increase in observed in-hospital mortality risk (RR=3.5, 95%CI:1.5;8.0) |
| **Gratwohl et al., 2011 [79]** | ▪ Follow-up study<br>▪ Jan 1999–Jan 2007<br>▪ Comparing centres at baseline, in preparation, after application, and after accreditation<br>▪ 421 centres in Europe | ▪ 107,904 children and adults with haematopoietic stem-cell transplant (HSCT) | ▪ Accreditation by the JACIE<br>▪ Mortality defined as overall survival, disease-free survival, non-relapse mortality and relapse-free survival | ▪ Overall survival was better for accredited centres than at baseline (HR = 0.87, 95% CI: 0.79; 0.97).<br>▪ No difference in nonrelapse mortality between accredited and baseline for allogeneic HSCT (HR = 0.89, CI: 0.77; 1.02) or autologous HSCT (HR = 0.85, 95% CI: 0.57; 1.26).<br>▪ Relapse-free survival was higher for both allogeneic and autologous HSCT at accredited centres compared with baseline (HR = 0.86, 95% CI: 0.78; 0.95); (HR = 0.83, 95% CI: 0.74; 0.93). |
| **Chandra et al., 2009 [80]** | ▪ Follow-up study<br>▪ 2005<br>▪ Comparing accredited and non-accredited hospitals in the Unites States | ▪ 33,238 patients with non-ST segment elevation myocardial infarction (NSTEMI) and ACS | ▪ Accreditation by the SCPC<br>▪ In-hospital mortality | ▪ No difference in in-hospital mortality for patients treated at accredited vs. nonaccredited hospitals (3.5% vs. 3.5%), (OR = 1.17, 95% CI: 0.88; 1.55) |
| **Chen et al., 2003 [52]** | ▪ Follow-up study<br>▪ Jan 1994–Feb 1996<br>▪ Comparing accredited and non-accredited hospitals<br>▪ 4,221 nongovernmental hospitals in the USA | ▪ 234,769 fee-for-service Medicare patients aged ≥ 65 years with clinically confirmed AMI | ▪ Accreditation by the JCAHO<br>▪ 30-day mortality | ▪ Treatment at nonaccredited hospitals was associated with a higher 30-day mortality risk compared to accredited hospitals (HR = 1.08, P < 0.001) |

### *2.6.7 Summary of existing literature*

Given how many years hospital accreditation has been used worldwide, the literature review found remarkably few studies on the subject. The findings on the association between accreditation and recommended care, patient experiences, and clinical outcomes have been mixed and inconsistent.

The discrepancies in the reported associations could be ascribed to the use of different accreditation programmes and implementation strategies. However, as all the included studies used an observational design, and thus no randomization between the compared groups was performed, confounding and biases may also have influenced findings. Especially selection bias remains a risk, as most studies compared accredited and nonaccredited hospitals, and those hospitals seeking accreditation often differ from those not seeking accreditation. Accredited hospitals tend to more often be teaching hospitals and have a better staff–patient ratio, higher patient volume and are more often located in metropolitan areas, which makes it easier to attract specialists. Despite these differences, only a fraction of the included studies accounted for these differences in analyses. In addition, most studies provided few or no details about the content of their accreditation programme. It therefore remains unclear to what extent the specific content of the programme as well as how they were implemented may have affected the different outcomes.

Overall, based on this review, it has not been possible to draw a firm conclusion regarding the association between accreditation and the delivery of recommended care, patient experiences and clinical outcomes. More robust studies are needed which address the weaknesses of the studies carried out in the past.

# 3.0 AIMS AND HYPOTHESES

This chapter contributes with an overview of the aims as well as the hypotheses of the three studies included in this dissertation.

## 3.1 Recommended care (Study I)

The aim of Study I was to examine the association between first-time hospital accreditation and the delivery of recommended care (fulfilment of process performance measures). The hypothesis (H1) was that patients treated in Faroese hospitals after accreditation would be more likely to meet relevant process performance measures and thus receive more recommended care compared with patients treated in hospitals before accreditation.

## 3.2 Patient experiences (Study II)

The aim of Study II was to examine the association between first-time hospital accreditation and patient experiences (support, information, and involvement). The hypothesis (H2) was that patients treated in Faroese hospitals after accreditation would have more positive patient experiences based on more support from health professionals, more information, and more involvement in decisions compared with patients treated in hospitals before accreditation.

## 3.3 Length of stay, acute readmission, and 30-day mortality (Study III)

The aim of Study III was to examine the association between first-time hospital accreditation and clinical outcomes, including LOS, all-cause AR, and all-cause 30-day mortality. The hypotheses (H3, H4, H5) were that patients treated in Faroese hospitals after accreditation would have a shorter LOS (H3), fewer ARs (H4), and a lower risk of death within 30 days of admission (H5) compared with patients treated in hospitals before accreditation.

# 4.0 METHODS

## 4.1 Study design

All three studies were designed as before and after studies in relation to the first-time accreditation of Faroese hospitals. The studies included inpatients and outpatients treated in Faroese hospitals in the periods 2012–2013 and 2016 before accreditation and the period 2017–2018 after accreditation.

## 4.2 Setting

All studies conducted for this dissertation were performed in the public hospitals of the Faroe Islands. The Faroe Islands are part of the Danish Kingdom but have extensive autonomy. Faroese citizens who require treatment in Faroese hospitals can get it free of charge as treatment is funded through taxes. Under a cooperation agreement with Denmark, patients admitted to Faroese hospitals who require highly specialised treatment can also receive such treatment in Danish hospitals free of charge. The cooperation agreement also includes Danish doctors working periodically in Faroese hospitals to offer various types of special diagnostics and treatment not normally available in the Faroe Islands.

## 4.3 The intervention (first-time hospital accreditation)

The three Faroese hospitals were all voluntary accredited using a modified second version of the DDKM in 2017 [38]. From 2011 to 2017, all three hospitals prepared for accreditation. Several initiatives were started from 2011 to 2013, although major changes were not initiated or implemented before the 2014–2017 period.

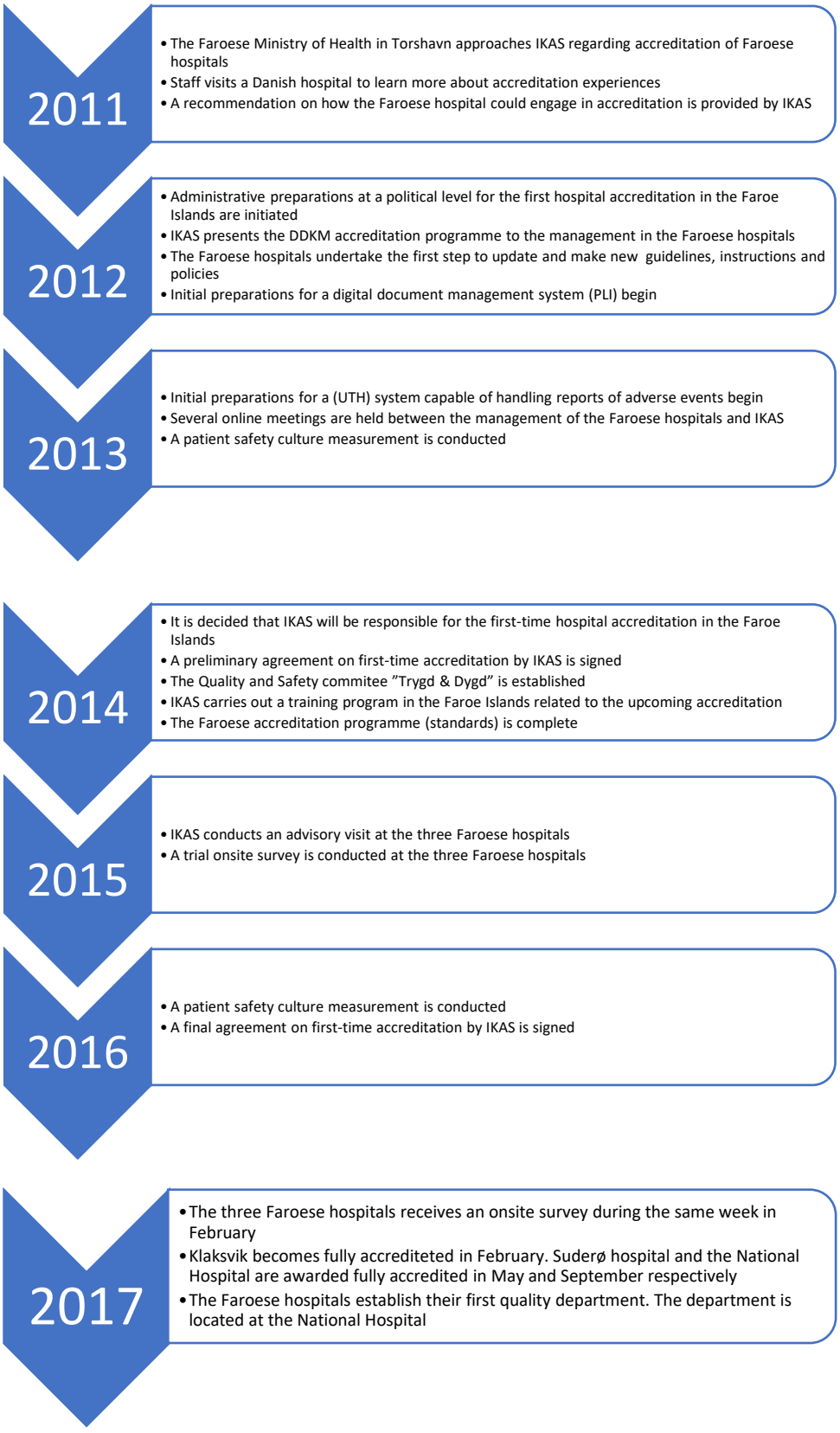
### *4.3.1 Preparing for the first round of accreditation in the Faroe Islands*

From 2011 to 2013, preparatory activities were undertaken for the Faroese hospitals to be accredited. These activities included a study visit to a hospital in Denmark for the purpose of acquiring knowledge on how to prepare the Faroese hospitals for accreditation. A recommendation on how to envisage hospitals becoming accredited was completed by IKAS in December 2011. In addition, the initial development of instructions, guidelines, and policies started in 2012, followed in 2013 by preparations for the development of an adverse event management system to focus more on patient safety.

During the period 2014–2016, when the Faroese hospitals were in full preparation for becoming accredited, selected key individuals – a project manager and three employees at the National Hospital and two employees at Klaksvik and Suderø Hospitals – developed new evidence-based guidelines and updated

existing ones. The same was true for hospital policies and procedures. Furthermore, a new digital document system (PLI) became fully operational, ensuring that all employees had access to new as well as updated documents. In parallel with all of the changes, new workflows were implemented and staff in all departments received training, which ensured that they were updated on all of the changes across the hospitals. There was a strong focus on ensuring that all tasks related to meeting the patient-critical accreditation standards were completed. Finally, systematic work was conducted to update the hospital's electronic patient record system (Cambio COSMIC), which was intended to help standardise patient documentation and enable patient extracts for statistics and reports. In addition to all activities, audits were conducted on a regular basis to ensure that all assignments had been satisfactorily completed (see Figure 2 for an overview of the main activities from 2011 to 2017).

*Figure 2. Timeline for preparation for accreditation in Faroese hospitals*



## 4.4 Definition of outcomes

### *4.4.1 Recommended care (Study I)*

Recommended care was defined as a patient's probability of receiving recommended care according to the national clinical recommendations from 2016 in the Danish Clinical Quality Registries (RKKP) [81]. Each RKKP registry has a team of specialists who work together to identify relevant evidence-based process performance measures to improve the quality of patient care. In Study I, recommended care was measured using 63 relevant disease-specific process performance measures for seven clinical conditions. The content and timeframe for all process performance measures are available in Additional file 1, paper I. Information on recommended care was obtained through reviewing medical records.

### *4.4.2 Patient experiences (Study II)*

Patient experiences were defined as the experiences that patients have in relation to support, information, and involvement during their hospitalisation. Information on patient experiences was obtained using two validated questionnaires in the three Faroese hospitals [82].
The two questionnaires were designed and validated to measure patient experiences in relation to acute and scheduled hospitalisation in Danish hospitals [83]. Both questionnaires have been used for more than 20 years and the results have been publicly presented [84]. The validation of the questionnaires was performed according to the item response theory [85], including test for criterion-related validity [86] and differential item function [87].

### *4.4.3 Length of stay (Study III)*

LOS was defined as the time from admission to discharge. If a patient is transferred to another hospital in the Faroe Islands to receive additional treatment, rehabilitation, or special examinations, then the admission period continues. Only when the patient is assessed as having completed treatment in one of the Faroese hospitals is the period of admission terminated. Information on LOS was obtained from medical records.

### *4.4.4 Acute readmission (Study III)*

AR was defined as all-cause AR at any hospital in the Faroe Islands within 30 days of discharge. Information on AR was obtained from medical records.

*4.4.5 Mortality (Study III)*

Mortality was defined as death, regardless of cause and location, within 30 days of admission. Information on mortality was obtained from medical records. To ensure that all data on death is complete, the electronic patient record system (Gambio COSMIC) is continuously updated using the Faroese Population Registry (FÓLK).

## 4.5 Study population

*4.5.1 Power calculation (Studies I and II)*

For Study I, the sample size calculation was based on an estimation that the chance of receiving recommended care per patient contact was 40% before accreditation. Thus, for a power of 80% and a Z-alpha value of 1.96, we needed to include a total of 601 patient contacts before and after first-time accreditation to detect a difference in the relative risk of 1.2 for receiving recommended care.

For Study II, the sample size was based on the assumption that the baseline prevalence of being supported, receiving information, and being involved during hospitalisation was 40%. Hence, for a power of 80% and 5% confidence (two-sided), the minimum sample size required to detect a relative risk of 1.25 was 387 before and after first-time accreditation.

No sample size calculation was performed for Study III as it was based on the study population of Study I.

*4.5.2 Inclusion process (Studies I and III)*

In Studies I and III, we identified patients who were eligible for inclusion through the Faroese National Patient Registry. The registry can be accessed at the National Hospital in Torshavn and holds information on all patients treated in the Faroese healthcare system.

Patients treated at the Faroese hospitals from January 1, 2012 to December 31, 2013 (before accreditation) or from February 21, 2017 to June 1, 2018 (after accreditation) and diagnosed with one of eight clinical conditions (stroke/transient ischaemic attack [stroke/TIA], perforated gastric ulcer, bleeding gastric ulcer, diabetes, COPD, childbirth, heart failure, or hip fracture) were eligible for inclusion if they were aged 18 years or older (≥30 years for patients with COPD). The selected diagnoses were chosen on the basis of their attendance as disease-specific standards in the first version of the DDKM [29]. Given that the three Faroese hospitals achieved fully accredited status at different times in 2017, patients were included in the order in which the hospital was fully accredited. Thus, we first included patients treated at Klaksvik Hospital from February 21, followed by Suderø Hospital from June 1, and finally the National Hospital from September 20,

2017. To ensure independence between observations, patients were included only based on their first hospital admission/outpatient contact. Patients with stroke/TIA, perforated gastric ulcer, bleeding gastric ulcer, heart failure, or hip fracture or those in childbirth were all included as inpatients. Patients with diabetes were only included as outpatients, whereas patients with COPD were included as in- and outpatients.

Figure 3 illustrates the inclusion of patient pathways in Study I. The extract from the Faroese National Patient Registry included a total of 1,722 patient pathways before accreditation and 1,699 after accreditation, among which we had to exclude 835 patient pathways from the period before accreditation and 1,242 from the period after accreditation due to multiple visits for the same clinical condition, wrong treatment period, incorrect diagnoses code, or lack of required process performance measures. Furthermore, as only one patient had been treated for perforated gastric ulcer, this patient (patient group) also had to be excluded due to the risk of violating patient anonymity. For more details, please see Figure 3

*Figure 3. Flowchart of patient pathways included in Study I*

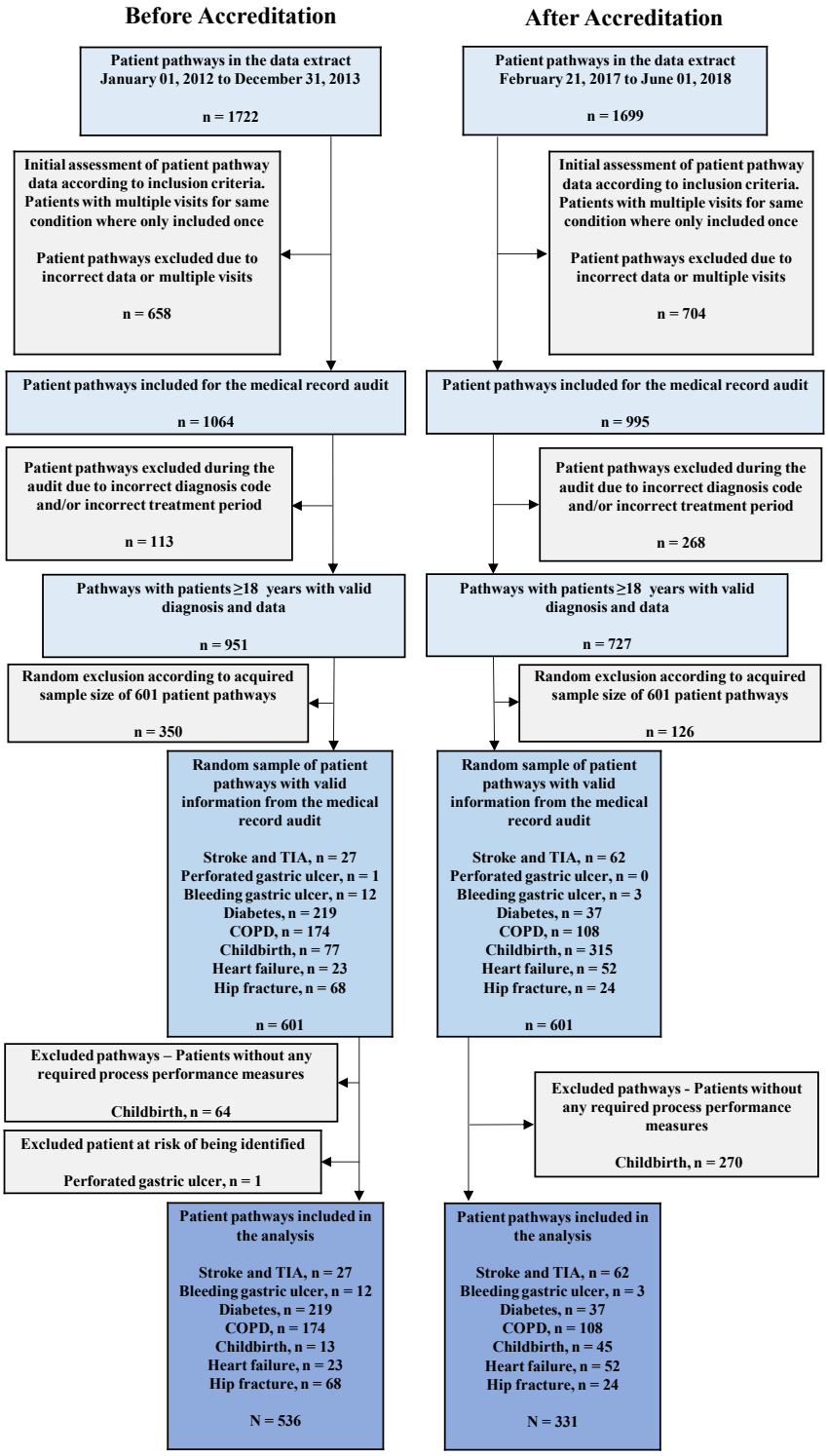
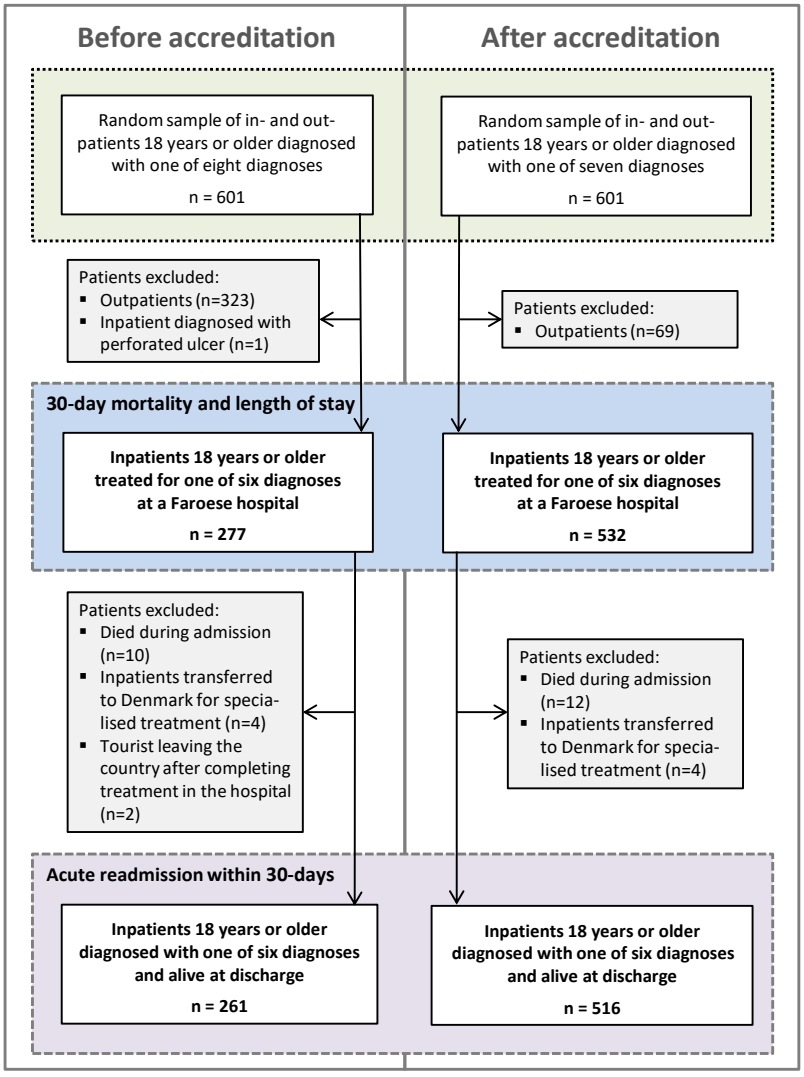


Figure 4 presents the process for including patients in Study III. We used the same study population as in Study I; however, in relation to the medical record audit, we excluded a total of 323 outpatients before accreditation and 69 afterwards as these patients' medical records did not include any information on LOS, AR, or 30-day mortality. In addition, 16 patients had to be excluded before as well as after accreditation based on mortality or departure from the Faroe Islands (Figure 4).

*Figure 4. Flowchart of inpatients included in Study III*



*4.5.3 Inclusion process (Study II)*

The patients included in Study II were identified and randomly sampled from medical, surgical, and mixed medical/surgical departments in the three Faroese hospitals. To be included, patients had to be aged 18 years or older, be able to sign an informed consent form, and understand spoken and written Faroese, Danish, or English. Moreover, the patients had to have been hospitalised for more than 24 hours in one of the three Faroese hospitals in the period from July 7 to October 8, 2016 (before accreditation) and from June 16 to August 21, 2018 (after accreditation) at the time of inclusion.

Patients were identified through the patient lists of the respective departments. Initially, the lists were screened against the inclusion criteria, and subsequently, patients who met the criteria were presented to the responsible physicians and/or nurses. Because no staff knew the content of the questionnaire, they only had to consider whether the patient would be able to understand and sign an informed consent for and not, for example, be suffering from dementia. Most patients were included from the National Hospital as it had significantly more departments and patients. Overall, 465 inpatients were available for inclusion before accreditation and 448 inpatients were available afterwards. In total, we excluded 65 inpatients before accreditation and 48 after accreditation from the final study population as they were either terminally ill or unable to sign an informed consent form (65 patients), diagnosed with dementia (38 patients), underage (five patients), or did not want to participate (five patients). Thus, the final study population consisted of 400 patients before accreditation and 400 patients after accreditation.

## 4.6 Data collection

*4.6.1 Medical records (Studies I and III)*

The data for Studies I and III were collected using electronic and paper medical records. Data were collected by students with a bachelor's degree in medicine with detailed knowledge of the Faroese healthcare system. Two students participated in the data collection before accreditation and four participated afterwards. One student participated in both rounds of data collection to ensure consistency in how data were collected.

The students used the extract from the Faroese National Patient Registry (Figure 3), which after cleaning contained information on 1064 patients before accreditation and 995 patients after accreditation. Initially, before reviewing all patients' medical records, the students had to ensure that the inclusion criteria were met and that the diagnosis was consistent with what the patient had been treated for. Second, when collecting data for Study I, the students had to find evidence for whether recommended care had been provided or not. This was done by comparing the recommendations from RKKP and the data available in the medical records. Recommended care was registered in relation to four response categories: "Yes" – recommended care had been provided; "No" – the care provided was not consistent with the recommendation; "Unknown" – no

information in the medical record was related to recommended care; and "Not applicable" – the recommended care was not relevant for the patient. For the outcomes of Study III, the students reviewed the medical records only in relation to inpatients from the same study population and gathered information regarding LOS, AR, and 30-day mortality. The data for the only outcome measure, namely 30-day mortality, were validated by comparing data in the medical records with the original withdrawal from the Faroese National Patient Registry, which also contained updated information on mortality from the Faroese Population Registry. All data from the medical record audit was documented using an audit tool and database in REDCap [88]. Finally, to test for inter-rater reliability (IRR), two auditors independently entered data from 100 medical records; IRR was assessed as 0.86 using Cohen's kappa [89].

### *4.6.2 Questionnaires (Study II)*

Information on patient experiences was obtained using two Danish validated questionnaires [83] for acute and scheduled hospitalisation [82]. Each of the questionnaires consisted of nine dimensions and 40 items; however, we only included three dimensions with 16 associated items in the final analyses, which the accreditation programme could have reasonably impacted. Moreover, the three dimensions 'Support from staff during hospitalisation', 'Information before and after hospitalisation', and 'Patient involvement in decision-making' were chosen based on the knowledge that they could potentially have a major impact on the overall hospitalisation course and further prognosis of the patients [90, 91]. Most items in the questionnaires were answered on a 5-point Likert scale ranging from 1 (not at all) to 5 (to a high degree). A high score indicated a higher degree of satisfaction with a specific care measure. During the data collection, patients were presented with one of two questionnaires depending on their mode of admission. Please see Appendixes 1 and 2 in paper II for more details on the items and dimensions included in the final analyses. Since the last item in both questionnaires – "Do you to an appropriate extent participate in making decisions about your examination/exams?" – could only be answered with "yes" or "no," we recoded this item to allow patients to rate their experiences on a 5-point Likert scale; thus, their response could be included in an overall estimation of patient experiences. In the recoded version, "yes" was equal to 5 on the 5-point Likert scale and "no" was equal to 1.

The data collection was conducted either at the patient's bedside or in a waiting room on the patient's ward. Patients were initially presented with the purpose of the study and then given an informed consent form to sign if they agreed to participate. Then, the patient had to answer all of the questions related to the chosen questionnaire. All questions were read aloud by the same person who included all patients, thus ensuring consistency. The patient's answers were recorded on a paper questionnaire and subsequently entered into the REDCap database. To ensure that there were no errors in the entries from the paper version to the database in

REDCap, the answers from all 800 patients were entered twice into the REDCap database by two different researchers.

## 4.7 Covariates

Prior to the data collection in the Faroe Islands, several known covariates were identified that could help to characterise our study populations and allow confounder adjustments. For Studies I and III, which included the same study population, the identified covariates with a known or possible impact on outcomes were sex, age (<50 years, 50–75 years, >75 years), cohabitant status (cohabitant, living alone, other [e.g., nursing home]), employment status (working or not working), type of patient (inpatient or outpatient), type of admission (acute or scheduled), inpatient department (surgical, medical, mixed, or specialist), clinical condition (seven different diagnoses), transfer between hospitals (yes or no), treatment in Denmark (yes or no), rehabilitation during hospitalisation (yes or no), and treating hospital (National hospital, Klaksvik Hospital, or Suderø Hospital). All information on covariates for Studies I and III were obtained from medical records; however, because information on disease severity and comorbidities was incomplete in many of the medical records, disease severity and comorbidities were not included as covariates. In Study II, which only included self-reported data, the identified covariates were sex, age (<50 years, 50–75 years, >75 years), LOS before inclusion in the study, previous hospitalisation (one, several, or no previous hospitalisations), cohabitant status (cohabitant or living alone), employment status (working or not working), education level (primary school, college student, ≤2 years, ≤3–4 years, or ≥5 years), type of hospitalisation (acute or scheduled), inpatient department (surgical, medical, or mixed), room type (single or multi-bed room), and treating hospital (National hospital, Klaksvik Hospital, or Suderø Hospital).

## 4.8 Data analysis

### *4.8.1 Analysis strategy (All studies)*

In all of the studies, we compared patient-related outcomes from before and after first-time hospital accreditation in the three Faroese hospitals. To account for differences between hospital characteristics, which could potentially confound the effect, all analyses were adjusted for the cluster effect at the hospital level. In addition, in Studies I and III we also adjusted the variance for the cluster effect at the patient level using cluster robust variance, to account for the fact that some patients were included more than once on the basis of different diagnoses. Moreover, in all of the studies, we implemented robust variance estimation to account for potential deviations from the assumed residual distribution. All statistical analyses were

performed using StataSE version 14.2 (StataCorp, 2015; College Station, TX: StataCorp LLC) and we applied a two-sided significance level of 0.05.

### *4.8.2 Analysis of recommended care (Study I)*

In Study I, the delivery of recommended care was evaluated as an opportunity-based composite score (the proportion of fulfilled eligible process performance measures) and as an all-or-none score (the number of patient pathways who received all relevant process performance measures). In the primary analysis for the opportunity-based composite score, we included all patients, and in the all-or-none analyses, we only included patients with a minimum of two relevant process performance measures.

The two different scores were computed as a total across all clinical conditions and for each clinical condition separately. When comparing before and after accreditation, the differences in opportunity-based composite scores was calculated as a percentage point difference including 95% CI. The all-or-none scores were calculated as a risk difference (RD) with 95% CI. In addition, we estimated the relative risk (RR) with 95% CI for receiving all recommended care (all-or-none) when treated at a Faroese hospital after accreditation. The RR was estimated using Poisson regression with robust variance. Furthermore, the percentage point difference and RD were calculated using linear regression.

In addition to the primary analyses, we calculated the RR for receiving individual process performance measures when treated in a Faroese hospital after accreditation. The results are presented as a forest plot. As the primary analyses for all-or-none scores only included patients with a minimum of two relevant process performance measures, a sensitivity analysis was subsequently performed including all patients regardless of the number of relevant process performance measures. The results are not presented in this dissertation as they are similar to the results from the primary analyses (see Additional File 2, paper I for further information)

We have also not included additional covariates in any of the analyses in Study I as each process performance measure is a direct measure of quality of care and only patients eligible for a specific care measure were included.

### *4.8.3 Analysis of patient experiences (Study II)*

In Study II, patient experiences in relation to the Faroese hospitals' first-time accreditation were evaluated in relation to 16 items and the three overall dimensions of support, information, and involvement.

We calculated the RR for a high/very high score (≥4) when treated in a hospital after accreditation. The difference in patient experiences between before and after accreditation was calculated as a mean difference with 95% CI and as an RD with 95% CI for a high/very high score (≥4).

The RR was estimated using Poisson regression with robust variance and the mean difference and RD were calculated using linear regression. The results of the RR analyses are not presented in this dissertation but are available in Appendixes 4 and 5 of paper II. In all of the analyses, we accounted for differences between patients by adjusting for important covariates such as age, sex, type of hospitalisation, level of education, and previous hospitalisation.

### *4.8.4 Analysis of length of stay, (Study III)*

In Study III, LOS was calculated in days and analyses were performed as a total including all clinical conditions and as stratified according to each clinical condition.

In the LOS analysis, patients were followed from the day of admission until the day of discharge or death, whichever came first. If a patient died during hospitalisation, then the person was censored. The same applied if a patient was transferred to Denmark for treatment. The association between accreditation and LOS was calculated as a cause-specific hazard rate ratio (HR) with 95% CI. The analyses were performed using Cox proportional hazards regression with before accreditation as the reference. All proportional hazards assumptions were visually assessed using log-log plots.

To complement the HR analyses, we conducted additional RR and RD analyses with death as a competing risk. This was done to assess whether the results were guided by competing risks. The RR and RD analyses were performed using inverse-probability-of-treatment weights and bootstrapped to derive 95% CIs. The risk estimates were obtained from adjusted Aalen–Johansen cumulative incidences at 30-day follow-up.

To account for outliers, as some patients were hospitalised for a very long time, we performed a sensitivity analysis that only included patients hospitalised for less than 31 days. All analyses were adjusted for additional important covariates such as age, sex, cohabitant status, type of admission, diagnosis, and in-hospital rehabilitation.

### *4.8.5 Analysis of acute readmission (Study III)*

Patients included in the AR analyses in Study III were followed for a total of 30 days from discharge to AR or death, whichever occurred first. Censoring was applied if a patient died during follow-up. Analyses were performed as stratified for each clinical condition and as a total combining all clinical conditions.

The association between first-time accreditation and AR was estimated using Cox proportional hazards regression with before accreditation as a reference. The results are presented as cause-specific HRs with 95% CIs. The proportional hazards assumption was assessed visually by comparing plots from before and after accreditation as log-log plots.

Again, we conducted additional RR and RD analyses with death as a competing risk to complement the HR analyses. The RR and RD analyses were performed using inverse-probability-of-treatment weights and bootstrapped to derive 95% CIs. The risk estimates were obtained from adjusted Aalen–Johansen cumulative incidences at 30-day follow-up.

A sensitivity analysis was performed that excluded women in childbirth as their risk of AR was considered lower than the other clinical conditions. We accounted for potential confounding by adjusting for additional factors such as age, sex, cohabitant status, type of admission, and diagnosis.

#### *4.8.6 Analysis of 30-day mortality (Study III)*

Patients were followed from the day of admission until 30 days after discharge or death, whichever came first. Patients who transferred to a hospital for additional treatment in Denmark were censored. Analyses were performed for all clinical conditions together and separately for each clinical condition.

The association between first-time accreditation and 30-day mortality was estimated as an HR with 95% CI using Cox proportional hazards regression with before accreditation as a reference. The proportional hazards assumption was assessed visually by comparing plots from before and after accreditation as log-log plots. Once more, we conducted RR and RD analyses identically to above but without competing risks. Again, we accounted for potential confounding by adjusting for additional factors such as age, sex, cohabitant status, type of admission, and diagnosis.

# 5.0 RESULTS

This chapter presents a summary of the main findings from Studies I, II, and III. Detailed explanations and further results can be found in the accompanying papers at the back of this dissertation.

## 5.1 Delivery of recommended care (Study I)

Overall, 536 patient pathways before and 331 patient pathways after accreditation were included in the analyses of recommended care, corresponding to 4282 and 1739 relevant process performance measures, respectively. More patients were included after accreditation (39.7% vs. 79.2%), and among them, more were treated for stroke/TIA (5.0% vs. 18.7%), heart failure (4.3% vs. 15.7%), and childbirth (2.4% vs. 13.6%). Furthermore, more patients after accreditation were admitted to mixed surgical/medical departments (12.7% vs. 19.1%) or specialist departments (13.6% vs. 67.6%). In addition, more women were included after accreditation. For more details, please see Table 1 in paper I.

### *5.1.1 Overall changes in the delivery of recommended care*

The opportunity-based composite score (recommended care) was not found to be significantly different when we compared hospitals before and after accreditation. Hence, patients treated before accreditation received 44.6% recommended care and those treated after accreditation received 45.0%, which corresponded to a statistically nonsignificant difference of 4.4% (Table 6). By contrast, the probability of receiving all recommended care, represented as an all-or-none score, was significantly higher among patients treated in hospitals after accreditation (adjusted RR: 2.32; 95% CI: 2.03 to 2.67; Table 7).

*Table 6. Opportunity-based composite score across all clinical conditions before and after accreditation*

| ALL CLINICAL CONDITIONS | Mean (%) (95% CI) | Difference [b] (%) (95% CI) |
|---|---|---|
| **All clinical conditions** | | |
| Before accreditation[a] | 44.6 (41.8 to 47.4) | 4.4 (−0.7 to 9.6) |
| After accreditation | 45.0 (41.6 to 49.4) | |

*[a] Reference group; [b] Adjusted for the cluster effect at the patient and hospital levels*

*Table 7. All-or-none score across all clinical conditions before and after accreditation*

| ALL CLINICAL CONDITIONS | All recommended care (%) | RR [b] (95% CI) | RD [b] (95% CI) |
|---|---|---|---|
| **All clinical conditions** | | | |
| Before accreditation[a] | 5.4 | 1.0 | 0.07 (0.05 to 0.09) |
| After accreditation | 12.5 | 2.32 (2.03 to 2.67) | |

*[a] Reference group; [b] Adjusted for the cluster effect at the patient and hospital levels*

*5.1.2 Changes in the delivery of recommended care for clinical conditions, separately*

At the clinical condition level, patients treated for stroke/TIA, bleeding ulcers, and COPD received significantly more recommended care during hospitalisation after accreditation. The same applied for women in childbirth. Overall, the difference was 17.6% (95% CI: 9.7 to 25.4) for patients with stroke/TIA, 22.5% (95% CI: 18.9 to 26.2) for bleeding gastric ulcer, and 14.33% (95% CI: 5.5 to 23.1) for patients with COPD. The largest difference was found among women in childbirth who received 27.9% (95% CI: 24.8 to 31.0) more recommended care when treated in hospitals after accreditation. No difference was found for patients with heart failure. Moreover, patients with diabetes or hip fracture received less recommended care after accreditation (Table 8).

*Table 8. Opportunity-based composite score according to clinical condition before and after accreditation*

| Clinical condition | Mean (%) (95% CI) | Difference [b] (%) (95% CI) |
|---|---|---|
| **STROKE/TIA** | | |
| Before accreditation[a] | 50.9 (39.9 to 62.5) | 17.6 (9.7 to 25.4) |
| After accreditation | 69.7 (62.6 to 76.7) | |
| **BLEEDING GASTRIC ULCER** | | |
| Before accreditation | 36.7 (26.9 to 46.5) | 22.5 (18.9 to 26.2) |
| After accreditation | 58.3 (14.4 to 100) | |
| **DIABETES** | | |
| Before accreditation | 70.8 (68.2 to 73.4) | −4.3 (−6.2 to −2.4) |
| After accreditation | 68.2 (61.0 to 75.3) | |
| **COPD** | | |
| Before accreditation | 15.5 (11.8 to 19.2) | 14.3 (5.5 to 23.1) |
| After accreditation | 25.3 (18.0 to 32.6) | |
| **CHILDBIRTH** | | |
| Before accreditation | 10.2 (0.0 to 27.4) | 27.9 (24.8 to 31.0) |
| After accreditation | 38.1 (27.6 to 48.6) | |
| **HEART FAILURE** | | |
| Before accreditation | 59.5 (45.5 to 72.5) | −1.2 (−4.2 to 1.7) |
| After accreditation | 56.1 (48.2 to 64.0) | |
| **HIP FRACTURE** | | |
| Before accreditation | 34.4 (31.0 to 37.8) | −5.9 (−8.7 to −3.1) |
| After accreditation | 27.7 (23.6 to 31.9) | |

*[a] Reference group; [b] Adjusted for the cluster effect at the patient and hospital levels*

Patients' probability of receiving all recommended care was highest among patients with COPD when treated in hospitals after accreditation (RR: 16.22; 95% CI: 14.54 to 18.10). For patients treated for stroke/TIA and diabetes, there was no statistically significant difference. By contrast, patients with heart failure were less likely to receive all recommended care after hospitals were accredited (RR: 0.44; 95% CI: 0.29 to 0.66), although the difference was not statistically significant (RD: −0.12; 95% CI: −0.25 to 0.01) (Table 9).

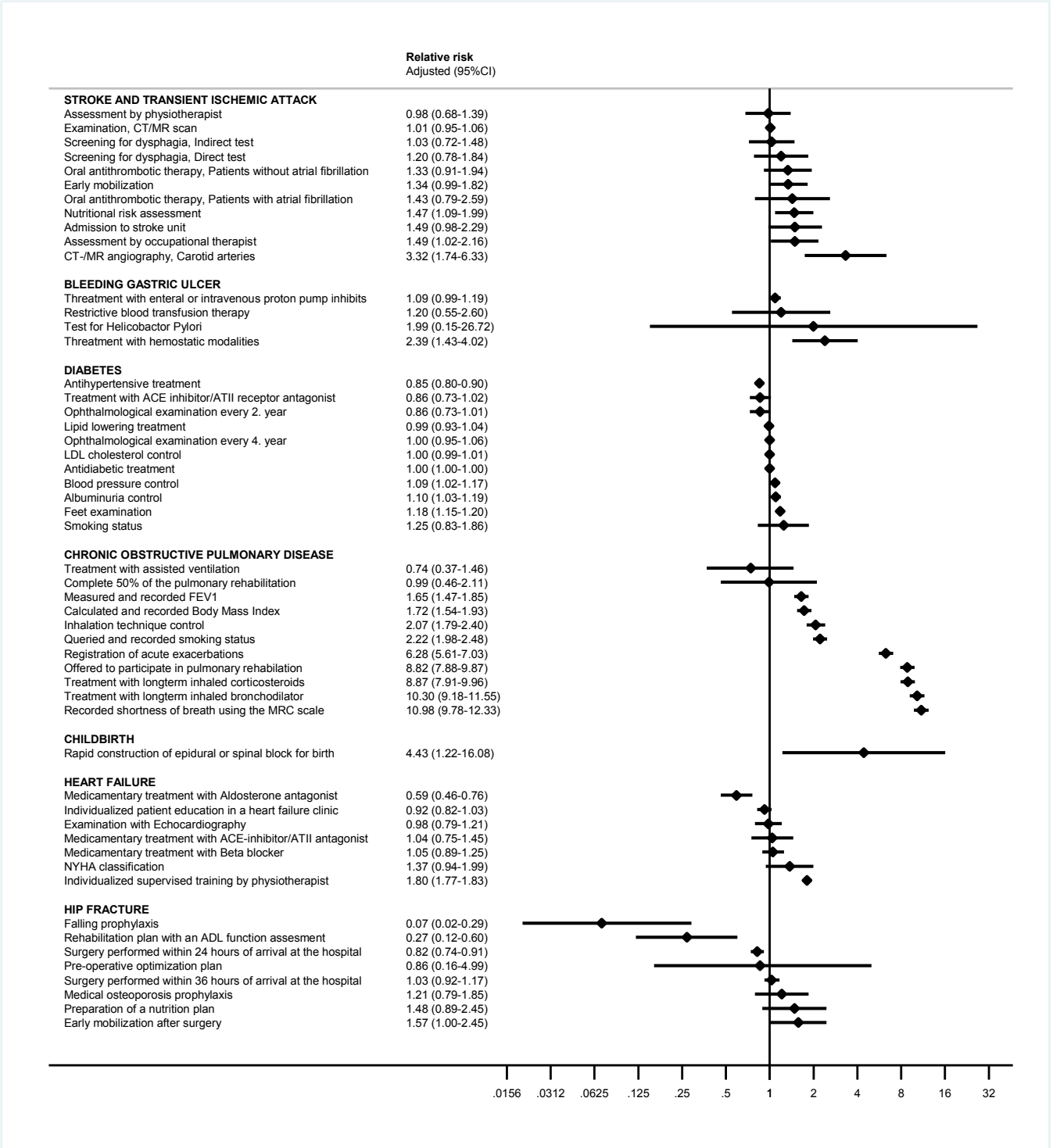
*Table 9. Proportion of patient pathways who received all recommended care before and after accreditation*

| Clinical condition | All recommended care (%) | RR [b] (95% CI) | RD [d] (95% CI) |
|---|---|---|---|
| **STROKE/TIA** | | | |
| Before accreditation[a] | 7.4 | 1.00 | 0.20 (−0.01 to 0.41) |
| After accreditation | 27.4 | 3.69 (0.76 to 17.91) | |
| **BLEEDING GASTRIC ULCER** | | | |
| Before accreditation | 0.0 | - | - |
| After accreditation | 0.0 | | |
| **DIABETES** | | | |
| Before accreditation | 7.8 | 1.00 | 0.003 (−0.013 to 0.019) |
| After accreditation | 8.1 | 1.04 (0.84 to 1.29) | |
| **COPD** | | | |
| Before accreditation | 1.0 | 1.00 | 0.147 (0.146 to 0.148) |
| After accreditation | 15.6 | 16.22 (14.54 to 18.10) | |
| **CHILDBIRTH** | | | |
| Before accreditation | 0.0 | - | - |
| After accreditation | 0.0 | | |
| **HEART FAILURE** | | | |
| Before accreditation | 21.7 | 1.00 | −0.12 (−0.25 to 0.01) |
| After accreditation | 9.6 | 0.44 (0.29 to 0.66) | |
| **HIP FRACTURE** | | | |
| Before accreditation | 0.0 | - | - |
| After accreditation | 0.0 | | |

*[a] Reference group; [b] Adjusted for the cluster effect at the patient and hospital levels; [d] Adjusted for the cluster effect at the hospital level*

Variation was observed in the likelihood of receiving an individual process performance measure (individual care) when treated in hospitals after accreditation. Overall, 19 measures improved, 29 were unchanged, and five declined. As illustrated in Figure 5, patients with COPD and women in childbirth were found to have the greatest probability of receiving an individual process performance after hospitals were accredited, whereas findings for stroke/TIA, bleeding gastric ulcer, and heart failure were mixed. Only treatment for hip fractures was associated with a decline in several process performance measures. For more details, see Figure 5.

*Figure 5. The probability of receiving an individual process performance measure according to clinical condition after first-time hospital accreditation. The relative risk estimates were adjusted for cluster effect at patient and hospital levels.*



## 5.2 Patient experiences (Study II)

In relation to the data collection for patient experiences, a total of 400 patients before accreditation and 400 after accreditation participated. On average, patients were included and completed the questionnaire survey on their fourth day of admission. Patients before and after accreditation were comparable in all characteristics except for the fact that, before accreditation, more patients had been hospitalised more than once (43% vs. 29%), while after accreditation, fewer patients had been hospitalised previously (40% vs. 53%) (Table 1, paper II).

### *5.2.1 Changes in dimension scores after accreditation*

After first-time hospital accreditation, patients' experiences improved significantly in relation to all three dimensions of 'Support from staff during hospitalisation', 'Information before and during hospitalisation', and 'Patient involvement in decision making'. Patients who received treatment at hospitals after accreditation experienced higher levels of support with mean scores rising from 1.19 before accreditation to 3.19 after accreditation. The same pattern applied to experiences related to information before and during admission and patient involvement in decision making (Table 10).

*Table 10. Dimensions of patient experience scores during hospitalization before and after first-time accreditation*

| | Before Accreditation 2016 | After Accreditation 2018 | |
|---|---|---|---|
| **DIMENSION** | **Mean (95% CI)** | **Mean (95% CI)** | **Adjusted mean difference (95% CI) [a]** |
| Support from staff during hospitalisation | 1.19 (1.82 to 1.99) | 3.91 (3.82 to 3.99) | 1.99 (1.89 to 2.10) |
| Information before and during hospitalisation | 3.09 (3.04 to 3.15) | 4.23 (4.18 to 4.29) | 1.14 (1.07 to 1.20) |
| Patient involvement in decision making | 2.64 (2.56 to 2.73) | 4.43 (4.37 to 4.49) | 1.79 (1.76 to 1.82) |

*[a] Adjusted for age, sex, level of education, previous hospitalisations, type of hospitalisation, and cluster effect at the hospital level*

When focusing only on positive experiences (i.e., ratings of 4 and 5 in relation to the three dimensions), there were also far more of these after accreditation. The percentage of positive ratings changed significantly from before to after accreditation, with ratings from 1% to 40% for support from staff, from 2% to 57% for information before and during admission, and from 9% to 72% for the experience of being involved in decision making (Table 11).

*Table 11. Highly positive (≥4) dimensions of patient experience during hospitalization before and after accreditation*

| | Before Accreditation 2016 | | After Accreditation 2018 | | | |
|---|---|---|---|---|---|---|
| **DIMENSION** | **Dimension score ≥ 4** | | **Dimension score ≥ 4** | | **Adjusted RD [b]** | |
| | **N [a]** | **%** | **N** | **%** | **%** | **(95% CI)** |
| Support from staff during hospitalisation | 3 | 1 | 160 | 40 | 39 | (36 to 42) |
| Information before and during hospitalisation | 8 | 2 | 277 | 57 | 54 | (50 to 58) |
| Patient involvement in decision making | 35 | 9 | 284 | 72 | 63 | (59 to 66) |

*[a] Patients answering "not relevant to me" or "do not know" were not included; [b] Adjusted for age, sex, level of education, previous hospitalisations, type of hospitalisation, and cluster effect at the hospital level*

### *5.2.2 Changes in item scores after accreditation*

Admission to hospitals after accreditation was associated with an improvement in patient experiences in 15 of 16 items. In particular, two items – 'Have you had conversations with staff about how best to manage your illness/condition?' and 'Have you had a dialogue with staff about the advantages and disadvantages of the examination/treatment options available?' – were rated significantly higher after accreditation. Ratings were 1.62 and 1.52 before accreditation, respectively, and increased to 3.86 and 4.31 afterwards, meaning that these ratings more than doubled after the hospitals were accredited (Table 4, paper II).

When only including ratings of 4 and 5 (i.e., positive ratings), patient experiences were still rated significantly higher in 15 of 16 items after hospitals had been accredited. In Dimension 1 (Support from staff during hospitalisation), two items in particular – 'Have the staff given you the opportunity to participate in decisions about your examination/treatment?' and 'Have you had conversations with the staff about how to

best handle your illness/condition' – received significantly more positive ratings among patients after accreditation, which corresponded to an adjusted RD in favour of accreditation of 74% and 55%, respectively. For Dimension 2 (Information before and during hospitalisation), the item with the greatest change in positive score was "Did you receive information about the effects and side effects of the medication (including painkillers) you were given while you were hospitalised?'. The change on this item went from a positive rating of 17% before accreditation to 85% after accreditation, which corresponded to an adjusted RD of 67%. Similarly, in Dimension 3 (Patient involvement in decision making), the number of positive ratings increased among all items, although the item with the greatest change was 'Have you had a dialogue with staff about the advantages and disadvantages of the examination/treatment options available?', which received a positive rating of 14% before accreditation, while after accreditation it was as high as 83%, corresponding to an adjusted RD of 68% (Table 5, paper II).

## 5.3 Length of stay, acute readmission, and 30-day mortality (Study III)

Overall, a total of 277 patients before accreditation and 532 after accreditation were included in the LOS and 30-day mortality study population. As 22 patients died during admission, eight patients were transferred for treatment in Denmark and two tourists left the Faroe Islands after discharge. They were all excluded; thus, we included a total of 261 patients before accreditation and 516 patients afterwards in the AR analyses.

The inpatients from before and after accreditation were not homogeneous as the average age was higher (62 vs. 48 years) and more men were included before accreditation. In addition, more patients from before accreditation lived alone (17% vs. 7%) or were in a nursing home (12% vs. 6%). Moreover, before accreditation, more patients were transferred between the Faroese hospitals in relation to their hospitalisation (14% vs. 6%; Table 1, paper III).

### *5.3.1 Changes in length of stay (Study III)*

For patients hospitalised before accreditation, the mean LOS was 13.4 days (95% CI: 10.8–15.9), whereas it was 7.5 days (95% CI: 6.1–8.9) for patients after accreditation (Table 12).

The results of the LOS analyses revealed that patients admitted to hospitals after accreditation were more likely to be discharged before those at hospitals before accreditation (overall adjusted HR: 1.23; 95% CI: 1.04–1.46). Thus, this corresponded to a RD for a shorter LOS after accreditation of 0.07 (95% CI: 1.04–1.46; Appendix 1 [Table 1] in paper III). When stratifying according to clinical conditions, the results were still in favour of accreditation although only among women in childbirth (adjusted HR: 1.30; 95% CI: 1.04–1.62). The sensitivity analysis, which only included patients with a short LOS, did not alter the overall result (overall adjusted HR: 1.26; 95% CI: 1.07–1.49).

*Table 12. Length of stay and hazard rate ratio for a shorter length of stay, according to clinical condition, when treated in a hospital after accreditation*

| | | Mean | | Median | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|---|---|---|
| | N | in days | 95% CI | in days | IQR | HR | 95% CI | HR | 95% CI |
| **ALL CLINICAL CONDITIONS** | | | | | | | | | |
| Before accreditation[a] | 277 | 13.4 | 10.8–15.9 | 6 | 3–13 | 1.00 | | 1.00 | |
| After accreditation | 532 | 7.5 | 6.1–8.9 | 4 | 2–6 | **1.59** | **1.38–1.83** | **1.23** | **1.04–1.46[b]** |
| **BY CLINICAL CONDITION** | | | | | | | | | |
| **STROKE/TIA** | | | | | | | | | |
| Before accreditation[a] | 27 | 24.4 | 11.6–37.1 | 9 | 4–35 | 1.00 | | 1.00 | |
| After accreditation | 62 | 20.7 | 11.0–30.4 | 8 | 2–11 | 1.17 | 0.76–1.81 | 1.07 | 0.72–1.59[d] |
| **BLEEDING GASTRIC ULCER** | | | | | | | | | |
| Before accreditation[a] | 12 | 9.7 | 4.5–14.9 | 6 | 3.5–11.5 | 1.00 | | 1.00 | |
| After accreditation | 3 | 10.7 | 5.6–15.8 | 11 | 5–16 | 0.85 | 0.36–2.03 | 0.93 | 0.45–1.92[d] |
| **COPD** | | | | | | | | | |
| Before accreditation[a] | 70 | 8.8 | 6.5–11.1 | 6 | 3–9 | 1.00 | | 1.00 | |
| After accreditation | 76 | 7.0 | 5.2–8.9 | 5 | 3–9 | 1.20 | 0.87–1.65 | 1.27 | 0.88–1.83[d] |
| **CHILDBIRTH** | | | | | | | | | |
| Before accreditation[a] | 77 | 6.3 | 3.8–8.7 | 4 | 3–5 | 1.00 | | 1.00 | |
| After accreditation | 315 | 3.8 | 3.5–4.2 | 3 | 2–4 | **1.43** | **1.15–1.78** | **1.30** | **1.04–1.62[d]** |
| **HEART FAILURE** | | | | | | | | | |
| Before accreditation[a] | 23 | 11.8 | 6.3–17.3 | 6 | 2–14 | 1.00 | | 1.00 | |
| After accreditation | 52 | 8.6 | 5.4–11.8 | 4 | 2.5–10.5 | 1.41 | 0.82–2.41 | 0.95 | 0.53–1.71[d] |
| **HIP FRACTURE** | | | | | | | | | |
| Before accreditation[a] | 68 | 20.9 | 15.3–26.5 | 14 | 6.5–24 | 1.00 | | 1.00 | |
| After accreditation | 24 | 21.5 | 11.2–31.8 | 12 | 6–16.5 | 1.02 | 0.58–1.81 | 1.36 | 0.81–2.28[d] |

*[a] Reference group [b] Adjusted for age, sex, cohabitant status, diagnosis, in-hospital rehabilitation, type of admission, and cluster effect at patient and hospital levels; [d] Adjusted for age, sex, cohabitant status, type of admission, and cluster effect at patient and hospital levels*

### *5.3.2 Changes in acute readmission (Study III)*

The percentage of AR within 30 days of discharge was 12.3% among patients treated at hospitals before accreditation and 9.5% among those treated after accreditation (Table 13).

When comparing patients treated in the Faroese hospitals before accreditation with those hospitalised afterwards, no difference was found in overall AR rate (overall adjusted HR: 1.34; 95% CI: 0.82–2.18). Correspondingly, the overall adjusted RD for fewer ARs when treated after accreditation was nonsignificant (overall adjusted RD: 0.02; 95% CI: −0.03 to 0.06) (Appendix 1 [Table 2], paper III). In a subgroup analysis stratified by clinical conditions, patients with bleeding gastric ulcers had a higher risk of AR when hospitalised after accreditation (adjusted HR: 6.47; 95% CI: 1.12–37.63). After excluding women in childbirth in a sensitivity analysis, as their risk of AR was considered different compared with those in the other clinical conditions, the overall result did not change (overall adjusted HR:1.37; 95% CI: 0.82–2.27).

*Table 13. Acute readmissions and hazard ratio for acute readmissions when treated in a hospital after accreditation*

| | | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|
| | N | % (n) | HR | 95% CI | HR | 95% CI |
| **ALL CLINICAL CONDITIONS** | | | | | | |
| Before accreditation[a] | 261 | 12.3 (32) | 1.00 | | 1.00 | |
| After accreditation | 516 | 9.5 (49) | 0.77 | 0.47–1.27 | 1.34 | 0.82–2.18[b] |
| **BY CLINICAL CONDITION** | | | | | | |
| **STROKE/TIA** | | | | | | |
| Before accreditation[a] | 26 | 11.5 (3) | 1.00 | | 1.00 | |
| After accreditation | 54 | 9.3 (5) | 0.80 | 0.19–3.37 | 1.03 | 0.24–4.36[e] |
| **BLEEDING GASTRIC ULCER** | | | | | | |
| Before accreditation[a] | 12 | 8.3 (1) | 1.00 | | 1.00 | |
| After accreditation | 3 | 33.3 (1) | 4.90 | 0.36–66.57 | **6.47** | **1.12–37.63[f]** |
| **COPD** | | | | | | |
| Before accreditation[a] | 62 | 19.4 (12) | 1.00 | | 1.00 | |
| After accreditation | 72 | 36.1 (26) | 2.06 | 1.03–4.15 | 1.70 | 0.83–3.50[e] |
| **CHILDBIRTH** | | | | | | |
| Before accreditation[a] | 77 | 2.6 (2) | 1.00 | | 1.00 | |
| After accreditation | 314 | 1.6 (5) | 0.61 | 0.12–3.14 | 0.77 | 0.14–4.15[e] |
| **HEART FAILURE** | | | | | | |
| Before accreditation[a] | 19 | 21.1 (4) | 1.00 | | 1.00 | |
| After accreditation | 50 | 18.0 (9) | 0.91 | 0.28–2.96 | 0.96 | 0.25–3.78[e] |
| **HIP FRACTURE** | | | | | | |
| Before accreditation[a] | 65 | 15.4 (10) | 1.00 | | 1.00 | |
| After accreditation | 23 | 13.0 (3) | 0.83 | 0.24–2.82 | 0.83 | 0.22–3.13[e] |

*[a] Reference group; [b] Adjusted for age, sex, cohabitant status, diagnosis, type of admission, and cluster effect at patient and hospital levels; [e] Adjusted for age, sex, cohabitant status, and cluster effect at patient and hospital levels; [f] Adjusted for age, sex, and cluster effect at patient and hospital levels*

### *5.3.3 Changes in 30-day mortality (Study III)*

Before accreditation, a total of 3.3% of the patients died within 30 days of hospitalisation. After accreditation this percentage had reduced to 2.8% (Table 14).

No association was found between first-time hospital accreditation and the risk of 30-day mortality among patients hospitalised before and after accreditation (overall adjusted HR:1.33; 95% CI: 0.55–3.21), which corresponded to an overall nonsignificant RD (overall adjusted RD: 0.01; 95% CI: −0.01 to 0.04) (Appendix 1 [Table 3], paper III). When examining the association according to clinical condition, we found no link. Furthermore, the overall result was not altered when we excluded women in childbirth in a sensitivity analysis (overall adjusted HR:1.33; 95% CI: 0.55–3.20).

*Table 14. 30-day mortality and hazard rate ratio for 30-day mortality when treated in a hospital after accreditation*

| | | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|
| | N | % (n) | HR | 95% CI | HR | 95% CI |
| **ALL CLINICAL CONDITIONS** | | | | | | |
| Before accreditation[a] | 277 | 3.3 (9) | 1.00 | | 1.00 | |
| After accreditation | 532 | 2.8 (15) | 0.86 | 0.37–1.99 | 1.33 | 0.55–3.21[b] |
| **BY CLINICAL CONDITION** | | | | | | |
| **STROKE/TIA** | | | | | | |
| Before accreditation[a] | 27 | 3.7 (1) | 1.00 | | 1.00 | |
| After accreditation | 62 | 9.7 (6) | 2.67 | 0.32–22.58 | 3.23 | 0.33–31.45[e] |
| **BLEEDING GASTRIC ULCER** | | | | | | |
| Before accreditation[a] | 12 | 0 | - | - | - | - |
| After accreditation | 3 | 0 | - | - | - | - |
| **COPD** | | | | | | |
| Before accreditation[a] | 70 | 7.1 (5) | 1.00 | | 1.00 | |
| After accreditation | 76 | 9.2 (7) | 1.25 | 0.39–4.05 | 1.05 | 0.30–3.65[e] |
| **CHILDBIRTH** | | | | | | |
| Before accreditation[a] | 77 | 0 | - | - | - | - |
| After accreditation | 315 | 0 | - | - | - | - |
| **HEART FAILURE** | | | | | | |
| Before accreditation[a] | 23 | 4.4 (1) | 1.00 | | 1.00 | |
| After accreditation | 52 | 1.9 (1) | 0.43 | 0.03–6.68 | 0.27 | 0.02–3.52[e] |
| **HIP FRACTURE** | | | | | | |
| Before accreditation[a] | 68 | 2.9 (2) | 1.00 | | 1.00 | |
| After accreditation | 24 | 4.2 (1) | 1.37 | 0.13–14.55 | 1.07 | 0.20–5.98[e] |

*[a] Reference group; [b] Adjusted for age, sex, diagnosis, type of admission, and cluster effect at patient and hospital levels; [e] Adjusted for age, sex, type of admission, and cluster effect at patient and hospital levels*

# 6.0 DISCUSSION

## 6.1 Main findings

This dissertation set out to examine the association between first-time hospital accreditation and the delivery of recommended care, patient experiences, and clinical outcomes in the hospitals of the Faroe Islands, which had never previously participated in systematic quality improvement activities. Following accreditation, more recommended care was delivered in these hospitals. The improvement was particularly strong for patients with COPD. However, patients treated for stroke/TIA and bleeding gastric ulcers as well as women in childbirth also received significantly more recommended care. We found no difference among patients with heart failure. Outpatients with diabetes and patients hospitalised due to hip fracture received less recommended care after accreditation. In addition, patients admitted to hospitals after accreditation experienced significantly more support from staff, received more information before and during hospitalisation, and felt more involved in decision making. Finally, patients hospitalised after accreditation had a significantly shorter LOS. No difference was found in AR and 30-day mortality between before and after accreditation. Overall, this confirmed three (H1, H2, H3) out of five hypotheses of the dissertation.

## 6.2 Comparison with existing literature

### *6.2.1 Accreditation and recommended care (Study I)*

Earlier studies have found that hospital accreditation was associated with the provision of more recommended care [45, 46, 49-53]. Overall, the findings of Study I confirmed this relationship. Yet, not all previous studies found such an association [48], which may be due to the fact that the included hospitals had already engaged in several rounds of accreditation as well as participated in other systematic quality improvement activities, whereby the level of recommended care was already high before accreditation. In Study I, an *a priori* high level of recommended care was also present with regard to patients with diabetes, which could be a possible explanation for why this patient group did not benefit from accreditation. Surprisingly, patients with heart failure did not benefit from the first round of accreditation. This finding was supported by a previous Danish study [48] but is in contrast to other studies from Denmark and the United States [45, 46, 50, 53]. Even though these studies included the same group of patients, direct comparisons are difficult due to differences in study design. For example, Lutfiyya et al. [53] used data from the Hospital Compare database to which accredited and nonaccredited hospitals self-report. This could introduce bias as accredited hospitals might be more willing to register data in order to maintain their accreditation status [53]. Furthermore, both Lutfiyya et al. and Schmaltz et al. compared accredited and nonaccredited hospitals, where unaccounted differences in hospital characteristics could have confounded the results [50, 53]. In addition, the results could have been biased due to a lack of complete data, whereby many hospitals were

excluded from the inclusion process [50]. Thus, it remains unclear whether patients with heart failure benefits from hospital accreditation.

The overall surprisingly low level of recommended care at the Faroese hospitals (50%) might partially explain the improvements associated with accreditation. Since the Faroese hospitals had never participated in systematic quality improvement activities before accreditation, this provided a solid opportunity for improvement. Despite this, there were clinical conditions that did not improve, which may be explained by the fact that hospitals had to spend many resources to prepare their first round of accreditation, meaning that not all patients received the same attention throughout the process [9]. In addition, patients with complex medical conditions might not have experienced the same rapid progress as those treated for less complex conditions. Several rounds of accreditation were reported as a way to benefit the most from accreditation as the programme eventually becomes an integrated part of everyday life [92].

### *6.2.2 Accreditation and patient experiences (Study II)*

Study II demonstrated strong and consistent associations between patient experiences and accreditation. The scarce literature on the impact of accreditation on patient experiences is not conclusive. Some studies [55, 56, 58] have found a substantial positive impact on patient experience, while others have not [54, 59-61]. Yet, two studies that have not found such an impact [59, 61] had operationalised patient experience as propensity to recommend the hospital to others, which is very different from our focus on support, information, and involvement in decisions. The third study [54] collected patient experiences by means of a private Facebook page provided by the hospitals. This might have excluded patients who did not use or did not want to use Facebook. In addition, one study had a response rate of only 57%, which might have biased the results towards underestimating the level of satisfaction [61]. Only one study [55] investigated the long-term effects of accreditation on patient experience during a 15-month follow-up, and indicated that patients treated at hospitals after accreditation were more satisfied even long time after the accreditation process was completed.

However, due to methodological differences, it is difficult to draw firm conclusions on the effect of accreditation on patient experience. Future research should clearly define patient experience and focus on patient-relevant dimensions. Including patients in the definition of these dimensions might help to sharpen the focus.

### *6.2.3 Accreditation and length of stay (Study III)*

The reduction in LOS in Study III indicated that accreditation can improve the efficiency of hospitals. Again, these findings are consistent with earlier research [63-69, 71]. However, the reduction in most studies was not as pronounced as in Study III. One explanation could be that the average LOS in the Faroese hospitals was comparatively high prior to accreditation, which allowed the 'harvesting of low hanging fruit'.

However, by contrast, Lee et al. found no difference in LOS when comparing accredited and nonaccredited hospitals [62]. Such a discrepancy in findings could be explained by unaccounted differences in hospital characteristics between accredited and nonaccredited hospitals. Thus, although several obvious differences between hospitals are accounted for, it is rarely possible to adequately adjust for the disadvantages of nonaccredited hospitals. Furthermore, Kurichi et al. [70] found no difference in LOS, but with an average hospitalisation of one month, their patients differed significantly from those in most studies, including Study III. Hence, their study population could not be compared with other studies [70]. Yet, their lack of findings could be explained by the fact that Kurichi et al. included LOS as a secondary outcome and were consequently underpowered for detecting a difference.

### *6.2.4 Accreditation and acute readmission (Study III)*

In agreement with four earlier studies [62, 65, 67, 71], we did not find an association between AR and accreditation. Falstie-Jensen et al. included two rounds of accreditation and were the only study to do so, yet they still found no association [65]. A possible explanation for the lack of association could be that most accreditation standards focus on the course of hospitalisation and less on factors that could influence readmissions. However, as neither of the four studies provided a power calculation, the possibility that the studies were underpowered for detecting a difference cannot be ruled out, although this scenario seems less likely given the large number of patients included in the studies. The main limitation was included in the study by Nguyen et al., who only included patients readmitted to the index hospital, which could potentially have biased the study findings [71].

### *6.2.5 Accreditation and 30-day mortality (Study III)*

In contrast to the literature [52, 62-65, 68, 69, 71-79] on associations between accreditation and mortality, we found no difference in the risk of 30-day mortality. Only Chandra et al. also found no difference [80]. The *a priori* mortality rate in both studies was low, which might explain the finding.

However, another possible explanation for the difference in findings may be related to the choice of accreditation programme. Six studies that have used a special accreditation programme targeting a specific

clinical condition or department found a significantly lower risk of dying when treated in accredited hospitals [68, 69, 74, 77-80]. Although it is not possible to make direct comparisons as our accreditation programme was designed to target all parts of the hospital regardless of diagnosis, we cannot rule out that similar findings could have been obtained in Faroese hospitals had we used a similar accreditation programme. In addition, other studies [52, 62-65, 71, 73, 75, 76] that also found a strong association between accreditation and mortality included far more patients than we did, which may also explain the different findings.

## 6.3 Methodological considerations

The overall aim of this dissertation was to examine the association between first-time hospital accreditation and the delivery of recommended care, patient experiences and clinical outcomes including LOS, AR and 30-day mortality. However, as all three studies used an observational design, methodological considerations about potential systematic or random errors that may have affected our results must be considered before an overall conclusion can be made.

### *6.3.1 Selection bias*

The source population for Studies I and III were patients treated for any of the assessed clinical conditions at the three Faroese hospitals during the two inclusion periods. As patients have free access to all hospitals and the Faroese National Patient Registry holds updated information on all hospitalisations, this reduced the risk of the systematic exclusion of patients. Moreover, as a result of the link between the National Faroese Patient Registry and the Faroese Population Registry (FÓLK), which contains patients' unique personal identifier, there was a complete follow-up on patients' mortality status. In addition, to ensure that the extraction of patients from the Faroese National Patient Registry was completely random, the sampling was based on a list of patients in a random order and performed by an administrative employee without knowledge of the aim of the two studies.

Nevertheless, it was evident from an inspection of the patient characteristics that differences existed in the patient populations included before and after accreditation. However, the differences seemed to be explained by random variation in the distribution of the sampled diagnoses, erroneous diagnosis code entries, and patients being excluded due to multiple visits with the same clinical condition. Furthermore, for Study I, patients were excluded after the medical record audit if no relevant process performance measures could be identified for the patient, and the proportion of patients excluded due to this criterion also varied between the two study periods. Likewise, for Study III, all outpatients were excluded as they had no information on LOS and AR. Consequently, the study population before and after accreditation ended up being somewhat

different in terms of numbers and patient characteristics, but without the exclusion mechanisms being directly linked to a differential association between exposure and outcomes.

In Study II, we addressed the possible concern of selection bias by including all patients available and using the same inclusion procedure before and after accreditation. The identification of potential patients for inclusion was based on a list in random order of patients admitted to the department and hospital in question. Furthermore, if a patient was to be included, staff were consulted to determine whether he or she was healthy enough (e.g., not diagnosed with dementia) to participate. The risk that staff might have selected some patients who they did not want to disclose their experiences exists, but it was estimated to be negligible as the participation rate was 89% and the nonparticipants included terminally ill patients, underage patients, patients with dementia, and patients who were unwilling to participate.

In summary, the patients included in all three studies were based on random samples of the general hospital population in the Faroe Islands before and after accreditation. However, due to many patients being excluded before and during the medical record audit, we cannot entirely rule out the presence of selection problems in Studies I and III, although the apparent random nature of the selection indicates that the risk of systematic selection bias is likely to be small. For Study II, the risk of selection bias was considered to be small and most likely nonsignificant.

### *6.3.2 Information bias*

All outcome data in relation to Studies I and III were collected using medical records, which are considered a primary source of information on patient-related outcomes in hospitals. However, misclassification could potentially have occurred if a patient was assessed as not being relevant for a specific recommended care measure and no information was provided in the medical record. The same situation would be the case if a recommended care was provided but not documented in a patient's record. Since there were no signs of systematic changes in documentation practices between before and after accreditation, we believe that the risk of systematic misclassification in the recording of information on recommended care was very low and any misclassification was thus most likely to be of a nondifferential nature.

Data on death were validated through record linkage with the Faroese Population Registry (FÓLK), which ensured a very low misclassification risk for vital status. Information on LOS and AR was complete in the medical records for all included subjects, although documentation of these outcomes was provided in different places in the medical records.

Another source of concern is the risk of intentional misclassification (gaming) related to our outcomes; however, as data from before accreditation was related to the years 2012 and 2013 and therefore before the

health professionals had any knowledge of an upcoming hospital accreditation, this is not likely to have been a significant problem, at least not related to our outcomes. Furthermore, incorrect registration in the REDCap database in relation to reviewing the medical records could be a source of bias. This concern was addressed by adding special features to the REDCap database that continuously alerted the students to possible incorrect entries, and also by having two different people double entering 100 random medical records to identify a possible discrepancy. Based on a Cronbach's alpha of 0.86, misclassification was not immediately assessed to be a problem. Errors could however also arise from misinterpretation of the contents of the medical records. We addressed this potential limitation by only employing Faroese medical students with extensive knowledge of the Faroese healthcare system and the clinical conditions included in the studies. Furthermore, we complemented this knowledge by teaching and training using the electronic patient record system (Cambio COSMIC). Additionally, to ensure uniformity in the data collection before and after accreditation, one student participated in both rounds of data collection. Hence, any misclassification was most likely nondifferential and expected to yield a bias toward the null association.

For Study II, the risk of misclassification also seemed to be low due to the fact that all data were collected systematically and prospectively using validated questionnaires without any missing data. In addition, to avoid the risk of recall bias as a possible source of misclassification, all data were collected at the time of patients' hospitalisation. Furthermore, as the person collecting the data was the same for all 800 patients, there was no variation in the way the questionnaire and the items were presented to patients. However, there may be a risk of misclassification associated with response bias as the patients who completed the questionnaires in the multi-bed rooms may have answered certain questions more cautiously than those in single-bed rooms, in an attempt to prevent fellow patients from subsequently informing staff of any negative responses. However, as the number of patients in multi-bed rooms was not statistically different before and after accreditation, a possible misclassification is expected to be nondifferential.

In conclusion, the influence of information bias according to the patient-related outcomes in Studies I, II, and III was considered to be low overall.

### *6.3.3 Confounding*

In Study I, we addressed the risk of confounding by conducting stratified analysis according to each clinical condition and for all individual process performance measures included. Furthermore, as all included process performance measures were defined according to very specific inclusion and exclusion criteria, only those patients who required the specific measure would be offered it, regardless of patient characteristics, which increased the homogeneity between patients before and after accreditation and thus reduced the likelihood of confounding. However, confounding by indication could be a possible concern as the responsibility for

determining each patient's eligibility for a specific process performance measure belonged to different health professionals. In addition, it was person-dependent whether a patient received a process performance measure or not. Yet, since it is a requirement to explain such choices in the patient's medical record, which was also true among patients in Study I, the likelihood of this type of confounding having an impact on the delivery of recommended care was expected to be low. Another concern regarding possible confounding is related to the fact that the National Hospital recruited its first lung specialist and transferred all patients with lung diseases from a general ward to a specialist ward in relation to the hospital's first-time accreditation. Given that after accreditation a significant difference existed in the delivery of recommended care to patients with COPD, this difference may have been confounded. However, it seems highly unlikely that one specialist would be able to cause such great improvements over a relatively short period of time. Nevertheless, we cannot rule out the possibility that the changes in recommended care related to COPD may be explained by other factors than accreditation *per se.*

For Study III, we had access to a wide range of patient characteristics from the medical records, which is known to be strongly associated with LOS, AR, and 30-day mortality. Overall, we were able to adjust for sex, age, diagnosis, cohabitant status, in-hospital rehabilitation, and type of admission, which contributed to minimising the risk that any of our findings could be explained by confounding. This was supplemented by analyses stratified according to each of the clinical conditions. However, disease severity and comorbidities, which are powerful prognostic markers related to LOS, AR, and 30-day mortality, were incomplete and thus not accounted for in any of the analyses. Therefore, we cannot exclude that confounding occurred as a result of this limitation. However, it seems unlikely that unaccounted confounding would be instrumental in changing the overall results, given that we adjusted for six important confounders known to be associated with the outcomes in question.

In Study II, we only had access to patient characteristics as possible confounding factors using two validated questionnaires. Against this background, we accounted for possible confounding by including a total of five characteristics (age, sex, level of education, previous hospitalisation, and type of hospitalisation) in all analyses. However, as we did not collect information on patient diagnosis because we did not want to compromise the anonymity of the study participants, it was not possible to conduct stratified analysis according to clinical conditions nor adjust for diagnosis in any of the analyses. Hence, confounding by diagnosis cannot be excluded; however, as a single factor it is not likely to alter the overall findings. Moreover, once again, unmeasured and unknown confounding could have occurred; however, if unmeasured and unknown risk factors were to confound our findings, then they would have been differentially distributed among patients hospitalised before and after accreditation and would not be correlated with the confounding factors already accounted for in our analyses.

In addition to the confounding factors accounted for in Studies I and III, we also adjusted for the cluster effect at the patient level to account for patients' independence, as some patients were included more than once. Furthermore, in all three studies, we adjusted for the clustering of patients within hospitals, including unmeasured hospital characteristics associated with all outcomes. As we compared the same hospitals before and after accreditation, no other precautions were undertaken to account for possible confounding related to hospital characteristics. However, other factors related to healthcare, including the possibility of going to a nursing home or receiving assistance at home after discharge, were not accounted for and could have affected our outcomes. Yet, it does not seem likely that such factors should be linked to accreditation.

In summary, as it was not possible to account for all possible confounding, including confounding related to disease severity and co-morbidities, the possibility of residual confounding was still present and must be considered when assessing the findings presented in this dissertation.

### *6.3.4 Precision*

The study populations of Studies I and II were both based on power calculations, which minimised the risk of random errors related to the precision of the estimates. Furthermore, all analyses for Studies I, II, and III included estimates with 95% CIs, which should be adequate for evaluating their precision.

The findings from the main analyses related to recommended care, patient experiences, and LOS were all subject to narrow 95% CIs, and thus, the estimates can be interpreted as reasonably precise. However, most 95% CIs at the clinical condition level (Studies I and III) and findings from the main analyses for AR and 30-day mortality (Study III) yielded broad 95% CIs, and we found the lack of consistent results for the stratified analyses to be a consequence of low power.

# 7.0 CONCLUSION

In conclusion, the three studies included in this dissertation demonstrated that first-time hospital accreditation was associated with the delivery of more recommended care, improved patient experiences, and shorter LOS. No difference was observed in relation to AR and 30-day mortality. However, as the Faroese hospitals had never participated in systematic quality improvement activities before, including accreditation, the differences identified should be considered against this context. Thus, hospitals with several rounds of accreditation using another accreditation programme may not experience the same differences as a result of accreditation.

These findings provide further support for the hypothesis that accreditation may be associated with positive effects on patient-related outcomes. However, better insights are warranted on why hospital accreditation contributes to improvements in hospitals for some but not all patients and outcomes, preferably using qualitative and mixed-methods designs.

# 8.0 PERSPECTIVES

Over the past century, healthcare systems around the world have undergone major changes to provide better and safer care in hospitals. Several different approaches have been employed to achieve these transformations, but given the complexity of healthcare and hospitals in particular, the effectiveness of these different approaches has often proven difficult to evaluate. Based on the findings from this dissertation, it was possible to document that hospital accreditation can be an effective strategy for achieving significant improvements in recommended care, patient experiences and clinical outcomes. However, this dissertation does not provide an unequivocal answer regarding the effectiveness of accreditation, and many questions must still be addressed to fully understand its constraints and potentials.

An interesting finding was the impact of accreditation on patient experiences. Even though some accreditation programmes include the patient perspective, to the best of our knowledge, patients' experiences have never been a fundamental part of the accreditation processes in hospitals. Going forward, accreditation planners could benefit from including patient experience in the development of accreditation standards to ensure continued attention to those experiences of great importance to patients. As a result, hospitals will be able to monitor the quality of care related to patients' experiences and thus identify where action may be required, while also providing person-centred and safe care. Nevertheless, patient experiences could also usefully be included in the overall assessment of whether a hospital should achieve fully accredited status, as negative patient experiences could serve as a proxy for a dysfunctional organisation. As we did not include outpatients in our study on patient experiences, future research on this topic should include this patient group to discover whether their experiences are also positively associated with accreditation. In addition, any future research must also examine whether those patients who have positive experiences in accredited hospitals also have superior outcomes.

In this dissertation, the intervention was a modified and slightly smaller version of the original Danish Healthcare Quality Programme, and despite this, the Faroese hospitals achieved substantial improvements. Going forward, to justify the continued use of accreditation worldwide, it would be beneficial to identify the underlying mechanisms by which accreditation works. Such information may help to identify whether a small-scale version of an accreditation programme could achieve the same results without necessarily addressing all of the components outlined in a programme. Such a down-scaled accreditation programme might be of great interest for particularly low-income countries, but more generally, it would probably be of interest to the vast majority of countries for utilising the limited resources available in the healthcare system. Against this background, it would be interesting to explore whether accreditation in its current form versus that used on a smaller scale would either way be cost-effective without compromising patient safety and the quality of care delivered in hospitals.

## 9.0 SUMMARY

Accreditation is an external review process used to assess how well an organization meets established standards. Accreditation provides a framework for continuous quality improvement and is recognized worldwide as a way to improve organisational structures and quality of care in hospitals. However, despite its widespread use, the effectiveness of accreditation is still questioned today, partly due to the lack of consistent scientific literature. Despite this and based on a desire to improve the quality of care and patient safety in Faroese hospitals, the Faroese Ministry of Health decided in 2014, that the Faroese hospitals should be first-time accredited using a modified second version of the Danish Healthcare Quality Programme (DDKM). This provided a unique opportunity to study the effectiveness of accreditation on the basis of a baseline, as Faroese hospitals had never previously participated in systematic quality improvement activities, including accreditation.

To contribute additional knowledge in an otherwise scarce research area, the studies included in this dissertation aimed to examine the association between first-time hospital accreditation in the Faroe Islands and the delivery of recommended care (Study I), patient experiences (Study II), and clinical outcomes including length of stay (LOS), acute readmission (AR), and 30-day mortality (Study III). All studies were designed as before and after studies in which all three Faroese hospitals were included. All data were collected using the Faroese National Patient Registry (Studies I and III), medical records (Studies I and III), and two validated questionnaires (Study II). For Studies I and III, data were collected from January 1, 2012 to December 31, 2013 (before accreditation) and February 21, 2017 to June 1, 2018 (after accreditation). The data collection for Study II was completed bedside in the Faroese hospitals in the period from July 7 to October 8, 2016 (before accreditation) and from June 16 to August 21, 2018 (after accreditation).

In the study on the delivery of recommended care, a total of 867 patient pathways with 6023 relevant process performance measures were included. After accreditation, recommended care measured as the opportunity-based composite score was marginally higher, although the change did not reach statistical significance (adjusted percentage point difference (%): 4.4%; 95% CI: −0.7 to 9.6). However, the total all-or-none score, which was the probability of a patient receiving all recommended care, was significantly higher (adjusted relative risk (RR): 2.32; 95% CI: 2.03–2.67). The improvement was particularly strong for patients with chronic obstructive pulmonary disease (adjusted RR: 16.22; 95% CI: 14.54–18.10). In the study on patient experiences, a total of 400 patients before and 400 after accreditation completed the survey. After accreditation, patients experienced significantly more support from healthcare professionals, more information before and during hospitalisation, and more involvement in decision making. In the study on LOS, a total of 277 patients before and 532 patients after accreditation were included with a mean LOS of 13.4 days (95% CI: 10.8–15.9) before and 7.5 days (95% CI: 6.10–8.89) after accreditation. Compared with before accreditation, patients were found to have greater risk of a shorter LOS when treated in a hospital

after accreditation (adjusted HR: 1.22; 95% CI: 1.04 –1.43). In the study on AR, a total of 216 patients before and 516 patients after accreditation were included, of whom 12.3% before and 9.5% after accreditation were readmitted acutely within 30 days after discharge. No difference was found in the risk of AR before and after accreditation (adjusted HR: 1.34; 95% CI: 0.82– 2.18). In the study on 30-day mortality, a total of 277 patients before and 532 patients after accreditation were included, where the risk of dying within 30 days after admission was 3.3% before accreditation and 2.8% after accreditation. No difference was found in 30-day mortality risk when comparing patients admitted before and after accreditation (adjusted HR: 1.33; 95% CI: 0.55–3.21).

In conclusion, first-time hospital accreditation in the Faroe Islands was associated with the delivery of more recommended care, more support from staff, more information, more involvement in decision making, and shorter LOS. No difference was found in relation to AR and 30-day mortality.

## 10.0 DANSK RESUME

Akkreditering er en ekstern evalueringsproces, som benyttes til at vurdere hvor godt et hospital præsterer i forhold til fastlagte standarder. Akkreditering er med til at skabe rammerne for et kontinuerligt kvalitetsforbedringsarbejde og er anerkendt over hele verden, som en måde hvorpå man kan forbedre organisatoriske strukturer og kvaliteten i patientbehandlingen. På trods af akkrediterings udbredte anvendelse stilles der fortsat spørgsmålstegn ved dens effektivitet, hvilket blandt andet skyldes en mangelfuld og inkonsistent videnskabelig litteratur på området. På trods af ovenstående og med et ønske om at forbedre behandlingskvaliteten og patientsikkerheden på de færøske sygehuse, besluttede de færøske sundhedsmyndigheder i 2014, at de færøske sygehuse skulle akkrediteres baggrund af en modificeret anden udgave af den danske kvalitetsmodel (DDKM). Dette skabte en helt unik mulighed for at undersøge effekten af akkreditering på baggrund af en baseline, idet de færøske sygehuse aldrig tidligere havde deltaget i systematiske kvalitets forbedringsaktiviteter heriblandt heller ikke akkreditering.

For at tilvejebringe ny viden om akkreditering i et ellers sparsomt undersøgt forskningsområde, var formålet med denne afhandling at undersøge associationen mellem første-gangs akkreditering på Færøerne og leveringen af rekommanderet behandling (studie I), patientoplevelser (studie II) og kliniske resultater herunder indlæggelseslængde, akut genindlæggelse og 30-dages dødelighed (studie III). Alle tre studier inkluderede de tre færøske sygehuse og var designet som før og efter undersøgelser. Data blev indsamlet ved hjælp af det færøske nationale patientregister (studie I og III), patient journaler (studie I og III) og på baggrund af to validerede spørgeskemaer (studie II). For studie I og III blev data indsamlet svarende til perioden 1. januar, 2012 til 31. december, 2013 (før akkreditering) og fra 21. februar, 2017 til 1. juni, 2018 (efter akkreditering). Dataindsamlingen i forhold til studie II blev gennemført ved patientens seng på alle tre sygehuse i perioden 7. juli til 8. oktober, 2016 (før akkreditering) og fra 16. juni til 21. august, 2018 (efter akkreditering).

I studiet om rekommanderet behandling blev der inkluderet samlet 867 patientforløb hvilket svarede til 6023 procesindikatorer. Efter akkreditering var den rekommanderede behandling, målt som den mulighedsbaserede sammensatte score, marginalt større, men ikke statistisk signifikant (justeret procentpointforskel (%): 4.4%; 95% CI: -0.7 til 9.6). Derimod var sandsynligheden for at få al den rekommanderede behandling statistisk signifikant højere (justeret relativ risiko (RR) 2.23; 95% konfidensinterval (CI): 2.03 til 2.67). Forbedringen var særlig stærk for patienter med kronisk obstruktiv lungesygdom (justeret RR: 16.22; 95% CI: 14.54 til 18.10). I studiet om patientoplevelser deltog samlet 400 patienter før og 400 patienter efter akkreditering i spørgeskemaundersøgelsen. Efter akkrediteringen oplevede patienterne signifikant mere støtte fra sundhedspersonalet, mere information før og under indlæggelsen samt mere medinddragelse i beslutninger. I studiet om indlæggelseslængde indgik samlet 277 patienter før akkreditering og 532 patienter efter akkreditering. Patienterne havde en gennemsnitlig

indlæggelseslængde på henholdsvis 13.4 dage (95% CI: 10.8 til 15.9) før akkreditering og 7.5 dage (95% CI: 6.10 til 8.89) efter akkreditering. Sammenlignet med før akkreditering, så havde patienterne er statistisk signifikant større sandsynlighed for en kortere indlæggelsestid ved behandling på et sygehus efter akkreditering (justeret hasard rate ratio (HR): 1.22; 95% CI: 1.04 til 1.43). I studiet om akut genindlæggelse indgik samlet 216 patienter før akkreditering og 516 patienter efter akkreditering, hvoraf 12.3% før og 9.5% efter akkreditering blev akut genindlagt indenfor 30 dage efter udskrivelsen. Der blev ikke fundet nogen forskel i risikoen for akut genindlæggelse før og efter akkreditering (justeret HR: 1.34; 95% CI: 0.82 til 2.18). I studiet om 30-dages dødelighed indgik 277 patienter før akkreditering og 532 patienter efter akkreditering hvoraf risikoen for at dø indenfor 30 dage efter indlæggelsen var 3.3% før akkreditering og 2.8% efter akkreditering. Der blev ikke fundet nogen forskel i risikoen for 30-dages dødelighed, ved sammenligning af patienter indlagt før og efter akkreditering (justeret HR: 1.33; 95% CI: 0.55 til 3.21).

Det konkluderes at første-gangs akkreditering på Færøerne var associeret med signifikant mere rekommanderet behandling på sygehusene, mere støtte fra personalet, mere information før og under indlæggelsen samt større medinddragelse i beslutningstagningen og en kortere indlæggelsestid. Der blev ikke fundet nogen forskel i risiko for akut genindlæggelse eller 30-dages dødelighed.

## 11.0 REFERENCES


1. Roberts JS, Coale JG, Redman RR: **A history of the Joint Commission on Accreditation of Hospitals**. *JAMA* 1987, **258**(7):936-940.
2. Donabedian A: **The quality of care. How can it be assessed?** *JAMA* 1988, **260**(12):1743-1748.
3. Djulbegovic B, Guyatt GH: **Progress in evidence-based medicine: a quarter century on**. *Lancet* 2017, **390**(10092):415-423.
4. Griffith JR: **Is It Time to Abandon Hospital Accreditation?** *Am J Med Qual* 2018, **33**(1):30-36.
5. Ministeriet for sundhed og forebyggelse: **Nationalt kvalitetsprogram for sundhedsområdet 2015-2018**. In.
6. Duckett S JC, Moran G et al.: **Safer Care Saves Money: How to Improve Patient Care and Save Public Money at the Same Time**. In.: Grattan Institute, Carlton, Victoria, Australia; 2018.
7. Devkaran S, O'Farrell PN: **The impact of hospital accreditation on quality measures: an interrupted time series analysis**. *BMC Health Serv Res* 2015, **15**:137.
8. Al-Alawy K, Azaad Moonesar I, Ali Mubarak Obaid H, Gaafar R, Ismail Al-Abed Bawadi E: **A Mixed-Methods Study to Explore the Impact of Hospital Accreditation**. *Inquiry* 2021, **58**:46958020981463.
9. Bogh SB, Blom A, Raben DC, Braithwaite J, Thude B, Hollnagel E, Plessen CV: **Hospital accreditation: staff experiences and perceptions**. *Int J Health Care Qual Assur* 2018, **31**(5):420-427.
10. Triantafillou P: **Against all odds? Understanding the emergence of accreditation of the Danish hospitals**. *Soc Sci Med* 2014, **101**:78-85.
11. Mumford V, Greenfield D, Hogden A, Forde K, Westbrook J, Braithwaite J: **Counting the costs of accreditation in acute care: an activity-based costing approach**. *BMJ open* 2015, **5**(9):e008850-e008850.
12. Mumford V, Forde K, Greenfield D, Hinchcliff R, Braithwaite J: **Health services accreditation: what is the evidence that the benefits justify the costs?** *Int J Qual Health Care* 2013, **25**(5):606-620.
13. Brubakk K, Vist GE, Bukholm G, Barach P, Tjomsland O: **A systematic review of hospital accreditation: the challenges of measuring complex intervention effects**. *BMC Health Serv Res* 2015, **15**:280.
14. Hinchcliff R, Greenfield D, Moldovan M, Westbrook JI, Pawsey M, Mumford V, Braithwaite J: **Narrative synthesis of health service accreditation literature**. *BMJ Qual Saf* 2012, **21**(12):979-991.
15. **Joint Commission International** [https://www.jointcommissioninternational.org/ Accessed 26 September 2021]
16. Berwick DM, Nolan TW, Whittington J: **The triple aim: care, health, and cost**. *Health Aff (Millwood)* 2008, **27**(3):759-769.
17. Porter ME: **A strategy for health care reform--toward a value-based system**. *N Engl J Med* 2009, **361**(2):109-112.
18. Corallo AN, Croxford R, Goodman DC, Bryan EL, Srivastava D, Stukel TA: **A systematic review of medical practice variation in OECD countries**. *Health Policy* 2014, **114**(1):5-14.
19. McGlynn EA, Asch SM, Adams J, Keesey J, Hicks J, DeCristofaro A, Kerr EA: **The quality of health care delivered to adults in the United States**. *N Engl J Med* 2003, **348**(26):2635-2645.

20. Runciman WB, Hunt TD, Hannaford NA, Hibbert PD, Westbrook JI, Coiera EW, Day RO, Hindmarsh DM, McGlynn EA, Braithwaite J: **CareTrack: assessing the appropriateness of health care delivery in Australia**. *Med J Aust* 2012, **197**(2):100-105.
21. Braithwaite J, Hibbert PD, Jaffe A, White L, Cowell CT, Harris MF, Runciman WB, Hallahan AR, Wheaton G, Williams HM *et al*: **Quality of Health Care for Children in Australia, 2012-2013**. *JAMA* 2018, **319**(11):1113-1124.
22. **Improving healthcare quality in Europe: Characteristics, effectiveness and implementation of different strategies** [https://www.ncbi.nlm.nih.gov/books/NBK549276/ Accessed 26 September 2021]
23. Mainz J: **Basal kvalitetsudvikling**: Munksgaard; 2017.
24. Shaw C: **Toolkit for Accreditation Programs**. In: *The international Society for Quality in Health Care, Australia.* 2004.
25. Shaw CD: **Evaluating accreditation**. *Int J Qual Health Care* 2003, **15**(6):455-456.
26. Scrivens E: **Putting continuous quality improvement into accreditation: improving approaches to quality assessment**. *Qual Health Care* 1997, **6**(4):212-218.
27. Keil OR: **The Joint Commission's Agenda for Change: what does it mean for equipment managers?** *Biomed Instrum Technol* 1994, **28**(1):14-17.
28. Taylor MJ, McNicholas C, Nicolay C, Darzi A, Bell D, Reed JE: **Systematic review of the application of the plan-do-study-act method to improve quality in healthcare**. *BMJ Qual Saf* 2014, **23**(4):290-298.
29. **Introduction to DDKM** [https://www.ikas.dk/den-danske-kvalitetsmodel/ddkm-in-english/introduction-to-ddkm/ Accessed 26 September 2021]
30. Tabrizi JS, Gharibi F, Wilson AJ: **Advantages and Disadvantages of Health Care Accreditation Mod-els**. *Health Promot Perspect* 2011, **1**(1):1-31.
31. **World Bank Open Data** [https://data.worldbank.org/country/faroe-islands Accessed 26 September 2021]
32. **Healthcare in the Faroe Islands** [https://www.hmr.fo/en/what-we-do/health-and-prevention/healthcare-in-the-faroe-islands/ Accessed 26 September 2021]
33. **Landslægen på Færøerne** [https://stps.dk/da/om-os/organisation/landslaegen-paa-faeroeerne/ Accessed 26 September 2021]
34. **Ministry of Health** [https://www.hmr.fo/en/home/ Accessed 26 September 2021]
35. **Statistics Faroe Islands** [https://hagstova.fo/en/population/population/population Accessed 26 September 2021]
36. **Sjúkrahúsverkið** [http://www.ssh.fo/ Accessed 26 September 2021]
37. **Adgang til behandling i Danmark** [https://stps.dk/da/eu-sygesikring/adgang-til-behandling-i-danmark/# Accessed 26 September 2021]
38. **Akkrediteringsstandarder for de færøske sygehuse** [https://www.ikas.dk/deltagere-i-ddkm/faeroeske-sygehuse/ Accessed 26 September 2021]
39. **Den Danske Kvalitetsmodel (DDKM)** [https://www.ikas.dk/den-danske-kvalitetsmodel/ Accessed 26 September 2021]
40. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M: **Developing and evaluating complex interventions: the new Medical Research Council guidance**. *BMJ* 2008, **337**:a1655.
41. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M: **Developing and evaluating complex interventions: the new Medical Research Council guidance**. *Int J Nurs Stud* 2013, **50**(5):587-592.

42. Øvretveit J, Gustafson D: **Evaluation of quality improvement programmes**. *Qual Saf Health Care* 2002, **11**(3):270-275.
43. Craig P, Cooper C, Gunnell D, Haw S, Lawson K, Macintyre S, Ogilvie D, Petticrew M, Reeves B, Sutton M *et al*: **Using natural experiments to evaluate population health interventions: new Medical Research Council guidance**. *J Epidemiol Community Health* 2012, **66**(12):1182-1186.
44. Falstie-Jensen AM, Bogh SB, Johnsen SP: **Consecutive Cycles of Accreditation and Quality of in-Hospital Care - A Danish Population-Based Study**. *Int J Qual Health Care* 2021.
45. Falstie-Jensen AM, Bogh SB, Hollnagel E, Johnsen SP: **Compliance with accreditation and recommended hospital care-a Danish nationwide population-based study**. *Int J Qual Health Care* 2017, **29**(5):625-633.
46. Bogh SB, Falstie-Jensen AM, Hollnagel E, Holst R, Braithwaite J, Raben DC, Johnsen SP: **Predictors of the effectiveness of accreditation on hospital performance: A nationwide stepped-wedge study**. *Int J Qual Health Care* 2017, **29**(4):477-483.
47. Bogh SB, Falstie-Jensen AM, Hollnagel E, Holst R, Braithwaite J, Johnsen SP: **Improvement in quality of hospital care during accreditation: A nationwide stepped-wedge study**. *Int J Qual Health Care* 2016, **28**(6):715-720.
48. Bogh SB, Falstie-Jensen AM, Bartels P, Hollnagel E, Johnsen SP: **Accreditation and improvement in process quality of care: a nationwide study**. *Int J Qual Health Care* 2015, **27**(5):336-343.
49. Merkow RP, Chung JW, Paruch JL, Bentrem DJ, Bilimoria KY: **Relationship between cancer center accreditation and performance on publicly reported quality measures**. *Ann Surg* 2014, **259**(6):1091-1097.
50. Schmaltz SP, Williams SC, Chassin MR, Loeb JM, Wachter RM: **Hospital performance trends on national quality measures and the association with Joint Commission accreditation**. *J Hosp Med* 2011, **6**(8):454-461.
51. Ross MA, Amsterdam E, Peacock WF, Graff L, Fesmire F, Garvey JL, Kelly S, Holmes K, Karunaratne HB, Toth M *et al*: **Chest pain center accreditation is associated with better performance of centers for Medicare and Medicaid services core measures for acute myocardial infarction**. *Am J Cardiol* 2008, **102**(2):120-124.
52. Chen J, Rathore SS, Radford MJ, Krumholz HM: **JCAHO accreditation and quality of care for acute myocardial infarction**. *Health Aff (Millwood)* 2003, **22**(2):243-254.
53. Lutfiyya MN, Sikka A, Mehta S, Lipsky MS: **Comparison of US accredited and non-accredited rural critical access hospitals**. *Int J Qual Health Care* 2009, **21**(2):112-118.
54. AI AR, Ibrahim MI, Musa KI, Chua SL: **Facebook Reviews as a Supplemental Tool for Hospital Patient Satisfaction and Its Relationship with Hospital Accreditation in Malaysia**. *Int J Environ Res Public Health* 2021, **18**(14).
55. Andres EB, Song W, Song W, Johnston JM: **Can hospital accreditation enhance patient experience? Longitudinal evidence from a Hong Kong hospital patient experience survey**. *BMC Health Serv Res* 2019, **19**(1):623-623.
56. Aboshaiqah AE, Alonazi WB, Patalagsa JG: **Patients' assessment of quality of care in public tertiary hospitals with and without accreditation: comparative cross-sectional study**. *J Adv Nurs* 2016, **72**(11):2750-2761.

57. Haj-Ali W, Bou Karroum L, Natafgi N, Kassak K: **Exploring the relationship between accreditation and patient satisfaction - the case of selected Lebanese hospitals**. *Int J Health Policy Manag* 2014, **3**(6):341-346.
58. Al-Qahtani M, Al-Dohailan SK, Al-Sharani HT, Al-Medaires MA, Khuridah EN, Al-Dossary NM: **The impact of the status of hospital accreditation on patient satisfaction with the Obstetrics and Gynecology Clinics in the Eastern Province, Saudi Arabia**. *J Med Med Sci* 2012, **3**(10):665-673.
59. Sack C, Scherag A, Lütkes P, Günther W, Jöckel KH, Holtmann G: **Is there an association between hospital accreditation and patient satisfaction with hospital care? A survey of 37,000 patients treated by 73 hospitals**. *Int J Qual Health Care* 2011, **23**(3):278-283.
60. Hayati IN, Azimatun N, Rozita H, Ezat W, Rizal A: **In-patient's satisfaction in the medical and surgical wards-A comparison between accreditted and non accreditated hospital in the state of Selangor**. *J Community Health* 2010, **16**(1):60-68.
61. Sack C, Lütkes P, Günther W, Erbel R, Jöckel K-H, Holtmann GJ: **Challenging the holy grail of hospital accreditation: a cross sectional study of inpatient satisfaction in the field of cardiology**. *BMC Health Serv Res* 2010, **10**:120-120.
62. Lee BY, Chun YJ, Lee YH: **Comparison of Major Clinical Outcomes between Accredited and Nonaccredited Hospitals for Inpatient Care of Acute Myocardial Infarction**. *Int J Environ Res Public Health* 2021, **18**(6).
63. El-Menyar A, Mekkodathil A, Asim M, Consunji R, Strandvik G, Peralta R, Rizoli S, Abdelrahman H, Mollazehi M, Parchani A *et al*: **Maturation process and international accreditation of trauma system in a rapidly developing country**. *PLoS One* 2020, **15**(12):e0243658.
64. Sun P, Li J, Fang W, Su X, Yu B, Wang Y, Li C, Chen H, Wang X, Zhang B *et al*: **Effectiveness of chest pain centre accreditation on the management of acute coronary syndrome: a retrospective study using a national database**. *BMJ Qual Saf* 2020.
65. Falstie-Jensen AM, Bogh SB, Johnsen SP: **Consecutive cycles of hospital accreditation: Persistent low compliance associated with higher mortality and longer length of stay**. *Int J Qual Health Care* 2018, **30**(5):382-389.
66. Al-Sughayir MA: **Effect of accreditation on length of stay in psychiatric inpatients: pre-post accreditation medical record comparison**. *Int J Ment Health Syst* 2016, **10**(1):55.
67. Falstie-Jensen AM, Norgaard M, Hollnagel E, Larsson H, Johnsen SP: **Is compliance with hospital accreditation associated with length of stay and acute readmission? A Danish nationwide population-based study**. *Int J Qual Health Care* 2015, **27**(6):451-458.
68. Telem DA, Talamini M, Altieri M, Yang J, Zhang Q, Pryor AD: **The effect of national hospital accreditation in bariatric surgery on perioperative outcomes and long-term mortality**. *Surg Obes Relat Dis* 2015, **11**(4):749-757.
69. Morton JM, Garg T, Nguyen N: **Does hospital accreditation impact bariatric surgery safety?** *Ann Surg* 2014, **260**(3):504-508; discussion 508-509.
70. Kurichi JE, Vogel WB, Kwong PL, Xie D, Bates BE, Stineman MG: **Factors associated with total inpatient costs and length of stay during surgical hospitalization among veterans who underwent lower extremity amputation**. *Am J Phys Med Rehabil* 2013, **92**(3):203-214.
71. Nguyen NT, Nguyen B, Nguyen VQ, Ziogas A, Hohmann S, Stamos MJ: **Outcomes of bariatric surgery performed at accredited vs nonaccredited centers**. *J Am Coll Surg* 2012, **215**(4):467-474.

72. Chun YJ, Lee BY, Lee YH: **Association between Accreditation and In-Hospital Mortality in Patients with Major Cardiovascular Diseases in South Korean Hospitals: Pre-Post Accreditation Comparison**. *Medicina (Kaunas)* 2020, **56**(9).
73. Ko T, Yang CH, Mao CT, Kuo LT, Hsieh MJ, Chen DY, Wang CY, Lin YS, Hsieh IC, Chen SW *et al*: **Effects of National Hospital Accreditation in Acute Coronary Syndrome on In-Hospital Mortality and Clinical Outcomes**. *Acta Cardiol Sin* 2020, **36**(5):416-427.
74. Fan F, Li Y, Zhang Y, Li J, Liu J, Hao Y, Smith SC, Jr., Fonarow GC, Taubert KA, Ge J *et al*: **Chest Pain Center Accreditation Is Associated With Improved In-Hospital Outcomes of Acute Myocardial Infarction Patients in China: Findings From the CCC-ACS Project**. *J Am Heart Assoc* 2019, **8**(21):e013384.
75. Mikami M, Shida M, Shibata T, Katabuchi H, Kigawa J, Aoki D, Yaegashi N: **Impact of institutional accreditation by the Japan Society of Gynecologic Oncology on the treatment and survival of women with cervical cancer**. *J Gynecol Oncol* 2018, **29**(2):e23-e23.
76. Falstie-Jensen AM, Larsson H, Hollnagel E, Norgaard M, Svendsen ML, Johnsen SP: **Compliance with hospital accreditation and patient mortality: a Danish nationwide population-based study**. *Int J Qual Health Care* 2015, **27**(3):165-174.
77. Gratwohl A, Brand R, McGrath E, van Biezen A, Sureda A, Ljungman P, Baldomero H, Chabannon C, Apperley J: **Use of the quality management system "JACIE" and outcome after hematopoietic stem cell transplantation**. *Haematologica* 2014, **99**(5):908-915.
78. Gebhart A, Young M, Phelan M, Nguyen NT: **Impact of accreditation in bariatric surgery**. *Surg Obes Relat Dis* 2014, **10**(5):767-773.
79. Gratwohl A, Brand R, Niederwieser D, Baldomero H, Chabannon C, Cornelissen J, de Witte T, Ljungman P, McDonald F, McGrath E *et al*: **Introduction of a quality management system and outcome after hematopoietic stem-cell transplantation**. *J Clin Oncol* 2011, **29**(15):1980-1986.
80. Chandra A, Glickman SW, Ou FS, Peacock WF, McCord JK, Cairns CB, Peterson ED, Ohman EM, Gibler WB, Roe MT: **An analysis of the Association of Society of Chest Pain Centers Accreditation to American College of Cardiology/American Heart Association non-ST-segment elevation myocardial infarction guideline adherence**. *Ann Emerg Med* 2009, **54**(1):17-25.
81. **Regionernes kliniske kvalitetsudviklingsprogram** [https://www.rkkp.dk/in-english/ Accessed 26 September 2021]
82. **LUP 2015 resultater** [https://www.regionh.dk/patientinddragelse/LUP/resultater/Sider/Resultater-fra-LUP-2015.aspx Accessed 26 September 2021]
83. **Metoder anvendt til validering af skalaer i LUP og resultater af analyser** [https://www.regionh.dk/patientinddragelse/udgivelser/udgivelser/Sider/Metoder-anvendt-til-validering-af-skalaer-i-LUP-og-resultater-af-analyser.aspx?rhKeywords=bang Accessed 26 September 2021]
84. **Hvad er LUP?** [https://www.regionh.dk/patientinddragelse/LUP/Om-lup/Sider/hvad-er-lup.aspx Accessed 26 September 2021]
85. Van de Linden WJ, Hambleton RK: **Handbook of Modern Item Response Theory**. New York: Springer-Verlag,; 1997.
86. Rosenbaum PR: **Criterion-related construct validity**. *Psychometrika* 1989, **54**(4):625-633.
87. Holland PW, Wainer H: **Differential Item Functioning**. New York: Lawrence Erlbaum 1993.

88. REDCap [https://projectredcap.org/ Accessed 26 September 2021]
89. McHugh ML: Interrater reliability: the kappa statistic. *Biochem Med (Zagreb)* 2012, 22(3):276-282.
90. Mattila E, Kaunonen M, Aalto P, Ollikainen J, Astedt-Kurki P: Support for hospital patients and associated factors. *Scand J Caring Sci* 2010, 24(4):734-745.
91. Doyle C, Lennox L, Bell D: A systematic review of evidence on the links between patient experience and clinical safety and effectiveness. *BMJ open* 2013, 3(1).
92. Pomey MP, Lemieux-Charles L, Champagne F, Angus D, Shabah A, Contandriopoulos AP: Does accreditation stimulate change? A study of the impact of the accreditation process on Canadian healthcare organizations. *Implement Sci* 2010, 5:31.

# 12.0 APPENDIX

***Appendix 1. A Faroese accreditation standard***

| Heading | Decripsion | | | | |
|---|---|---|---|---|---|
| **Title of standard** | **2.9.6 – Medicine for emergency situations (5/7)** | | | | |
| **Sector** | The Faroe Islands | **Version** | 1 | **Edition** | 2 |
| **Category** | General patient care standards | **Theme** | Medication | | |
| **Purposes of the standard** | • To ensure that medicines for use in emergency situations are available and properly stored<br>• To prevent adverse events related to the dispensing of medicines used in emergency situations<br>• To ensure that the responsibility for emergency medicines is clearly assigned | | | | |
| **Content of the standard** | **Medicines used in emergency situations are readily available**<br>The medicines required for emergencies will vary according to the size of the hospital.<br><br>In the guidelines, each department should decide and describe what medicines for use in emergency situations are required by the department (e.g., in emergency trays).<br>Emergency medicines must be stored in accordance with the rules as well as be available around the clock to the staff who use them.<br><br>The guidelines in indicator 1 describe at least the following:<br>a. emergency containers are stored safely and without unauthorised access<br>b. emergency containers are accessible to relevant personnel in emergency situations<br>c. who is responsible for the control of:<br>• that appropriate emergency containers are available<br>• medicinal products have not passed their expiry date<br>• medicinal products are stored correctly<br>• that emergency trays are filled after an emergency<br><br>It may be appropriate to seal emergency trays after checking. However, it is not a requirement of the DDKM to seal emergency trays | | | | |
| **Cross-references** | | | | | |
| **Scope** | All departments with patient contact | | | | |
| **The assessment of compliance with the standard by external survey is based on the following indicators:** | | | | | |
| **Indicator 1** | Guidelines are available on how to ensure the availability of medical devices for use in emergency situations. | | | | |
| **Indicator 2** | Emergency trays are provided and checked according to the guidelines. | | | | |
| **Indicator 3** | Emergency trays are accessible to relevant staff in emergency situations. | | | | |
| **Indicator 4** | The control of emergency bins is documented in a logbook and special attention is paid to the fact that emergency bins are filled after an emergency. | | | | |
| **Indicator 5** | Where checks have identified shortcomings in the availability and content of emergency trays, action has been taken to improve quality. The impact of the measures has been assessed and either it has been concluded that they had the desired effect or new corrective actions have been initiated. | | | | |

## PAPERS

The association between first-time accreditation and the delivery of recommended care: a before and after study in the Faroe Islands

PAPER I

Patients experience more support, information and involvement after first-time hospital accreditation: a before and after study in the Faroe Islands

PAPER II

Shorter length of stay after first-time after first-time hospital accreditation: a national before and after study in the Faroe Islands

PAPER III

The association between first-time accreditation and the delivery of recommended care:

a before and after study in the Faroe Islands

PAPER I

**Note:** Error in abstract. The results should have stated that patients with diabetes received less recommended care after accreditation

BMC Health Services Research

RESEARCH Open Access

# The association between first-time accreditation and the delivery of recommended care: a before and after study in the Faroe Islands

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## Abstract

**Background:** Significant resources are spent on hospital accreditation worldwide. However, documentation of the effects of accreditation on processes, quality of care and outcomes in healthcare remain scarce. This study aimed to examine changes in the delivery of patient care in accordance with clinical guidelines (recommended care) after first-time accreditation in a care setting not previously exposed to systematic quality improvement initiatives.

**Methods:** We conducted a before and after study based on medical record reviews in connection with introducing first-time accreditation. We included patients with stroke/transient ischemic attack, bleeding gastric ulcer, diabetes, chronic obstructive pulmonary disease (COPD), childbirth, heart failure and hip fracture treated at public, non-psychiatric Faroese hospitals during 2012–2013 (before accreditation) or 2017–2018 (after accreditation). The intervention was the implementation of a modified second version of The Danish Healthcare Quality Program (DDKM) from 2014 to 2016 including an on-site accreditation survey in the Faroese hospitals. Recommended care was assessed using 63 disease specific patient level process performance measures in seven clinical conditions. We calculated the fulfillment and changes in the opportunity-based composite score and the all-or-none score.

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**Results:** We included 867 patient pathways (536 before and 331 after). After accreditation, the total opportunity-based composite score was marginally higher though the change did not reach statistical significance (adjusted percentage point difference (%): 4.4%; 95% CI: − 0.7 to 9.6). At disease level, patients with stroke/transient ischemic attack, bleeding gastric ulcer, COPD and childbirth received a higher proportion of recommended care after accreditation. No difference was found for heart failure and diabetes. Hip fracture received less recommended care after accreditation. The total all-or-none score, which is the probability of a patient receiving all recommended care, was significantly higher after accreditation (adjusted relative risk (RR): 2.32; 95% CI: 2.03 to 2.67). The improvement was particularly strong for patients with COPD (RR: 16.22; 95% CI: 14.54 to 18.10).

**Conclusion:** Hospitals were in general more likely to provide recommended care after first-time accreditation.

**Keywords:** Accreditation, Hospital, Recommended care, Before and after study, Medical record audit

## Background

Recent decades have seen substantial advances in patients receiving safe and high-quality healthcare [1–5]. The introduction of evidence-based medicine [6] in combination with systematic quality improvement initiatives [7], including accreditation [8], have played a central role in the efforts to ensure that patients receive the best possible care and achieve the best possible outcome [9–11].

Accreditation is an external review process to assess how well an organization performs relative to established organizational and patient related standards [12]. Accreditation was established more than a century ago and has since become a widely adopted intervention [13]. Today more than 100 countries use accreditation as an important element in their quality improvement strategy [14]. Despite its popularity, the effectiveness of accreditation is often debated due to perceptions that it can be bureaucratic and time-consuming, and uncertain evidence as to its efficacy. Past research on accreditation has been criticized for methodological limitations and inconsistent results [15–21]. Hence, there is a need for more robust empirical research into the effectiveness of accreditation to determine its value [22–24]. Accreditation should ideally be studied in a setting not exposed to other systematic quality improvement initiatives to examine how and to what extent it affects patient care. This unique setting was present in the Faroe Islands before its first hospital accreditation in 2017.

This study therefore aimed to examine accreditation-related changes in the delivery of care in accordance with clinical guidelines (recommended care) in connection with first-time hospital accreditation on the Faroe Islands. Based on past research, we hypothesized that accreditation would be associated with increased adherence to recommended care.

## Methods

### Study design

We conducted a before and after study on the delivery of recommended care for seven clinical conditions representing both acute and chronic diseases in relation to the first-time accreditation of the Faroe Islands hospitals.

### Setting

The Faroe Islands consists of 18 islands in the North Atlantic. It is an autonomous territory within the Kingdom of Denmark. The Faroe Islands are classified as a high-income country by the World Bank (GDP per capita, 2016, USD$ 55,823) [25] with a population of 52,584 people [26] predominantly of Scandinavian descent. The healthcare system is financed through taxation and all hospital healthcare is free of charge. The Faroe Islands three hospitals, The National Hospital in the capital Torshavn, Klaksvik Hospital and Suderø Hospital have never participated in accreditation or other systematic quality improvement activities before the first hospital accreditation in February 2017.

### Intervention

The three hospitals were assessed for accreditation through an on-site survey in February 2017 by the Danish Institute for Quality and Accreditation in Healthcare (IKAS) using the second version of the Danish Healthcare Quality program (DDKM) [27], modified for the Faroese Healthcare system [28]. IKAS had modified the 76 hospital standards in consultation with stakeholders in the Faroese health care system ensuring all standards being aligned with Faroese legislation.

All hospitals participated voluntarily in the first accreditation program. Updating existing policies, instructions and guidelines as well as developing entirely new evidence-based ones was a high priority throughout the implementation process from 2014 to 2016. All new documents were placed in a new electronic document management system ensuring all health professionals access to the latest and updated version wherever they were in the hospital. In addition, much time was spent implementing new workflows and teaching staff all new initiatives. In parallel with the implementation process,

an IT system for recording adverse events was developed. In addition, work began systematically on an electronic patient system that contained all patient data, ensuring all patient information was in one place and accessible to all healthcare professionals. During the on-site survey in February 2017, a team of surveyors assessed compliance with the standards through observation, interviews and review of the hospital documentation [9]. All three hospitals were subjected to the on-site survey the same week. The Danish Accreditation Award Committee subsequently awarded Klaksvik hospital full accreditation. Suderø hospital and the National hospital were not initially fully compliant with the accreditation standards but were after a follow-up survey (an interview after submitting additional documentation) assigned full accreditation in May and September 2017 respectively.

### Recommended care

We measured the ability of hospitals to deliver recommended care using the disease specific process performance measures from the National Clinical Registries. Each year, the level of quality of care delivered to patients in Danish healthcare, is evaluated at national level for each disease area. Based on the evaluations and the current evidence, all requirement regarding each disease specific process performance measure are updated. In the present study we used the requirements related to the year 2016 [29]. All measures was developed by expert panels in The Danish Clinical Quality Program – National Clinical Registries (RKKP) [29–34]. The process performance measures, and time limits included in the study all reflect recommendations from national clinical guidelines. However, not all process performance measures in the national registries were relevant, as some specialized treatments were not available in the Faroe Islands. Therefore, we chose 63 relevant disease specific process performance measures for seven clinical conditions. Stroke and transient ischemic attack (stroke/TIA) (12 measures), bleeding gastric ulcer (8 measures), diabetes (12 measures), COPD (11 measures), childbirth (3 measures), heart failure (7 measures) and hip fracture (10 measures). All process performance measures with time frames and diagnosis codes are provided in Additional file 1.

### Participants

We assessed eligibility for patients through the Faroese National patient register. The register holds information about all patients treated in the Faroese healthcare system. In- and outpatients with one of seven clinical conditions, were eligible for inclusion if they were ≥ 18 years (≥ 30 years for patients with COPD) and had been treated in one of the three hospitals during 2012 and 2013 (before accreditation) or during 2017 and 2018 (after accreditation). Due to different accreditation dates, patients from Klaksvik, Suderø and the National hospital were included after February 21, June 1, September 20, 2017 respectively. Diabetics were only included as outpatients. Patients with COPD were included as in- and outpatients. All other groups only included inpatients. Patients with multiple hospital contacts (with the same clinical condition) were only included with their first appearance in the study period. Patients treated for different clinical conditions were included once for each condition, as inclusion for one condition was considered independent of the others.

The registers included a total of 1722 patient pathways before and 1699 patient pathways after accreditation. Of these, we excluded respectively 835 patient pathways before accreditation and 1242 patient pathways after accreditation due to mismatches between recorded diagnosis and the true reason for a hospitalization/outpatient visit, incorrect treatment period, multiple visits and/or incomplete documentation of process performance measures. For more details, see Fig. 1.

### Data collection

We developed a medical record audit tool and database using REDCap [35]. Two medical auditors retrieved data before accreditation and four after accreditation. One of the medical auditors participated in both data collections to ensure consistency. The medical auditors were all Faroese with local contextual knowledge, and all had a bachelor's degree in medicine.

Data on recommended care were obtained through electronic and paper medical records. The medical auditors initially screened the medical records for inclusion criteria. Recommended care was registered in four categories as: "yes", care provided was consistent with the measure;, "no", care provided was not consistent with the measure;, "unknown", no data in the medical record related to the measure; and "not applicable" i.e., the measure was not relevant for the patient. All data were double-checked, and to ensure reliability, two auditors independently entered data from 100 randomly chosen patients; Cohen's kappa = 0.86 [36].

For a power of at least 80% and a Z-alpha value of 1.96, 601 medical records were needed before and after the first accreditation, respectively for detecting differences in the relative risk of receiving recommended care of 1.2. We estimated the chance of receiving recommended care per encounter before accreditation to be 40%.

### Statistical analysis

Initially, we conducted a descriptive summary of baseline characteristics stratified by before and after accreditation, presenting categorical variables as frequencies and

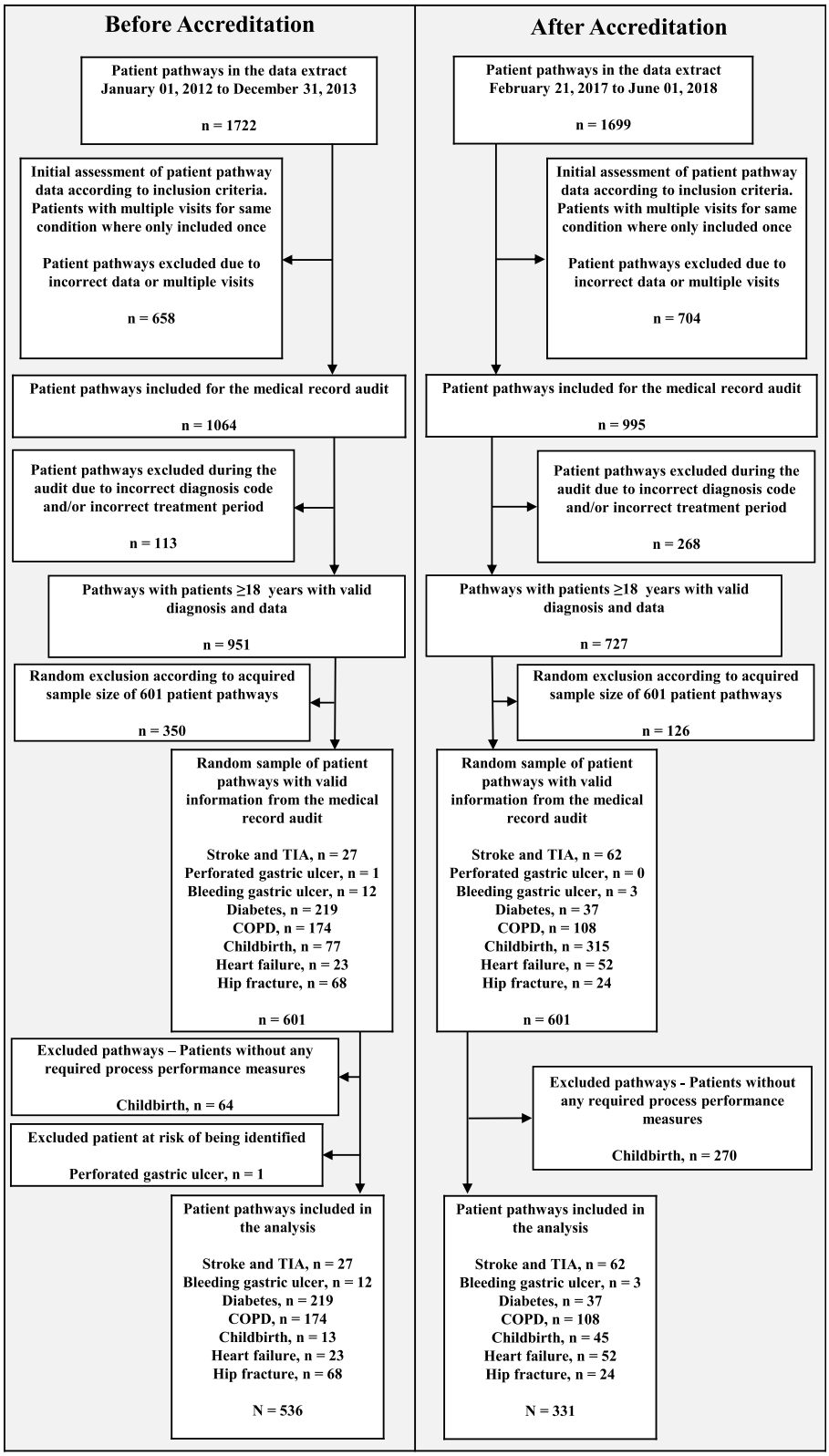


**Fig. 1** Flowchart on patient pathway before and after the first accreditation

percentages and continuous variables as means and ranges.

For the primary analyses, the level of recommended care was analyzed as an opportunity-based composite score and an all-or-none score. All scores involved the fulfillment of individual process performance measures.

The opportunity-based composite score [37] reflected the proportion of fulfilled eligible process performance measures. The all-or-none score reflected the number of patient pathways who had received care fulfilling all relevant process performance measures. Effect measures comparing the period after accreditation with the period before were presented as percentage point difference for the opportunity-based composite score and as relative risk (RR) and risk difference (RD) for the all-or-none score. The analyses were conducted on a total score including all clinical conditions and stratified by clinical conditions. The all-or-none analyses were restricted to patients with a minimum of two relevant process performance measures. A sensitivity analysis was subsequently undertaken including all patients. In addition, we estimated RR for each individual indicator, which were presented in a forest plot.

We computed the RR using Poisson regression with robust variance. The percent point difference as well as the RD was calculated using linear regression. In all cases, we used mixed effects analyses with a random intercept at patient- and hospital level to account for recurrent patient dependence as well as within hospital dependence. When the models were unable to converge, we used the clustered sandwich estimator for the patient-level or patient-level dependence was ignored. A two-sided significance level of 5% was applied. Data were analyzed in StataSE, version 14.2. (StataCorp, 2015. College Station, TX: StataCorp LLC).

## Results

A total of 867 patient pathways with 6023 relevant process performance measures were included in the analysis, corresponding to 536 before and 331 patient pathways after accreditation with 4284 and 1739 relevant measures, respectively. A total of 9 patients before accreditation and 40 patients after accreditation were treated more than once for different clinical conditions at the Faroese hospitals. Before and after accreditation the average age of patients was 66 years. More women were included after accreditation (44.0% vs 55.6%). The proportion of inpatients was higher after accreditation (39.7% vs 79.2%) and more often admitted to specialist departments after accreditation (13.6% vs 67.6%). After accreditation, more patients were hospitalized with stroke and TIA (5.0% vs 18.7%), childbirth (2.4% vs 13.6%) and heart failure (4.3% vs 15.7%) (Table 1).

### Changes in opportunity-based composite scores

The total opportunity-based composite score was higher after accreditation (adjusted percentage point difference (%): 4.4%; 95% CI: −0.7 to 9.6) but the difference did not reach statistical significance. The largest difference was found for childbirths that received 27.9% (95% CI: 24.8 to 31.0) more recommended care after accreditation. Patients treated for stroke/TIA, bleeding gastric ulcer and COPD had a difference of respectively, 17.6% (95% CI: 9.7 to 25.4), 22.5% (95% CI: 18.9 to 26.2) and 14.3% (95% CI: 5.5 to 23.1) after accreditation. No significant differences were found for patients with heart failure. In contrast, patients with diabetes and hip fractures received less recommended care after accreditation with a difference of − 4.3% (95% CI: − 6.2 to − 2.4) and − 5.9% (95% CI: − 8.7 to − 3.1) (Table 2).

### Changes in all-or-none scores

The all-or-none score for all clinical conditions was statistically significant higher after accreditation (adjusted relative risk (RR): 2.32; 95% CI: 2.03 to 2.67). At condition levels, patients with COPD were more likely to receive all the recommended care after accreditation (RR: 16.22; 95% CI: 14.54 to 18.10). The results were unchanged for patients with stroke/TIA and diabetes. In contrast, patients with heart failure were less likely to receive recommended care after accreditation, (RR: 0.44; 95% CI: 0.29 to 0.66) however the risk difference (RD) was not statistically significant, (RD: -0.12; 95% CI: − 0.25 to 0.01) (Table 3). Overall results remained the same when including all patients with no restrictions on the number of included process performance measures in a sensitivity analysis. However, the relative risk for receiving all the recommended care increased significantly for childbirth (RR: 2.59; 95% CI: 1.93 to 3.49) (see Additional file 2).

### Changes in individual process performance measures

Based on the calculated process performance measures (Fig. 2) a total of 19 process performance measures improved, 29 stayed unchanged and 5 declined. Overall, patients with COPD were found to have the greatest improvements after accreditation. A total of nine individual COPD process performance measures improved. Notably, the use of the Medical Research Council shortness of breath scale (RR: 10.98; 95% CI: 9.78 to 12.33), treatment with long-term inhaled bronchodilators (RR: 10.30; 95% CI: 9.18 to 11.55), long-term inhaled corticosteroids (RR: 8.87; 95% CI: 7.91 to 9.96) and participation in pulmonary rehabilitation (RR: 8.82; 95% CI: 7.88 to 9.87) improved significantly. Treatment with assisted ventilation and completing a pulmonary rehabilitation remained unchanged after accreditation. Mothers during childbirth were also significantly more likely to timely

**Table 1** Patient pathway characteristics

| Characteristic | Before Accreditation 2012 and 2013 | After Accreditation 2017 and 2018 |
|---|---|---|
| | *N* = 536 | *N* = 331 |
| Sex, n (%) | | |
| Male | 300 (56.0) | 147 (44.4) |
| Female | 236 (44.0) | 184 (55.6) |
| Age, n (%) | | |
| < 50 years | 98 (18.3) | 71 (21.4) |
| 50–75 years | 282 (52.6) | 135 (40.8) |
| > 75 years | 156 (29.1) | 125 (37.8) |
| Age (years) | | |
| Mean (range) | 66 (18–97) | 66 (18–96) |
| Cohabitant status, n (%) | | |
| Cohabitant | 288 (53.7) | 193 (58.3) |
| Living alone | 84 (15.7) | 49 (14.8) |
| Other, i.e. Nursing home | 44 (8.2) | 35 (10.6) |
| Undisclosed | 120 (22.4) | 54 (16.3) |
| Employment status, n (%) | | |
| Working | 133 (24.8) | 63 (19.0) |
| Not working e.g. Retirees | 178 (33.2) | 99 (29.9) |
| Undisclosed | 225 (42.0) | 169 (51.1) |
| Type of admission, n (%) | | |
| Inpatient | 213 (39.7) | 262 (79.2) |
| Outpatient | 323 (60.3) | 69 (20.8) |
| Type of inpatient, n (%) | | |
| Acute | 206 (96.7) | 248 (94.7) |
| Scheduled | 7 (3.3) | 14 (5.3) |
| Inpatient department, n (%) | | |
| Surgical | 65 (30.5) | 27 (10.3) |
| Medical | 92 (43.2) | 8 (3.0) |
| Mixed (surgical/medical) | 27 (12.7) | 50 (19.1) |
| Specialist e.g. Cardiology | 29 (13.6) | 177 (67.6) |
| Treating hospital, n (%) | | |
| The National hospital | 449 (83.8) | 257 (77.6) |
| Klaksvik hospital | 55 (10.3) | 47 (14.2) |
| Suderø hospital | 32 (5.9) | 27 (8.2) |
| Clinical conditions, n (%) | | |
| Stroke and Transient ischemic attack | 27 (5.0) | 62 (18.7) |
| Bleeding gastric ulcer | 12 (2.2) | 3 (0.9) |
| Diabetes | 219 (40.9) | 37 (11.2) |
| Chronic obstructive pulmonary disease | 174 (32.5) | 108 (32.6) |
| Childbirth | 13 (2.4) | 45 (13.6) |
| Heart failure | 23 (4.3) | 52 (15.7) |
| Hip fracture | 68 (12.7) | 24 (7.3) |

**Table 2** The opportunity-based composite score according to clinical condition before and after the first accreditation

| | Before Accreditation 2012 and 2013 | | | After Accreditation 2017 and 2018 | | | | |
|---|---|---|---|---|---|---|---|---|
| | N | Unadjusted Mean (%) | (95% CI)[a] | N | Unadjusted Mean (%) | (95% CI) | Adjusted Difference (%)[b] | (95% CI) |
| Clinical condition | | | | | | | | |
| Stroke and TIA | 27 | 50.9 | (39.9;62.5) | 62 | 69.7 | (62.6;76.7) | 17.6 | (9.7;25.4) |
| Bleeding gastric ulcer | 12 | 36.7 | (26.9;46.5) | 3 | 58.3 | (14.7;100) | 22.5 | (18.9;26.2) |
| Diabetes | 219 | 70.8 | (68.2;73.4) | 37 | 68.2 | (61.0;75.3) | −4.3 | (−6.2; −2.4) |
| COPD | 174 | 15.5 | (11.8;19.2) | 108 | 25.3 | (18.0;32.6) | 14.3 | (5.5;23.1) |
| Childbirth | 13 | 10.2 | (0.0;27.4) | 45 | 38.1 | (27.6;48.6) | 27.9 | (24.8;31.0) |
| Heart failure | 23 | 59.5 | (45.5;72.5) | 52 | 56.1 | (48.2;64.0) | −1.2 | (−4.2;1.7) |
| Hip fracture | 68 | 34.4 | (31.0;37.8) | 24 | 27.7 | (23.6;31.9) | −5.9 | (−8.7; −3.1) |
| Total | 536 | 44.6 | (41.8;47.4) | 331 | 45.0 | (41.6;49.4) | 4.4 | (−0.7;9.6) |

[a]*CI* Confidence interval [b]Adjusted for dependence between observations at patient level and cluster effect at hospital level

receive an epidural or spinal block after accreditation (RR: 4.43; 95% CI: 1.22 to 16.08). Patients with stroke were more likely to be assessed by an occupational therapist (RR: 1.49; 95% CI: 1.02 to 2.16) and by a nutritionist after accreditation (RR: 1.47; 95% CI: 1.09 to 1.99). The greatest improvement was observed for CT/MR angiography in patients with stroke and TIA (RR: 3.32; 95% CI: 1.74 to 6.33). For diabetics, the probability of having a foot examination (RR: 1.18; 95% CI: 1.15 to 1.20), an albuminuria (RR: 1.10; 95% CI 1.03 to 1.19) and blood pressure control (RR: 1.09; 95% CI: 1.02 to 1.17) improved significantly after accreditation. In contrast, the probability of receiving antihypertensive treatment declined after accreditation (RR: 0.85; 95% CI: 0.80 to 0.90). For patients with bleeding gastric ulcer, hemostatic treatment improved (RR: 2.39; 95% CI: 1.43 to 4.02). Patients with heart failure had a greater chance of receiving supervised physical mobilization during their hospitalization (RR: 1.80; 95% CI: 1.77 to 1.83). Yet, the likelihood of being treated with an aldosterone antagonist was lower after accreditation (RR: 0.59; 95% CI: 0.46 to 0.76). Patients with hip fracture had a greater chance of post-surgery mobilization after accreditation (RR: 1.57; 95% CI: 1.00 to 4.45), however the chances of

**Table 3** The proportion of patient pathways who received 100% of the recommended care before and after the first hospital accreditation

| | Before Accreditation 2012 and 2013 | | After Accreditation 2017 and 2018 | | | |
|---|---|---|---|---|---|---|
| | All recommended care (N)[a] | All recommended care (%) | All recommended care (N) | All recommended care (%) | RR[b] (95% CI)[c] | RD[d] (95% CI) |
| Clinical condition | | | | | | |
| Stroke and TIA | 2/27 | 7.4 | 17/62 | 27.4 | 3.69 (0.76; 17.91) | 0.20 (−0.01; 0.41) |
| Bleeding gastric ulcer | 0/12 | 0.0 | 0/3 | 0.0 | – | – |
| Diabetes | 17/219 | 7.8 | 3/37 | 8.1 | 1.04 (0.84; 1.29) | 0.003 (− 0.013; 0.019) |
| COPD | 1/104 | 1.0 | 5/32 | 15.6 | 16.22 (14.54; 18.10) | 0.147 (0.146; 0.148) |
| Childbirth | 0/12 | 0.0 | 0/30 | 0.0 | – | – |
| Heart failure | 5/23 | 21.7 | 5/52 | 9.6 | 0.44 (0.29; 0.66) | -0.12 (−0.25; 0.01) |
| Hip fracture | 0/68 | 0.0 | 0/24 | 0.0 | – | – |
| Total all-or-none | 25/465 | 5.4 | 30/240 | 12.5 | 2.32 (2.03; 2.67) | 0.07[e] (0.05;0.09) |

[a]Number of patient pathways who received 100% of the recommended care according to the clinical condition divided by the number of patient pathways eligible for the care. All patients have a minimum of two relevant process performance measures. [b]*RR* Relative Risk. Adjusted for dependence between observations at patient level and cluster effect at hospital level. [c]*CI* Confidence interval. [d]*RD* Risk difference. Adjusted for cluster effect at hospital level. [e]Adjusted for dependence between observations at patient level and cluster effect at hospital level

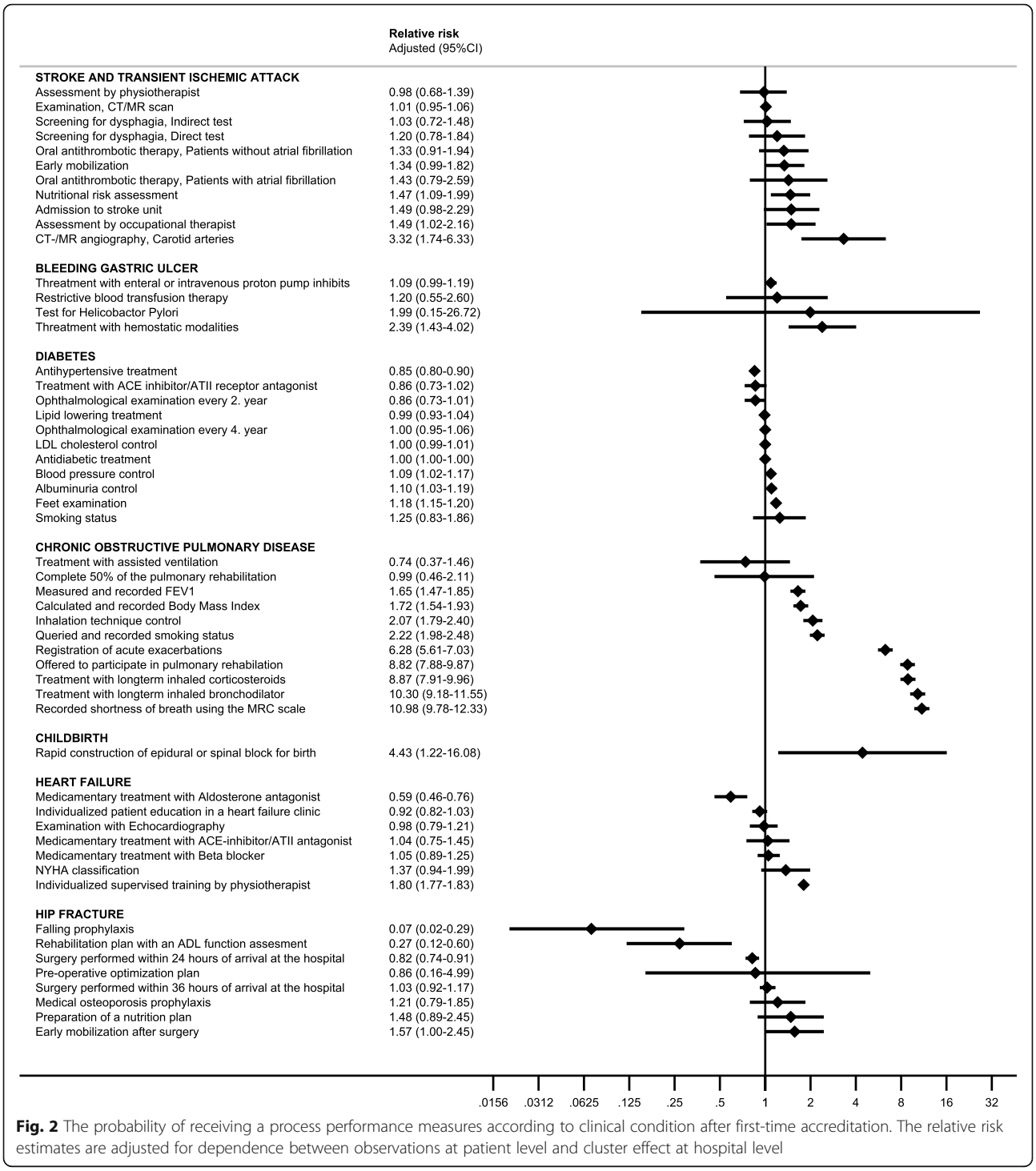


**Fig. 2** The probability of receiving a process performance measures according to clinical condition after first-time accreditation. The relative risk estimates are adjusted for dependence between observations at patient level and cluster effect at hospital level

surgery within 24 h of admission (RR: 0.82; 95% CI: 0.74 to 0.91), a rehabilitation plan (RR: 0.27; 95% CI: 0.12 to 0.60) or fall prophylaxis (RR: 0.07; 95% CI: 0.02 to 0.29) were lower after accreditation (Fig. 2).

## Discussion

To our knowledge, this is the first before and after study of voluntary hospital accreditation in a setting not previously exposed to any systematic quality improvement

initiatives. The unique context offered by the Faroe Islands made it possible to examine this intervention in significant detail. Following first-time accreditation of the Faroe Islands hospitals, hospitals were in general more likely to provide recommended care to patients. The improvement was most evident when the level of care meets all process performance measures, reflecting 'perfect care' (all-or-none). Echoing our findings, a study of U.S. critical access hospitals including 45 states, found that accredited hospitals more often provided their patients with recommended care [38]. Similarly, a recent Danish study [9] found hospitals with high compliance with accreditation standards, were more likely to deliver recommended care in hospitals. Although, the cause and effect relationship in the US study could not be determined, due to the cross-sectional design, these results indicate that accreditation of hospitals is associated with more guideline adherent care and hence improved quality of care to patients in hospitals [39]. In contrast, another Danish study [17] found no difference between accredited and non-accredited hospitals in the delivery of recommended care. Indeed, non-accredited hospitals outperformed accredited hospitals in the overall opportunity-based composite score. There are several possible explanations for these conflicting findings. The hospitals in Denmark and the Faroe Islands were accredited by different accreditation programs. Furthermore, hospitals in Denmark had for several years been subjected to many different quality and safety activities; this could have led to the establishment of high levels of quality of care before introducing accreditation. If so, higher levels of care may have been difficult to improve in Denmark using accreditation [40].

Improvement was, however, not found for all clinical conditions in our study. For instance, the overall quality of care for diabetes, heart failure and hip fracture did not benefit from accreditation. For diabetes, the proportion of patients receiving care in accordance with the process performance measures was already high before accreditation and therefore difficult to improve. These results are consistent with other studies [41, 42]. The unchanged heart failure care and reduced levels of recommended care to patients with hip fractures was surprising, as pre-existing levels of care were below those found in similar studies [9, 17]. One explanation could be that treating physicians might have considered some of the recommended care not applicable for the patient, however such a decision should have been documented in the medical record. Another explanation could be that accreditation does not affect the delivery of recommended care in all clinical conditions the same way and at the same speed. Similar results were found in a study from Saudi Arabia [43].

Patients with COPD received significantly more recommended care following first-time accreditation in our study. It is not clear why there was such a substantial improvement, but the recruitment of a specialist in respiratory medicine, employed at the National Hospital in 2016 could explain a part of the progress, however a single specialist being able to raise the quality of treatment so markedly for all COPD patients in all hospitals over a short period seems unrealistic. Also, patients hospitalized with pulmonary diseases were after accreditation moved from a general medical department to a specialized department for heart and lung patients. We cannot know whether this reorganization have affected the delivery of recommended care to COPD patients. Regardless, the improvement is important for this patient group, as they often entail higher socioeconomic costs and in general have a poor survival rate compared to those with many other clinical conditions [43–45]. We also found, when viewing all seven clinical conditions combined, that patients had a greater chance of receiving all recommended care after accreditation. An improvement in the all-or-none score is a great achievement for any hospital. High scores often emphasize that a hospital can handle the most challenging care problems [46]. Existing literature has found that improvements in all-or-none scores are associated with better patient outcomes [47, 48].

Interestingly, the overall level of recommended care before and after accreditation was below 50% which is lower than in other countries [9, 49, 50]. This may be explained by several factors, including a possible lack of specialized doctors, monitoring, no systematic quality improvement activities, and minimal transparency related to the level of care delivered in the Faroese hospitals. Hence, it is difficult to foster improvements if clinicians have no or very little knowledge about the levels of care being delivered. In such a context, it is not surprising that the overall effects of the first-time accreditation were modest. More profound changes and repeated cycles of accreditation and other quality initiatives are probably needed to achieve larger improvements. Countries with several cycles of accreditation and other ongoing quality improvement strategies including disclosure about performance have been found to deliver a higher levels of recommended care over time [9, 49–51].

While the accreditation preparation process can be a critical step through which accreditation can have an impact, it can also pose some challenges. Experiences related to the process has been investigated in a number of studies [52–54]. A Danish study, interviewing staff from Danish public hospitals, found that the implementation process, especially in relation to the first accreditation cycle, was chaotic and characterized by

uncertainly. Moreover, staff experienced being imposed to heavy administrative workloads of which the main task was to development and implement new guidelines [52]. In relation to the Faroe Islands first accreditation cycle, not all patients appeared to benefit from accreditation which may be explained the Faroese implementation process. The hospital had never prior participated in any systematic quality improvement activities and staff had to develop and implement of a large share of new guidelines, and at the same time monitor and study changes and act if the quality of care was considered inadequate. The heavy workload and new tasks may have been a contributing factor to the lack of consistent improvements across all diagnostic groups. Previous studies have reported that the implementation process is a period with less time and focus on patient care and many preparations may be performed at the expense of other tasks [52–54]. Moreover, the process may include unnecessary documentation and bureaucracy resulting in lower quality of services [54]. Although there are no detailed descriptions on how an accreditation model should be implemented to make the task worthwhile, there is some evidence that the process should be meaningful to the people in charge of the implementation [52]. A Canadian study found that the process become easier over time and the greatest benefits was related to second to fourth accreditation cycle. After 10 years of accreditation is likely to be a less challenging task [55].

As to the strengths to this study, firstly, the process performance measures used to collect data were developed by expert groups with extensive knowledge of the clinical conditions. Secondly, all the data were collected in relation to the hospitals' first-time accreditation and therefore created a benchmark. Additionally, all data were collected by Faroese medical students with a local contextual knowledge. One of the medical students participated in both data collections to ensure uniformity. To ensure objectivity, data collections and analyses was performed by different people. These factors minimize the risk of information bias. However, we cannot exclude the risk of information bias. If changes in documentation practices occurred between the pre-and post-accreditation period, this could potentially have biased our analyses. Also, patients exposed to low quality of care could at least in theory also have been exposed to deficient documentation practices, which could have made it difficult for the data collectors to find the necessary information in the medical record and therefore to include the patient. In such cases, this could have led us to potentially overestimate the effect of accreditation, as the observed change in quality of care after accreditation could also reflect a change in documentation practices. Accreditation speaks to a systematic improvement of many workflows so we cannot dismiss information bias, although there is no immediate evidence to suggest this, as far more records were excluded in the patient inclusion process after accreditation due to errors compared with the period before accreditation.

The limitations included a moderate statistical precision and lack of an external control group. We aimed to include 601 patient records both before and after the accreditation. Yet due to many childbirths delivered without need of epidural or spinal block and/or acute cesarean section, we did not include the planned number of patients and it was not possible for legal and administrative reasons to compensate for the larger than expected number of patients without relevant process performance measures. The small sample size could potentially limit the generalizability of the study results. The risk of selection bias was likely small in this study as the included patients represent a random sample both before and after accreditation. Furthermore, the preparation of the list of patients for possible inclusion was performed by an administrative employee of the National Hospital who was not affiliated with the project and did not know the purpose of the research project. Before the patient sample was presented to the data collectors, patients' appearance on the list was reassigned using the random function in excel, making sure that all patients had the same chance of being included. The risk of confounding is, as always in observational studies, also a possible cause of concern. However, we addressed the potential confounding by conducting stratified analyzes for each clinical condition as well as for individual process performance measures. Highly specific in- and exclusion criteria for each clinical condition and the included process performance measures ensured the eligibility of the patients and thereby comparability of the clinical needs in all analyzes. Adjusting for confounding factors would thus not give a reflection of true differences in the quality of care according to the definition of the performance measures but could potentially mask such differences. As this study did not include a control group, we cannot be sure that the changes in recommended care can be attributed to the first-time accreditation itself. However, the hospitals had not before or during the implementation of the accreditation model been subjected to any kind of systematic quality improvement initiatives or large structural changes. Thus, it is theoretically safe to assume, that the intervention contributed to the changes in recommended care. Additional support for this hypothesis could potentially have been obtained if a more systematic monitoring of the quality of care had been performed during the accreditation process rather than just the before and after assessment. Finally, the risk of chance findings should be considered as the statistical precision was modest in some of the analyzed subgroups. We did not correct for

multiple testing as it is not routinely recommended as it will lead to fewer errors of interpretation when the data under evaluation are not random numbers but actual observations on nature [56]. Moreover, the study hypotheses are mutually supportive if results are pointing in the same direction, thus, allowing us to observe an overall pattern.

The results from this study contribute to the sparse knowledge about the association between accreditation and the delivery of recommended care in hospitals. Whilst accreditation is an externally driven compliance activity and therefore not necessarily focused on bottom-up quality improvements, our results show that it can impact on the level of evidence-based and guideline adherent care delivered to patients. In terms of generalizability and transferability, the results from this study can be understood and transferred to patients and hospitals elsewhere. All patients included were treated for common clinical conditions in hospital settings very similar to hospitals in other high-income countries. However, it is conceivable that transferability is strongest to healthcare systems that have not completed several rounds of accreditation and participated in years of systematic quality improvement activities. The fact that we did not find stronger associations between accreditation and the delivery of recommended care, could partly be explained by the Islands' early stage of a quality improvement culture. First-time accreditation in the Faroe Islands has most likely affected many other areas of care than addressed in the current study. Further research is recommended to determine the impact of accreditation on other clinical conditions, patients' outcomes and in different contexts.

## Conclusion

Accreditation was found to be associated with the delivery of more recommended care in hospitals never previously exposed to systematic quality and safety initiatives including accreditation. Especially patients with COPD, received significantly more recommended care after accreditation. However, the overall improvement of process performance measures was modest.

### Abbreviations

COPD: Chronic Obstructive Pulmonary Disease; RR: Relative Risk; IKAS: The Danish Institute for Quality and Accreditation in Healthcare; DDKM: The Danish Healthcare Quality program; RKKP: The Danish Clinical Quality Program – National Clinical Registries; TIA: Transient Ischemic Attack; RD: Risk Difference

## Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12913-021-06952-w.

**Additional file 1.**

**Additional file 2.**

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### Authors' contributions

MDB, AMFJ, PH, JB, CVP and SPJ designed the study. The implementation of the data collections was coordinated by MDB and managed by GG, BJE and TR. Statistical analyzes were exclusively carried out by MDB in collaboration with statistician JBV. All authors read and approved the final manuscript.

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### Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to the privacy of the individuals that participated in the study. According to Danish law, access to data can only be granted by applying the National hospital in the Faroe Islands, the Danish Data Protection Agency, the Faroese Data Protection Agency and the Danish Patient Safety Authority.

## Declarations

### Ethics approval and consent to participate

According to Danish and Faroese law, the study did not need any ethics approval (J # 16018707) as approval from the Ethics Committee is only required if human biological material is included in the project. Access to patient data in medical records must be approved by the Danish Patient Safety Authority. The study was approved by the Danish Data Protection Agency (J # 2012-58-0004), the Faroese Data Protection Agency (J # 16/00135–12) and the Danish Patient Safety Authority (J # 3–3013-1648/1). Patient consent was not required. All methods were carried out in accordance with relevant guidelines and regulations.

### Consent for publication

Not required.

### Competing interests

The authors declare that they have no competing interests.

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## References

1. Mainz J, Hansen AM, Palshof T, Bartels PD. National quality measurement using clinical indicators: the Danish National Indicator Project. J Surg Oncol. 2009;99(8):500–4.
2. Mainz J, Kristensen S, Bartels P. Quality improvement and accountability in the Danish health care system. Int J Qual Health Care. 2015;27(6):523–7.
3. White CM, Thomson JE, Statile AM, Auger KA, Unaka N, Carroll M, et al. Development of a new care model for hospitalized children with medical complexity. Hosp Pediatr. 2017;7(7):410–4.
4. Grol R. Successes and failures in the implementation of evidence-based guidelines for clinical practice. Med Care. 2001;39(8 Suppl 2):II46–54.
5. Sungkar Y, Considine J, Hutchinson A. Implementation of guidelines for sepsis management in emergency departments: a systematic review. Australas Emerg Care. 2018;21(4):111–20.
6. Bernstein J. Evidence-based medicine. J Am Acad Orthop Surg. 2004;12(2):80–8.
7. Pronovost PJ, Berenholtz SM, Goeschel C, Thom I, Watson SR, Holzmueller CG, et al. Improving patient safety in intensive care units in Michigan. J Crit Care. 2008;23(2):207–21.
8. Siegfried A, Heffernan M, Kennedy M, Meit M. Quality improvement and performance management benefits of public health accreditation: National Evaluation Findings. J Public Health Manag Pract. 2018;24(Suppl 3):S3–s9.
9. Falstie-Jensen AM, Bogh SB, Hollnagel E, Johnsen SP. Compliance with accreditation and recommended hospital care-a Danish nationwide population-based study. Int J Qual Health Care. 2017;29(5):625–33.
10. Falstie-Jensen AM, Larsson H, Hollnagel E, Norgaard M, Svendsen ML, Johnsen SP. Compliance with hospital accreditation and patient mortality: a Danish nationwide population-based study. Int J Qual Health Care. 2015;27(3):165–74.
11. Pronovost PJ, Watson SR, Goeschel CA, Hyzy RC, Berenholtz SM. Sustaining reductions in central line-associated bloodstream infections in Michigan intensive care units: a 10-year analysis. Am J Med Qual. 2016;31(3):197–202.
12. Patterson CH. Joint commission on accreditation of healthcare organizations. Infect Control Hosp Epidemiol. 1995;16(1):36–42.
13. Roberts JS, Coale JG, Redman RR. A history of the joint commission on accreditation of hospitals. JAMA. 1987;258(7):936–40.
14. Joint Commission International. https://www.jointcommissioninternational.org/. Accessed 24 June 2021.
15. Flodgren G, Goncalves-Bradley DC, Pomey MP. External inspection of compliance with standards for improved healthcare outcomes. Cochrane Database Syst Rev. 2016;12(12):CD008992.
16. Hinchcliff R, Greenfield D, Moldovan M, Westbrook JI, Pawsey M, Mumford V, et al. Narrative synthesis of health service accreditation literature. BMJ Qual Saf. 2012;21(12):979–91.
17. Bogh SB, Falstie-Jensen AM, Bartels P, Hollnagel E, Johnsen SP. Accreditation and improvement in process quality of care: a nationwide study. Int J Qual Health Care. 2015;27(5):336–43.
18. Alkhenizan A, Shaw C. Impact of accreditation on the quality of healthcare services: a systematic review of the literature. Ann Saudi Med. 2011;31(4):407–16.
19. Greenfield D, Braithwaite J. Health sector accreditation research: a systematic review. Int J Qual Health Care. 2008;20(3):172–83.
20. Brubakk K, Vist GE, Bukholm G, Barach P, Tjomsland O. A systematic review of hospital accreditation: the challenges of measuring complex intervention effects. BMC Health Serv Res. 2015;15:280.
21. Shaw CD, Groene O, Botje D, Sunol R, Kutryba B, Klazinga N, et al. The effect of certification and accreditation on quality management in 4 clinical services in 73 European hospitals. Int J Qual Health Care. 2014;26(Suppl 1):100–7.
22. Mumford V, Forde K, Greenfield D, Hinchcliff R, Braithwaite J. Health services accreditation: what is the evidence that the benefits justify the costs? Int J Qual Health Care. 2013;25(5):606–20.
23. Mumford V, Greenfield D, Hogden A, Forde K, Westbrook J, Braithwaite J. Counting the costs of accreditation in acute care: an activity-based costing approach. BMJ Open. 2015;5(9):e008850.
24. Rockwell DA, Pelletier LR, Donnelly W. The cost of accreditation: one hospital's experience. Hosp Community Psychiatry. 1993;44(2):151–5.
25. World Bank Open Data. https://data.worldbank.org/country/faroe-islands. Accessed 24 June 2021.
26. Statistics Faroe Islands. https://hagstova.fo/en/population/population/population. Accessed 24 June 2021.
27. Introduction to DDKM. https://www.ikas.dk/den-danske-kvalitetsmodel/ddkm-in-english/introduction-to-ddkm/. Accessed 24 June 2021.
28. Akkrediteringsstandarder for de færøske sygehuse. https://www.ikas.dk/deltagere-i-ddkm/faeroeske-sygehuse/. Accessed 24 June 2021.
29. Regionernes kliniske kvalitetsudviklingsprogram. https://www.rkkp.dk/inenglish/. Accessed 24 June 2021.
30. Johnsen SP, Ingeman A, Hundborg HH, Schaarup SZ, Gyllenborg J. The Danish stroke registry. Clin Epidemiol. 2016;8:697–702.
31. Lange P, Tøttenborg SS, Sorknæs AD, Andersen JS, Søgaard M, Nielsen H, et al. Danish register of chronic obstructive pulmonary disease. Clin Epidemiol. 2016;8:673–8.
32. Jørgensen ME, Kristensen JK, Reventlov Husted G, Cerqueira C, Rossing P. The Danish adult diabetes registry. Clin Epidemiol. 2016;8:429–34.
33. Schjødt I, Nakano A, Egstrup K, Cerqueira C. The Danish heart failure registry. Clin Epidemiol. 2016;8:497–502.
34. Bliddal M, Broe A, Pottegård A, Olsen J, Langhoff-Roos J. The Danish medical birth register. Eur J Epidemiol. 2018;33(1):27–36.
35. REDCap. https://projectredcap.org/. Accessed 24 June 2021.
36. McHugh ML. Interrater reliability: the kappa statistic. Biochem Med (Zagreb). 2012;22(3):276–82.
37. Shwartz M, Restuccia JD, Rosen AK. Composite measures of health care provider performance: a description of approaches. Milbank Q. 2015;93(4):788–825.
38. Lutfiyya MN, Sikka A, Mehta S, Lipsky MS. Comparison of US accredited and non-accredited rural critical access hospitals. Int J Qual Health Care. 2009;21(2):112–8.
39. Woolf SH, Grol R, Hutchinson A, Eccles M, Grimshaw J. Clinical guidelines: potential benefits, limitations, and harms of clinical guidelines. BMJ. 1999;318(7182):527–30.
40. Bogh SB, Falstie-Jensen AM, Hollnagel E, Holst R, Braithwaite J, Johnsen SP. Improvement in quality of hospital care during accreditation: a nationwide stepped-wedge study. Int J Qual Health Care. 2016;28(6):715–20.
41. Devkaran S, O'Farrell PN. The impact of hospital accreditation on quality measures: an interrupted time series analysis. BMC Health Serv Res. 2015;15:137.
42. Bogh SB, Falstie-Jensen AM, Hollnagel E, Holst R, Braithwaite J, Raben DC, et al. Predictors of the effectiveness of accreditation on hospital performance: a nationwide stepped-wedge study. Int J Qual Health Care. 2017;29(4):477–83.
43. Lokke A, Hilberg O, Kjellberg J, Ibsen R, Jennum P. Economic and health consequences of COPD patients and their spouses in Denmark--1998-2010. COPD. 2014;11(3):237–46.
44. Tottenborg SS, Thomsen RW, Nielsen H, Johnsen SP, Frausing Hansen E, Lange P. Improving quality of care among COPD outpatients in Denmark 2008-2011. Clin Respir J. 2013;7(4):319–27.
45. Løkke A, Hilberg O, Tønnesen P, Ibsen R, Kjellberg J, Jennum P. Direct and indirect economic and health consequences of COPD in Denmark: a national register-based study: 1998-2010. BMJ Open. 2014;4(1):e004069.
46. Nolan T, Berwick DM. All-or-none measurement raises the bar on performance. JAMA. 2006;295(10):1168–70.
47. Ingeman A, Pedersen L, Hundborg HH, Petersen P, Zielke S, Mainz J, et al. Quality of care and mortality among patients with stroke: a nationwide follow-up study. Med Care. 2008;46(1):63–9.
48. Nielsen KA, Jensen NC, Jensen CM, Thomsen M, Pedersen L, Johnsen SP, et al. Quality of care and 30 day mortality among patients with hip fractures: a nationwide cohort study. BMC Health Serv Res. 2009;9:186.
49. McGlynn EA, Asch SM, Adams J, Keesey J, Hicks J, DeCristofaro A, et al. The quality of health care delivered to adults in the United States. N Engl J Med. 2003;348(26):2635–45.
50. Runciman WB, Hunt TD, Hannaford NA, Hibbert PD, Westbrook JI, Coiera EW, et al. CareTrack: assessing the appropriateness of health care delivery in Australia. Med J Aust. 2012;197(2):100–5.

51. Braithwaite J, Hibbert PD, Jaffe A, White L, Cowell CT, Harris MF, et al. Quality of health Care for Children in Australia, 2012-2013. JAMA. 2018; 319(11):1113–24.
52. Bogh SB, Blom A, Raben DC, Braithwaite J, Thude B, Hollnagel E, et al. Hospital accreditation: staff experiences and perceptions. Int J Health Care Qual Assur. 2018;31(5):420–7.
53. Chiu A, Seto WH, Lai L. Journey of a Hong Kong public teaching hospital in preparation of hospital accreditation. Hong Kong Med J. 2011;17(3):231–6.
54. Vali L, Mehrolhasani MH, Mirzaei S, Oroomiei N. Challenges of implementing the accreditation model in military and university hospitals in Iran: a qualitative study. BMC Health Serv Res. 2020;20(1):698.
55. Pomey MP, Lemieux-Charles L, Champagne F, Angus D, Shabah A, Contandriopoulos AP. Does accreditation stimulate change? A study of the impact of the accreditation process on Canadian healthcare organizations. Implement Sci. 2010;5:31.
56. Rothman KJ. No adjustments are needed for multiple comparisons. Epidemiology. 1990;1(1):43–6.

## Publisher's Note

**Additional file 1. Process performance measures, time frame criteria and diagnostic codes (ICD-10, version 2016)**

| Process performance measures (diagnosis codes) | Time frame criteria |
|---|---|
| **Stroke and TIA** (I61, I63, I64, G45) | |
| Door-to-needle time, thrombolysis treatment for acute ischemic stroke | 1 hour after arrival to the thrombolysis unit |
| Admission to stroke unit, acute stroke | Second day of hospitalization |
| Oral antithrombotic therapy initiated:<br>Antiplatelet therapy for acute ischemic stroke without atrial fibrillation<br>Antiplatelet therapy for TIA without atrial fibrillation<br>Oral anticoagulant therapy for acute ischemic stroke with atrial fibrillation<br>Oral anticoagulant therapy for TIA with atrial fibrillation | <br>Second day of hospitalization<br>Second day after first contact with a hospital<br>14th day of hospitalization<br>14th day after first contact with a hospital |
| Examination, CT/MR scan: - Acute stroke<br>- TIA | 6 hours after hospitalization<br>6 hours after first contact with a hospital |
| Assessment by a physiotherapist, acute stroke | Second day of hospitalization |
| Assessment by an occupational therapist, acute stroke | Second day of hospitalization |
| Early mobilization, acute stroke | First day of hospitalization |
| Nutritional risk assessment, acute stroke | Second day of hospitalization |
| Screening for dysphagia, acute stroke. Indirect test | First day of hospitalization |
| Screening for dysphagia, acute stroke. Direct test | First day of hospitalization |
| Examination of carotid arteries with ultrasound CT-/MR angiography: - Acute ischemic stroke<br>- TIA | 4th day of hospitalization<br>4th day of hospitalization |
| **Bleeding gastric ulcer** (K25.0, K25.4, K26.0, K26.4, K27.0, K27.4) | |
| Treatment of affected circulation | ≤ 60 minutes |
| Endoscopy: 1. Patient just arrived at the hospital<br>2. Hospitalized patient | ≤ two hours after arrival at the hospital<br>≤ two hours after examination by surgeon |
| Directly transferred to an operating/endoscopy theater due to sustained affected circulation | Immediately |
| Restrictive blood transfusion therapy | Hemoglobin ≥ 4.3 mM |
| Risk stratification, Rockall score | Before the end of the gastroscopy |
| Treatment with adrenaline-saline injection and another hemostatic modality | During endoscopy |
| Treatment with enteral or intravenous proton pump inhibitor | During hospitalization |
| Test for Helicobacter Pylori | During hospitalization or a scheduled test after discharge |
| **Diabetes** (E10 - E10.9, E11 - E11.9, E13 - E13.9, E14 - E14.9) | |
| Antidiabetic treatment initiated, Patients (Type 2 diabetes) with a HbA1c ≥ 75 mmol/mol | Every year |
| Blood pressure control | Every year |
| Antihypertensive treatment initiated, Blood pressure > 140/90 | Every year |
| LDL cholesterol control, Patients ≥ 30 years | Every second year |
| Lipid lowering treatment initiated, Patients (Type 2 diabetes) ≥ 40 years with LDL cholesterol > 2.5 | Every year |
| Albuminuria control | Every second year |
| Treatment with ACE inhibitor / ATII receptor antagonist, Patients with micro- or macroalbuminuria | Every year |

| | |
|---|---|
| Ophthalmological examination | Every second year |
| Ophthalmological examination | Every fourth year |
| Feet examination | Every second year |
| Smoking status | Every year |
| Call for smoking cessation, Patients who are smoking or recently stopped smoking | Every year |
| **Chronic obstructive pulmonary disease (COPD)**<br>(Outpatient: J44 or J96 including secondary diagnosis J44); (Inpatient: J44 or J96, J13 - J18 including secondary diagnosis J44) | |
| Measured and recorded $FEV_1$, Outpatient | Every year |
| Calculated and recorded Body Mass Index, Outpatient | Every year |
| Measured and recorded shortness of breath using the MRC scale, Outpatient | Every year |
| Queried and recorded smoking status, Outpatient | Every year |
| Offered to participate in pulmonary rehabilitation, Patients with MRC-level ≥ 3, Outpatient | Every second year |
| Implementation of 50 % of the pulmonary rehabilitation in the hospital, Outpatient | Every year |
| Treatment with long-term inhaled bronchodilator either as LAMA or LABA, Patients with MRC level ≥ 2, Outpatient | Every year |
| Treatment with ICS, Patients with MRC level ≥ 2, treated with long-term inhaled bronchodilator, $FEV_1$ < 50 % of expected value, Outpatient | Every year |
| Inhalation technique control, Patients treated with inhalation medicine, Outpatient | Every year |
| Registration of acute exacerbations pr. year, Outpatient | Every year |
| Treatment with assisted ventilation (NIV), Hospitalized patients with acute exacerbation, Inpatient | Every year |
| **Childbirth** (O80.0 - O84.9) | |
| Construction of epidural or spinal block for birth | ≤ 1 hour from ordering |
| Emergency caesarean section grade 1 | Baby born < 15 minutes from ordering |
| Emergency caesarean section grade 2 | Baby born < 30 minutes from ordering |
| **Heart failure** (I11.0, I13.0, I13.2, I42.0, I42.6, I42.7, I42.9, I50.0, I50.1, I50.9) | |
| Examination, Echocardiography | 6 months before and no later than 7 weekdays after admission/initiation of outpatient treatment |
| NYHA classification | At the first discharge/first outpatient visit or within the first 12 weeks of their illness |
| Treatment with ACE-inhibitor/ATII-receptor antagonist, Patients with a reduced systolic function LVEF ≤ 40% | Start treatment no later than 8 weeks after admission/first outpatient visit |
| Treatment with Beta blocker, Patients with LVEF ≤ 40% | Start treatment no later than 12 weeks after admission/first outpatient visit |
| Treatment with Aldosterone antagonist, Patients with LVEF ≤ 35% | Start treatment no later than 12 weeks after admission/first outpatient visit |
| Individualized supervised exercise training by physiotherapist in the hospital, or referred to training in a community setting, Patients with LVEF ≤ 40% | No later than 12 weeks after admission/initiation of outpatient treatment |
| Initiate an individualized patient education during follow-up in a heart failure clinic | No later than 12 weeks after admission/initiation of outpatient treatment |

**Additional file 2**. The proportion of patient pathways who received 100% of the recommended care before and after the first hospital accreditation

| | Before accreditation 2012 and 2013 | | After accreditation 2017 and 2018 | | | |
|---|---|---|---|---|---|---|
| | All recommended care (N)* | All recommended care (%) | All recommended care (N) | All recommended care (%) | RR¶ (95% CI)† | RD§ (95% CI) |
| Clinical condition | | | | | | |
| Stroke and TIA | 2/27 | 7.4 | 17/62 | 27.4 | 3.69 (0.76;17.91) | 0.20 (-0.01;0.41) |
| Bleeding gastric ulcer | 0/12 | 0.0 | 0/3 | 0.0 | - | - |
| Diabetes | 17/219 | 7.8 | 3/37 | 8.1 | 1.04 (0.84;1.29) | 0.003 (-0.013;0.019) |
| COPD | 6/174 | 3.5 | 9/108 | 8.3 | 2.41 (1.31;4.46) | 0.05 (0.01;0.09) |
| Childbirth | 1/13 | 7.7 | 9/45 | 20.0 | 2.59 (1.93;3.49) | 0.12 (0.09;0.15) |
| Heart failure | 5/23 | 21.7 | 5/52 | 9.6 | 0.44 (0.29;0.66) | -0.12 (-0.25;0.01) |
| Hip fracture | 0/68 | 0.0 | 0/24 | 0.0 | - | - |
| Total all-or-none | 31/536 | 5.8 | 43/331 | 13.0 | 2.32 (2.31;2.34) | 0.08* (0.04;0.11) |

*Number of patient pathways who received 100% of the recommended care according to the clinical condition divided by the number of patient pathways eligible for the care. No restrictions to the number of relevant process performance measures. ¶RR, Relative Risk. Adjusted for dependence between observations at patient level and cluster effect at hospital level. †CI, confidence interval. §RD, Risk difference. Adjusted for cluster effect at hospital level. *Adjusted for dependence between observations at patient level and cluster effect at hospital level.

Patients experience more support, information and involvement after first-time hospital accreditation: a before and after study in the Faroe Islands

PAPER II

**Patients experience more support, information and involvement after first-time hospital accreditation: a before and after study in the Faroe Islands**

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**ABSTRACT**

**Background** The impact of hospital accreditation on the experiences of patients remains a weak point in quality improvement research. This is surprising given the time and cost of accreditation and the fact that patient experiences influence outcomes. We investigated the impact of first-time hospital accreditation on patients' experience of support from healthcare professionals, information and involvement in decisions.

**Methods** We conducted a longitudinal study in the three Faroese hospitals that unlike hospitals on the Danish mainland and elsewhere internationally, had no prior exposure to systematic quality improvement activities. The hospitals were accredited in 2017 according to a modified second version of the Danish Healthcare Quality program. Study participants were 18 years or older and hospitalized for at least 24 hours in 2016 before or 2018 after accreditation. We administered the National Danish Survey of Patient Experiences for acute and scheduled hospitalization. Patients rated their experiences of support, information and involvement in decision-making on a 5-point Likert scale. We calculated individual and grouped mean item scores, the percentages of scores ≥4, the mean score difference, the relative risk (RR) for high/very high scores (≥4) using Poisson regression and the risk difference (RD). Patient experience ratings were compared using mixed effects linear regression.

**Results** In total, 400 patients before and 400 after accreditation completed the survey. After accreditation patients experienced more support; adjusted mean score difference (adj. mean diff.)= 1.99 (95%CI: 1.89, 2.10), more information before and during hospitalization; adj. mean diff.= 1.14 (95%CI: 1.07, 1.20) and more involvement in decision-making; adj. mean diff.= 1.79 (95%CI: 1.76, 1.82). Additionally, the RR for a high/very high score (≥4) was significantly greater on 15 of the 16 questionnaire items. The greatest RR for a high/very high score (≥4) after accreditation, was found for the item "Have you had a dialogue with the staff about the advantages and disadvantages of the examination/treatment options available?" RR= 5.73 (95%CI: 4.51, 7.27).

**Conclusion** Hospitalized patients experienced significantly more support from health professionals, information and involvement in decision-making after accreditation. Future research on accreditation should include the patient perspective.

## INTRODUCTION

The impact of hospital accreditation on patients' experiences remains poorly understood in quality improvement research [1, 2]. This is surprising given the amount of time and money spent on accreditation in times that require strict prioritization of constrained resources to achieve the best for patients [3]. Accreditation has been associated with shorter length of stay [4, 5] and lower mortality [6, 7] both valid dimensions of the quality of hospital care, but accreditation programs do not always include the perspective of patients.

A notable exception to the scarcity of patient centered accreditation research is the study of patient experiences [2, 8-15]. These experiences offer insight into patients´ satisfaction with staff and care. Moreover, they illustrate expectations concerning hospitalization, treatment and communication with healthcare professionals. However, it has proven difficult to document clear effects of accreditation on the experiences of patients. Four recent studies found no relationships between accreditation and patient satisfaction [8-11] and another was inconclusive [2]. Most of these studies were cross sectional, comparing accredited with non-accredited hospitals [10, 11] or hospitals with different accreditation status [8]. The main outcomes were recommendation rate of a hospital after discharge [9, 11] or ratings of service quality [8, 10]. Yet, cross-sectional designs only permit a momentary, snapshot picture of the complex changes of accreditation. Furthermore, these studies did not focus on patients´ experiences in relation to their own illness and treatment during hospitalization.

We propose patient experience of communication, involvement and participation in decisions as a focus for studying the effects of hospital accreditation on patients. Experience is strongly influenced by communication between patients and clinicians [16]. Tailored and effective communication have been found to reduce the numbers of examinations before diagnosis and initiation of treatment [16, 17]. Also, support from staff helps patients to cope with difficult and complicated processes during hospitalization [18]. Importantly, patients who experience being informed and involved in decisions about their health more often adhere to recommendations, treatment and follow-up [19, 20]. Thus communication not only largely determines patient experience, but can also have an impact on outcomes [20].

The Faroe Islands present a unique opportunity to study accreditation under conditions of very limited quality improvement experience. Quality improvement programs had not taken place before first-time hospital accreditation in February 2017. Thus, our aim was to investigate the changes in patient experiences after first-time hospital accreditation in this setting.

Based on past literature we hypothesized that patients treated in hospitals after they had undergone accreditation would experience more support, information and involvement in decision-making during hospitalization compared to patients treated in the hospitals before accreditation.

## METHODS

### Context

The Faroe Islands in the North Atlantic Ocean have a population of around 53,000 [21]. They are an independent territory of the Kingdom of Denmark and are classified as a high-income country [22]. The three public hospitals are: The National Hospital, Klaksvik hospital and Suderø hospital. Faroese citizens have free access to treatment in hospitals.

### Study design

We designed a before and after study of patient experiences in connection with the first-time accreditation of the Faroese hospitals. We used two validated Danish questionnaires for acute and scheduled hospitalizations [23, 24]. Since the year 2000, the questionnaires have been used regularly for assessing patients' experiences of Danish healthcare [25].

### Intervention

The intervention was first-time hospital accreditation in the three hospitals. The accreditation was performed by the Danish Institute for Quality and Accreditation in Healthcare (IKAS) [26] using a modified second version of the Danish Healthcare Quality program (DDKM) [27]. The accreditation program was modified collaboratively with local stakeholders to ensure that the model was fit for purpose in the Faroese healthcare system. The modified DDKM comprised 76 hospital standards. The hospitals were accredited by a team of experienced and trained Danish surveyors who assessed whether the hospitals were compliant with all standards through observations, interviews with staff and review of documents and medical records. All three hospitals voluntarily participated and achieved accreditation in 2017.

### Patient inclusion

We included patients 18 years or older who were hospitalized for at least 24 hours in one of the Faroe Islands hospitals during 7 July to 8 October, 2016 (before accreditation) and 16 June to 21 August, 2018 (after accreditation). They had to understand spoken and written Faroese, Danish or English. Patients who were not able to sign informed consent and/or were too ill were excluded.

Patients were sampled randomly from medical, surgical and mixed medical / surgical wards. Before inclusion the data collector (MDB) inquired with the staff which patients could be included according to the inclusion criteria. All eligible patients received a brief description of the project and if they wished to participate, they signed a letter of informed consent.

**Questionnaires**

Patients responded to the entire questionnaire of 40 items for acute and scheduled hospitalization respectively [24]. However, we only included 3 dimensions with 16 associated items in the final analyses that the accreditation model reasonably could have affected. The three dimensions consisted of 15 items for acute hospitalization and 14 items for scheduled hospitalization with 13 common items. The items were rated on a 5-point Likert scale ranging from 1 (Not at all) to 5 (To a very high degree). High scores indicated a higher degree of satisfaction with care during hospitalization. Scores were calculated for each item and for each dimension of care. As the last items for both acute and scheduled hospitalization "Do you to an appropriate extent participate in making decisions about your examination/treatment?" only included the ability to respond "yes" or "no", we recoded the answer "yes" equal to a 5 point and the answer "no" equal to a 1 point on the 5-point Likert scale, thus preserving item weight when summarizing the corresponding dimension. The answers "do not know" and "not relevant to me" were not included in any of the analyses. See Appendix 1 for items included for scheduled hospitalization, Appendix 2 for acute hospitalization and Appendix 3 for a juxtaposition of questionnaire items and accreditation standards.

**Data collection**

The data collector (MDB) completed both data collections sitting next to the patient's bed or with the patient in a waiting area or room. Dimensions and items were read out loud and all responses recorded in the questionnaire. Each patient spent approximately 40 minutes completing a questionnaire. All data from the questionnaire survey were collected on paper and subsequently entered into a REDCap database [28]. Data from all 800 patients were entered twice by different researchers to ensure accuracy of data transfer from paper to the database.

**Statistical analysis**

We used StataSE, version 14.2. (StataCorp, 2015. College Station, TX: StataCorp LLC) to analyze all the data. Two-sided tests with a significance level of 5% were used in all analyses.

Descriptive statistics were presented as frequencies and percentages for categorical variables and as means, min/max, median and interquartile range (IQR) for continuous variables, where appropriate. All characteristics were stratified by before and after accreditation.

The score of each item and dimension was presented as a mean with 95% confidence interval (CI) and as percentages for scores ≥4. The score of each dimension was calculated as the average over included items. To account for possible heterogeneity between hospitals, the before and after accreditation adjusted mean difference, was estimated with mixed effect linear regression with a random intercept at hospital level.

We estimated the relative risk (RR) with 95% CI for a score ≥4 for each item and each dimension with Poisson regression with robust variance. Results from the RR analyses are available in Appendix 4 and 5. The risk difference (RD) with 95% CI for a score ≥4 for each item and all dimensions was calculated using linear regression. In all analyses, we used mixed effect models with a random intercept at hospital level to adjust for within hospital dependence. To account for confounding, we included age, sex, level of education, previous hospitalization and type of hospitalization in the calculation of adjusted RR and RD as well as mean difference analyses.

## RESULTS

### Patient characteristics

During the inclusion period before accreditation (27/7 to 08/10-2016) 465 patients and after (16/6 to 21/8-2018) 448 patients fulfilled the inclusion criteria. During both periods 400 patients participated corresponding to a participation rate of 89% (800/903). Before accreditation, 65 patients were unable to participate due to their medical condition, one refused, and one was a minor. After accreditation 48 patients were unable to participate, two were minors and five refused.

The characteristics of the patients before and after accreditation were very similar, with only slightly more men (52%) than women (48%) before accreditation versus (50%) men and (50%) women after accreditation. Most hospitalizations were acute during both surveys (81% versus 82%), of which more patients before accreditation had been admitted more than once (43% versus 29%), while fewer before accreditation had not been admitted previously (40% versus 53%). On average, patients were included in the study after four days in the hospital (Table 1).

**Changes in dimension score of staff support, information and patient involvement after first-time hospital accreditation**

Patients reported improved experiences on all three dimensions "Support from the staff during hospitalization", "Information before and during hospitalization" and "Patient involvement in decision-making" after accreditation (Table 2). They experienced a higher level of support from staff with mean scores of 1.19 before and 3.91 after. Similarly, they reported having been better informed before and during admission as well as having been more involved in decisions. The average score for information increased from 3.09 to 4.23 and for involvement in decisions from 2.64 to 4.43 after accreditation (Table 2).

**Changes in positive dimension scores ≥ 4 after first-time hospital accreditation**

Positive ratings of 4 and 5 consistently improved (Table 3). The percentage of patients reporting having been supported rose from 1% to 40% with an adjusted risk difference (RD) of 39% for experiencing a high/very high level of support after accreditation. Changes on the two other dimensions were even more accentuated. Positive ratings of perceived information from staff increased from 2% to 57% and involvement in decisions from 9% to 72% with a RD of respectively 54% and 63% (Table 3).

**Changes in items scores after first-time hospital accreditation**

Experience scores were rated significantly higher by patients treated at the accredited hospitals (Table 4). Only the item, "Were you informed before your admission about what would happen during your admission?" did not improve significantly.

Most items increased from "a small degree" and "some extent" to "a high degree" and "a very high degree". The two items with the largest change in score were; "Have you had conversations with the staff about how to best handle your illness/conditions?" and "Have you had a dialogue with the staff about the advantages and disadvantages of the examination/treatment options available?". Both items more than doubled from 1.62 and 1.52 before accreditation to 3.86 and 4.31 after (Table 4).

**Changes in positive item scores ≥ 4 after first-time accreditation**

At item level, ratings increased significantly on the positive end of the Likert scale in 15 of the 16 items (Table 5). Two items in dimension 1 (Support from the staff during hospitalization) "Have the staff given you the opportunity to participate in decisions about your examination/treatment?" and "Have you had conversations with the staff about how to best handle your illness/conditions?" had an adjusted RD of respectively 74% and 55% after

accreditation. Likewise, in dimension 2 (Information before and during hospitalization) and 3 (Patient involvement in decision-making), the items “Have you received information about the effects and side effect of the medication (including painkillers) you received while you were hospitalized?”, “Did the staff inform you about the examination/treatment options that existed before you received your examination/treatment?”, “Have you had a dialogue with the staff about the advantages and disadvantages of the examination/treatment options available?“ and “Do you to an appropriate extent participate in making decisions about your examination/treatment?” increased from 17%, 31%, 14% and 44% of high scores to 84%, 90%, 83% and 98% respectively corresponding to an adjusted RDs of respectively 67%, 58%, 68% and 55% (Table 5).

## DISCUSSION

### Statement of principal findings

We found that hospitalized patients after accreditation felt better informed before and during hospitalization, more involved in decisions, and more supported by health professionals. To our knowledge, this is the first study examining the impact of first-time hospital accreditation on patient experiences in a context never previously subjected to national systematic quality improvement. The improvements were significant and consistent across all items, suggesting that first accreditation had a positive impact on the care experience by hospitalized patients in the Faroese hospitals.

### Strengths and limitations

A strength of this study is that hospitals of the Faroe Islands had never engaged in systematic national quality improvement before. Also, no other organizational changes or quality improvement measures were implemented during the study. This limits the risk of confounding from competing quality improvement interventions that today are omnipresent in hospitals. Second, data was collected prospectively during hospitalization limiting the risk of recall bias. All data from the 800 participants were collected at the bedside enabling patients with hearing or visual disabilities to participate and to assure data completeness. Third, we included a representative sample of a general hospital population before and after accreditation which increases the generalizability of our results. Fourth, we had a high participation rate of 89%, thereby minimizing non-response bias.

A limitation of our study is the lack of a control group. However, a controlled design was not feasible in the three hospitals as they did not have comparable catchment areas, or size or level of specialization. Another limitation is that the questionnaires were only validated for

differential function and criterion validity [23]. However, they were available in Danish and thoroughly and repeatedly tested during years of use in the Danish healthcare system [24]. Finally, we could not stratify our analyses for diagnoses. The inclusion of this information could have compromised the anonymity of the study participants in this comparatively small population. However, we find little reason to assume that diagnoses should have differed before and after accreditation given that all other demographic parameters were largely similar.

**Interpretation within the context of the wider literature**

The few prior studies of the impact of hospital accreditation on patient experiences, showed conflicting results. Two studies found a positive impact [12, 13], four studies no impact [8-11], and the only systematic review was inconclusive [2]. The majority of the studies with no impact applied cross sectional designs [8, 10, 11] that might be less suitable for complex longitudinal organizational change processes such as accreditation. The studies looking at recommendation rate [9, 11] found no association to accreditation which is likely because the outcome did not include patient-related factors such as support and patient involvement which can be directly affected by accreditation, which we assessed in our study.

The only other study that assessed patient outcomes with a longitudinal design, also found improvements of patient experiences after first-time hospital accreditation in a hospital in Hong Kong [12]. Consistent with our findings, accreditation was associated with an overall improvement of several dimensions of the care experience including "emotional support", "respect for patients' preferences" and "information and education". Moreover, changes in patient experiences also seemed to be sustainable with improvements as long as 15-months post accreditation [12]. Unfortunately, the results from Andres el al. only cover one Hong Kong hospital and do not clarify previous subjection to systematic quality improvement activities. Notwithstanding these methodological challenges, both ours and the study from Hong Kong illustrate the importance of patient experience as a study outcome for the evaluation of hospital accreditation.

**Implications for policy, practice and research**

Our study suggests that accreditation in hospitals can improve patient experiences. In future, authorities responsible for accreditation would be well advised to include patient feedback, and to collaborate with patients to update standards so that their perspectives are included in standards and accreditation models. This would support accreditation and standards to remain relevant to patients and an important element in quality improvement activities.

The development of valid questionnaires linked to accreditation, capturing important elements of patient experiences related to all phases of hospitalization can be an important and useful complement to current accreditation models. Knowledge of patients' experiences would not only help to improve accreditation but also practice. In addition, future research on accreditation should examine the patient perspective to provide a better understanding of how accreditation affects patients and their treatment.

## CONCLUSIONS

First-time hospital accreditation, in a setting without prior or concurrent national quality improvement activities and in a representative population of hospitalized patients, was associated with significant and consistent long-term improvements in patient experience. Patients felt more supported, informed and involved in decisions regarding their hospitalization after accreditation.

## CONTRIBUTORSHIP

All authors were responsible of the study design and interpreting the results. Data were collected by MDB, who drafted the manuscript. All statistical analysis was performed by MDB in collaboration with senior statistician JBV. All authors agreed on the final manuscript.

## ETHICS AND OTHER PERMISSIONS

The study was approved by the Danish (J # 2012-58-0004) and the Faroese (J # 16/00135-12) Data Protection Agency. According to Danish and Faroese law, this study did not need ethics approval.

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## CONFLICT OF INTERESTS

No known conflict of interests

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## DATA AVAILABILITY STATEMENT

According to Danish law, data from this study cannot be shared due to the high risk of identification and the privacy of the individuals included.

## REFERENCES


1. Hinchcliff R, Greenfield D, Moldovan M, Westbrook JI, Pawsey M, Mumford V, Braithwaite J: **Narrative synthesis of health service accreditation literature**. *BMJ Qual Saf* 2012, **21**(12):979-991.
2. Almasabi M, Yang H, Thomas S: **A systematic review of the association between healthcare accreditation and patient satisfaction**. *World Appl Sci J* 2014, **31**(9):1618-1623.
3. Mumford V, Forde K, Greenfield D, Hinchcliff R, Braithwaite J: **Health services accreditation: what is the evidence that the benefits justify the costs?** *Int J Qual Health Care* 2013, **25**(5):606-620.
4. Falstie-Jensen AM, Norgaard M, Hollnagel E, Larsson H, Johnsen SP: **Is compliance with hospital accreditation associated with length of stay and acute readmission? A Danish nationwide population-based study**. *Int J Qual Health Care* 2015, **27**(6):451-458.
5. Lee BY, Chun YJ, Lee YH: **Comparison of Major Clinical Outcomes between Accredited and Nonaccredited Hospitals for Inpatient Care of Acute Myocardial Infarction**. *Int J Environ Res Public Health* 2021, **18**(6).
6. Falstie-Jensen AM, Larsson H, Hollnagel E, Norgaard M, Svendsen ML, Johnsen SP: **Compliance with hospital accreditation and patient mortality: a Danish nationwide population-based study**. *Int J Qual Health Care* 2015, **27**(3):165-174.
7. Ko T, Yang CH, Mao CT, Kuo LT, Hsieh MJ, Chen DY, Wang CY, Lin YS, Hsieh IC, Chen SW *et al*: **Effects of National Hospital Accreditation in Acute Coronary Syndrome on In-Hospital Mortality and Clinical Outcomes**. *Acta Cardiol Sin* 2020, **36**(5):416-427.
8. Haj-Ali W, Bou Karroum L, Natafgi N, Kassak K: **Exploring the relationship between accreditation and patient satisfaction - the case of selected Lebanese hospitals**. *Int J Health Policy Manag* 2014, **3**(6):341-346.
9. Sack C, Scherag A, Lütkes P, Günther W, Jöckel KH, Holtmann G: **Is there an association between hospital accreditation and patient satisfaction with hospital care? A survey of 37,000 patients treated by 73 hospitals**. *Int J Qual Health Care* 2011, **23**(3):278-283.
10. Hayati IN, Azimatun N, Rozita H, Ezat W, Rizal A: **In-patient's satisfaction in the medical and surgical wards-A comparison between accreditted and non accreditated hospital in the state of Selangor**. *J Community Health* 2010, **16**(1):60-68.
11. Sack C, Lütkes P, Günther W, Erbel R, Jöckel K-H, Holtmann GJ: **Challenging the holy grail of hospital accreditation: a cross sectional study of inpatient satisfaction in the field of cardiology**. *BMC Health Serv Res* 2010, **10**:120-120.
12. Andres EB, Song W, Song W, Johnston JM: **Can hospital accreditation enhance patient experience? Longitudinal evidence from a Hong Kong hospital patient experience survey**. *BMC Health Serv Res* 2019, **19**(1):623-623.
13. Aboshaiqah AE, Alonazi WB, Patalagsa JG: **Patients' assessment of quality of care in public tertiary hospitals with and without accreditation: comparative cross-sectional study**. *J Adv Nurs* 2016, **72**(11):2750-2761.
14. Al Tehewy M, Salem B, Habil I, El Okda S: **Evaluation of accreditation program in non-governmental organizations' health units in Egypt: short-term outcomes**. *Int J Qual Health Care* 2009, **21**(3):183-189.
15. Al-Qahtani M, Al-Dohailan SK, Al-Sharani HT, Al-Medaires MA, Khuridah EN, Al-Dossary NM: **The impact of the status of hospital accreditation on patient**

**satisfaction with the Obstetrics and Gynecology Clinics in the Eastern Province, Saudi Arabia**. *J Med Med Sci* 2012, **3**(10):665-673.
16. Vincent CA, Coulter A: **Patient safety: what about the patient?** *Qual Saf Health Care* 2002, **11**(1):76-80.
17. Thom DH, Hall MA, Pawlson LG: **Measuring patients' trust in physicians when assessing quality of care**. *Health Aff (Millwood)* 2004, **23**(4):124-132.
18. Mattila E, Kaunonen M, Aalto P, Ollikainen J, Astedt-Kurki P: **Support for hospital patients and associated factors**. *Scand J Caring Sci* 2010, **24**(4):734-745.
19. Zolnierek KB, Dimatteo MR: **Physician communication and patient adherence to treatment: a meta-analysis**. *Med Care* 2009, **47**(8):826-834.
20. Doyle C, Lennox L, Bell D: **A systematic review of evidence on the links between patient experience and clinical safety and effectiveness**. *BMJ open* 2013, **3**(1).
21. **Statistics Faroe Islands** [https://hagstova.fo/en/population/population/population Accessed 14 September 2021]
22. **World Bank Open Data** [https://data.worldbank.org/country/faroe-islands Accessed 14 September 2021]
23. **Metoder anvendt til validering af skalaer i LUP og resultater af analyser** [https://www.regionh.dk/patientinddragelse/udgivelser/udgivelser/Sider/Metoder-anvendt-til-validering-af-skalaer-i-LUP-og-resultater-af-analyser.aspx?rhKeywords=bang Accessed 23 September 2021]
24. **Landsdækkende undersøgelse af patientoplevelser (LUP)** [https://www.regionh.dk/patientinddragelse/LUP/Sider/default.aspx Accessed 23 September 2021]
25. **Hvad er LUP?** [https://www.regionh.dk/patientinddragelse/LUP/Om-lup/Sider/hvad-er-lup.aspx Accessed 23 September 2021]
26. **Introduction to DDKM** [https://www.ikas.dk/den-danske-kvalitetsmodel/ddkm-in-english/introduction-to-ddkm/ Accessed 23 September 2021]
27. **Akkrediteringsstandarder for de færøske sygehuse** [https://www.ikas.dk/deltagere-i-ddkm/faeroeske-sygehuse/ Accessed 14 September 2021]
28. **REDCap** [https://projectredcap.org/ Accessed 23 September 2021]

## TABLES

**Table 1. Patient characteristics before and after first-time accreditation**

| | Before Accreditation 2016 | After Accreditation 2018 |
|---|---|---|
| **Characteristic** | N = 400 | N = 400 |
| **Sex, n (%)** | | |
| Male | 208 (52) | 199 (50) |
| Female | 192 (48) | 201 (50) |
| **Age (years)** | | |
| Age, median (IQR) | 69 (57, 78) | 70 (60, 80) |
| < 50 years, n (%) | 73 (18) | 69 (17) |
| 50-75 years, n (%) | 203 (51) | 183 (46) |
| > 75 years, n (%) | 124 (31) | 148 (37) |
| **Hospitalization time before inclusion (days)** | | |
| Median (IQR) | 1 (1, 3) | 2 (1, 3) |
| Mean (min; max) | 4 (1, 137) | 4 (1, 122) |
| **Previous hospitalization, n (%)** | | |
| Yes, one previous hospitalization | 67 (17) | 70 (18) |
| Yes, several previous hospitalizations | 173 (43) | 114 (29) |
| No previous hospitalization | 158 (40) | 213 (53) |
| **Cohabitant status, n (%)** | | |
| Cohabitant | 307 (77) | 291 (73) |
| Living alone | 93 (23) | 109 (27) |
| **Employment status, n (%)** | | |
| Working | 136 (34) | 137 (34) |
| Not working | 264 (66) | 263 (66) |
| **Education level, n (%)** | | |
| Primary school | 181 (45) | 157 (39) |
| College student | 30 (8) | 36 (9) |
| ≤2 years | 53 (13) | 50 (13) |
| ≤3-4 years | 126 (32) | 136 (34) |
| ≥5 years | 10 (3) | 21 (5) |
| **Hospitalization, n (%)** | | |
| Acute | 325 (81) | 329 (82) |
| Scheduled | 75 (19) | 71 (18) |
| **Department, n (%)** | | |
| Medical | 196 (49) | 194 (49) |
| Surgical | 145 (36) | 125 (31) |
| Mixed (surgical/medical) | 59 (15) | 81 (20) |
| **Room type during hospitalization, n (%)** | | |
| Single room | 89 (22) | 112 (28) |
| Multibed room | 310 (78) | 288 (72) |
| **Treating hospital, n (%)** | | |
| The National hospital | 341 (85) | 319 (80) |
| Klaksvik hospital | 34 (9) | 49 (12) |
| Suderø hospital | 25 (6) | 32 (8) |

**Table 2. Dimensions of patient experience scores during hospitalization before and after first-time accreditation**

| | Before Accreditation 2016 | | After Accreditation 2018 | | | |
|---|---|---|---|---|---|---|
| | Unadjusted mean | 95% CI * | Unadjusted mean | 95% CI | Adjusted mean difference ¶ | 95% CI |
| Support from the staff during hospitalization | 1.19 | 1.82, 1.99 | 3.91 | 3.82, 3.99 | 1.99 | 1.89, 2.10 |
| Information before and during hospitalization | 3.09 | 3.04, 3.15 | 4.23 | 4.18, 4.29 | 1.14 | 1.07, 1.20 |
| Patient involvement in decision-making | 2.64 | 2.56, 2.73 | 4.43 | 4.37, 4.49 | 1.79 | 1.76, 1.82 |

* 95% CI, 95% confidence interval

¶ Adjusted for cluster effect at hospital level, age, sex, level of education, previous hospitalizations and type of hospitalization

**Table 3. Highly positive (≥4) dimensions of patient experience during hospitalization before and after first-time accreditation**

| | Before Accreditation 2016 | | After Accreditation 2018 | | | |
|---|---|---|---|---|---|---|
| | Dimension score ≥ 4 | | Dimension score ≥ 4 | | Adjusted RD † | |
| | N * | % ¶ | N | % | % | 95% CI § |
| Support from the staff during hospitalization | 3 | 1 | 160 | 40 | 39 | 36, 42 |
| Information before and during hospitalization | 8 | 2 | 277 | 57 | 54 | 50, 58 |
| Patient involvement in decision-making | 35 | 9 | 284 | 72 | 63 | 59, 66 |

* Patients answering "not relevant to me" or "do not know" are not included
¶ %, percentage
† RD, Risk difference, adjusted for cluster effect at hospital level, age, sex, level of education, previous hospitalizations and type of hospitalization
§ 95% CI, 95% confidence interval

**Table 4. Items of patient experience scores during hospitalization before and after first-time accreditation, ordered by dimensions**

| Dimension/Item | Before Accreditation 2016 | | | After Accreditation 2018 | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Unadjusted | | | Unadjusted | | Adjusted | |
| | N * | Mean | 95% CI ¶ | N | Mean | 95% CI | Mean difference† | 95% CI |
| **SUPPORT FROM STAFF DURING HOSPITALIZATION** | | | | | | | | |
| Have the staff asked about your own experiences with your illness/condition? | 393 | 2.02 | 1.89, 2.15 | 389 | 3.75 | 3.64, 3.85 | 1.73 | 1.65, 1.81 |
| Have the staff given you the opportunity to participate in decisions about your examination/treatment? | 339 | 1.76 | 1.62, 1.89 | 192 | 4.32 | 4.20, 4.44 | 2.54 | 2.46, 2.62 |
| Have the staff (after your consent) given your relatives the opportunity to participate in decisions about your examination/treatment? | 78 | 3.20 | 2.88, 3.51 | 114 | 4.47 | 4.34, 4.61 | 1.21 | 0.96, 1.45 |
| Have you had conversations with the staff about how to best handle your illness/condition? | 381 | 1.62 | 1.51, 1.74 | 374 | 3.86 | 3.74, 3.97 | 2.23 | 2.12, 2.34 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **INFORMATION BEFORE AND DURING HOSPITALIZATION** | | | | | | | | |
| Were you informed before your admission about what would happen during your admission? § | 75 | 3.63 | 3.44, 3.81 | 70 | 4.63 | 4.50, 4.76 | 0.99 | 0.85, 1.13 |
| Is the verbal information you received during your hospitalization understandable? | 400 | 3.84 | 3.79, 3.89 | 400 | 4.53 | 4.47, 4.59 | 0.68 | 0.63, 0.73 |
| Did you get answers to the questions you asked during your admission? | 375 | 3.66 | 3.58, 3.74 | 386 | 4.44 | 4.38, 4.50 | 0.79 | 0.74, 0.83 |
| Does the information you have received from different staff in the department agree? # | 324 | 3.72 | 3.65, 3.78 | 325 | 4.29 | 4.22, 4.35 | 0.56 | 0.51, 0.61 |
| Have you received information about the effects and side effects of the medication (including painkillers) you received while you were hospitalized? | 370 | 1.93 | 1.81, 2.04 | 357 | 4.18 | 4.08, 4.28 | 2.25 | 2.12, 2.39 |
| Have you been continuously informed about the results of your treatment/examination? | 398 | 2.73 | 2.60, 2.86 | 382 | 3.90 | 3.78, 4.02 | 1.17 | 1.00, 1.33 |
| Have you been continuously informed about what is going to happen? # | 325 | 2.55 | 2.41, 2.70 | 324 | 3.90 | 3.78, 4.02 | 1.35 | 1.18, 1.52 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **PATIENT INVOLVEMENT IN DECISION-MAKING** | | | | | | | | |
| Did the staff inform you about the examination /treatment options that existed before you received your examination/treatment? | 385 | 2.14 | 2.00, 2.28 | 371 | 4.43 | 4.35, 4.52 | 2.29 | 2.26, 2.32 |
| Have you had a dialogue with the staff about the advantages and disadvantages of the examination/treatment options available? | 377 | 1.52 | 1.41, 1.63 | 210 | 4.31 | 4.18, 4.45 | 2.75 | 2.62, 2.88 |
| Have you been able to talk to the staff about concerns regarding your illness or your examination/course of treatment? | 136 | 3.17 | 2.95, 3.39 | 77 | 3.86 | 3.56, 4.16 | 0.60 | 0.51, 0.69 |
| Is your examination/treatment adapted to your situation? | 396 | 3.82 | 3.76, 3.88 | 385 | 4.39 | 4.33, 4.46 | 0.57 | 0.54, 0.59 |
| Do you to an appropriate extent participate in making decisions about your examination/treatment? | 345 | 2.75 | 2.54, 2.96 | 248 | 4.94 | 4.87, 4.99 | 2.20 | 2.07, 2.33 |

⋆ Patients answering “not relevant to me” or “do not know” are not included
¶ 95% CI, 95% confidence interval
† Adjusted for cluster effect at hospital level, age, sex, level of education, previous hospitalizations and type of hospitalization
§ Question only include patients scheduled for hospitalization
# Question only include patients for acute hospitalization

**Table 5. Highly positive (≥4) items of patient experience during hospitalization before and after first-time accreditation, ordered by dimensions**

| Dimension/Item | Before Accreditation 2016 | | After Accreditation 2018 | | | |
|---|---|---|---|---|---|---|
| | Patients score ≥ 4 | | Patients score ≥ 4 | | Adjusted RD † | |
| | N * | % ¶ | N | % | % | 95% CI § |
| **SUPPORT FROM STAFF DURING HOSPITALIZATION** | | | | | | |
| Have the staff asked about your own experiences with your illness/condition? | 85 | 22 | 222 | 57 | 35 | 30, 41 |
| Have the staff given you the opportunity to participate in decisions about your examination/treatment? | 55 | 16 | 175 | 91 | 74 | 70, 78 |
| Have the staff (after your consent) given your relatives the opportunity to participate in decisions about your examination/treatment? | 44 | 56 | 107 | 94 | 37 | 32, 43 |
| Have you had conversations with the staff about how to best handle your illness/condition? | 51 | 13 | 256 | 69 | 55 | 53, 57 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **INFORMATION BEFORE AND DURING HOSPITALIZATION** | | | | | | |
| Were you informed before your admission about what would happen during your admission? # | 57 | 14 | 67 | 17 | 3 | -1, 67 |
| Is the verbal information you received during your hospitalization understandable? | 333 | 83 | 387 | 97 | 13 | 10, 16 |
| Did you get answers to the questions you asked during your admission? | 288 | 77 | 369 | 96 | 19 | 17, 21 |
| Does the information you have received from different staff in the department agree? ‡ | 245 | 61 | 304 | 77 | 15 | 9, 21 |
| Have you received information about the effects and side effects of the medication (including painkillers) you received while you were hospitalized? | 62 | 17 | 299 | 84 | 67 | 60, 74 |
| Have you been continuously informed about the results of your treatment/examination? | 177 | 45 | 270 | 71 | 26 | 19, 33 |
| Have you been continuously informed about what is going to happen? ‡ | 115 | 29 | 215 | 54 | 25 | 15, 36 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **PATIENT INVOLVEMENT IN DECISIONS-MAKING** | | | | | | |
| Did the staff inform you about the examination/ treatment options that existed before you received your examination/treatment? | 212 | 31 | 333 | 90 | 58 | 56, 59 |
| Have you had a dialogue with the staff about the advantages and disadvantages of the examination/ treatment options available? | 53 | 14 | 174 | 83 | 68 | 63, 72 |
| Have you been able to talk to the staff about concerns regarding your illness or your examination/course of treatment? | 85 | 63 | 59 | 77 | 12 | 11, 13 |
| Is your examination/treatment adapted to your situation? | 341 | 86 | 363 | 94 | 8 | 7, 9 |
| Do you to an appropriate extent participate in making decisions about your examination/treatment? | 151 | 44 | 244 | 98 | 55 | 52, 58 |

⋆ Patients answering “not relevant to me” or “do not know” are not included
¶ %, percentage
† RD, Risk difference, adjusted for cluster effect at hospital level, age, sex, level of education, previous hospitalizations and type of hospitalization
§ 95% CI, 95% confidence interval
# Question only include patients scheduled for hospitalization
‡ Question only include patients for acute hospitalization

## SUPPLEMENTARY MATERIAL

**Appendix 1. Dimensions and items concerning scheduled hospitalization of the National Danish Survey of Patient Experiences***

| **Support from staff during hospitalization** | |
|---|---|
| 1. Have the staff asked about your own experiences with your illness/condition? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 2. Have the staff given you the opportunity to participate in decisions about your examination/treatment? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □<br><br>*If you have not needed to participate in decisions, please answer "not relevant"* |
| 3. Have the staff (after your consent) given your relatives the opportunity to participate in decisions about your examination/treatment? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 4. Have you had conversations with the staff about how to best handle your illness/condition? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |

| Information before and during hospitalization | |
|---|---|
| 5. Were you informed before your admission about what would happen during your admission? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 6. Is the verbal information you received during the hospitalization understandable? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 7. Did you get answers to the questions you asked during your admission? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 8. Have you received information about the effects and side effects of the medication (including painkillers) you received while you were hospitalized? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 9. Have you been continuously informed about the results of your treatment/examination? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |

| Patient involvement in decision-making | |
|---|---|
| 10. Did the staff inform you about the examination/treatment options that existed before you received your examination/treatment? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 11. Have you had a dialogue with the staff about the advantages and disadvantages of the examination/treatment options available? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 12. Have you been able to talk to the staff about concerns regarding your illness or your examination/course of treatment? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 13. Is your examination/treatment adapted to your situation? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 14. Do you to an appropriate extent participate in making decisions about your examination/treatment? | Not relevant to me □<br><br>Yes □<br>No □<br><br>Do not know □ |

*Thirteen questions of the questionnaires for scheduled and acute hospitalizations are identical

**Appendix 2. Dimensions and items concerning acute hospitalizations of the National Danish Survey of Patient Experiences***

| Support from staff during hospitalization | |
|---|---|
| 1. Have the staff asked about your own experiences with your illness/condition? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 2. Have the staff given you the opportunity to participate in decisions about your examination/treatment? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □<br><br>*If you have not needed to participate in decisions, please answer "not relevant"* |
| 3. Have the staff (after your consent) given your relatives the opportunity to participate in decisions about your examination/treatment? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 4. Have you had conversations with the staff about how to best handle your illness/condition? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |

| Information during hospitalization | |
|---|---|
| 5. Is the verbal information you received during your hospitalization understandable? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 6. Did you get answers to the questions you asked during your admission? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 7. Does the information you have received from different staff in the department agree? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 8. Have you received information about the effects and side effects of the medication (including painkillers) you received while you were hospitalized? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 9. Have you been continuously informed about the results of your treatment/examination? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |

| | |
|---|---|
| 10. Have you been continuously informed about what is going to happen? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| **Patient involvement in decision-making** | |
| 11. Did the staff inform you about the examination /treatment options that existed before you received your examination/treatment? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 12. Have you had a dialogue with the staff about the advantages and disadvantages of the examination /treatment options available? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 13. Have you been able to talk to the staff about concerns regarding your illness or your examination/course of treatment? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |
| 14. Is your examination/treatment adapted to your situation? | Not relevant to me □<br><br>To a very high degree (5) □<br>To a high degree (4) □<br>To some extent (3) □<br>To a small degree (2) □<br>Not at all (1) □<br><br>Do not know □ |

| | |
|---|---|
| 15. Do you to an appropriate extent participate in making decisions about your examination/treatment? | Not relevant to me □<br><br>Yes □<br>No □<br><br>Do not know □ |

*Thirteen questions of the questionnaires for scheduled and acute hospitalizations are identical

## Appendix 3. Dimensions and items of the National Danish Survey of Patient Experiences and DDKM* accreditation standards

| Dimension/items | Accreditation standard |
|---|---|
| **Support from staff during hospitalization** | |
| Have the staff asked about your own experiences with your illness/condition? | No standard |
| Have the staff given you the opportunity to participate in decisions about your examination/treatment? | 2.1.1: Informed consent<br>2.7.6: Treatment of the individual acute patient<br>2.7.7: Treatment of the electively referred patient |
| Have the staff (after your consent) given your relatives the opportunity to participate in decisions about your examination/treatment? | 2.1.2: Involvement of patients and relatives as partners |
| Have you had conversations with the staff about how to best handle your illness/condition? | No standard |
| **Information before and during hospitalization** | |
| Were you informed before your admission about what would happen during your admission? | 2.2.2: Written information about course of treatment and patients' rights<br>2.7.7: Treatment of the electively referred patient |
| Is the verbal information you received during your hospitalization understandable? | 2.2.1: Important conversations with the patient and the relatives |
| Did you get answers to the questions you asked during your admission? | No standard |
| Does the information you have received from different staff in the department agree? | No standard |
| Have you received information about the effects and side effects of the medication (including painkillers) you received while you were hospitalized? | 2.7.5: Pain assessment and treatment |
| Have you been continuously informed about the results of your treatment/examination? | 2.7.6: Treatment of the individual acute patient<br>2.7.7: Treatment of the electively referred patient |
| Have you been continuously informed about what is going to happen? | 2.7.6: Treatment of the individual acute patient<br>2.7.7: Treatment of the electively referred patient |
| **Patient involvement in decision-making** | |
| Did the staff inform you about the examination /treatment options that existed before you received your examination/treatment? | 2.1.1: Informed consent<br>2.2.2: Written information about course of treatment and patients' rights |
| Have you had a dialogue with the staff about the advantages and disadvantages of the examination/treatment options available? | 2.1.1: Informed consent<br>2.2.2: Written information about course of treatment and patients' rights |

| | |
|---|---|
| Have you been able to talk to the staff about concerns regarding your illness or your examination/course of treatment? | 2.19.1: Palliative care of patients with life-threatening disease and care for the patient´s relatives |
| Is your examination/treatment adapted to your situation? | 2.7.6: Treatment of the individual acute patient<br>2.7.7: Treatment of the electively referred patient |
| Do you to an appropriate extent participate in making decisions about your examination/treatment? | 2.1.1: Informed consent<br>2.19.1: Palliative care of patients with life-threatening disease and care for the patient´s relatives |

* The modified second version of the Danish Healthcare Quality program

**Appendix 4. The relative risk for highly positive patient experience dimension scores (≥4) when hospitalized after accreditation**

| Dimension | Unadjusted | | Adjusted | |
|---|---|---|---|---|
| | RR † | 95% CI § | RR # | 95% CI |
| Support from staff during hospitalization | 53.33 | 17.15, 165.82 | 51.81 | 33.65, 79.75 |
| Information before and during hospitalization | 28.38 | 14.21, 56.67 | 27.67 | 20.72, 36.95 |
| Patient involvement in decision-making | 8.19 | 5.94, 11.32 | 8.15 | 7.66, 8.66 |

† RR, Relative risk
§ 95% CI, 95% confidence interval
# Adjusted for cluster effect at hospital level, age, sex, level of education, previous hospitalizations and type of hospitalization

**Appendix 5. The relative risk for highly positive patient experience item scores (≥4) when hospitalized after accreditation**

| Dimension/Item | Unadjusted | | Adjusted | |
|---|---|---|---|---|
| | RR † | 95% CI § | RR # | 95% CI |
| **SUPPORT FROM STAFF DURING HOSPITALIZATION** | | | | |
| Have the staff asked about your own experiences with your illness/condition? | 2.63 | 2.05, 3.39 | 2.63 | 2.23, 3.09 |
| Have the staff given you the opportunity to participate in decisions about your examination/treatment? | 5.62 | 4.15, 7.61 | 5.49 | 4.96, 6.09 |
| Have the staff (after your consent) given your relatives the opportunity to participate in decisions about your examination/treatment? | 1.66 | 1.17, 2.36 | 1.62 | 1.48, 1.77 |
| Have you had conversations with the staff about how to best handle your illness/condition? | 5.11 | 3.79, 6.91 | 5.10 | 4.63, 5.63 |
| **INFORMATION BEFORE AND DURING HOSPITALIZATION** | | | | |
| Were you informed before your admission about what would happen during your admission? ¤ | 1.18 | 0.83, 1.68 | 1.21 | 0.94, 1.55 |
| Is the verbal information you received during your hospitalization understandable? | 1.16 | 1.00, 1.35 | 1.16 | 1.12, 1.19 |
| Did you get answers to the questions you asked during your admission? | 1.24 | 1.07, 1.45 | 1.24 | 1.22, 1.28 |
| Does the information you have received from different staff in the department agree? ◊ | 1.25 | 1.06, 1.48 | 1.23 | 1.13, 1.34 |
| Have you received information about the effects and side effects of the medication (including painkillers) you received while you were hospitalized? | 4.99 | 3.80, 6.57 | 5.00 | 3.48, 7.18 |
| Have you been continuously informed about the results of your treatment/examination? | 1.59 | 1.31, 1.92 | 1.59 | 1.37, 1.84 |
| Have you been continuously informed about what is going to happen? ◊ | 1.89 | 1.51, 2.37 | 1.87 | 1.43, 2.45 |

| | | | | |
|---|---|---|---|---|
| **PATIENT INVOLVEMENT IN DECISION-MAKING** | | | | |
| Did the staff inform you about the examination /treatment options that existed before you received your examination/treatment? | 2.86 | 2.32, 3.52 | 2.84 | 2.77, 2.91 |
| Have you had a dialogue with the staff about the advantages and disadvantages of the examination/treatment options available? | 5.89 | 4.33, 8.02 | 5.73 | 4.51, 7.27 |
| Have you been able to talk to the staff about concerns regarding your illness or your examination/course of treatment? | 1.23 | 1.17, 1.29 | 1.17 | 1.15, 1.19 |
| Is your examination/treatment adapted to your situation? | 1.09 | 0.94, 1.27 | 1.09 | 1.08, 1.11 |
| Do you to an appropriate extent participate in making decisions about your examination/treatment? | 2.25 | 1.84, 2.75 | 2.26 | 2.12, 2.41 |

† RR, Relative risk
§ 95% CI, 95% confidence interval
# Adjusted for cluster effect at hospital level, age, sex, level of education, previous hospitalizations and type of hospitalization
¤ Question only include patients scheduled for hospitalization
◊ Question only include patients for acute hospitalization

Shorter length of stay after first-time hospital accreditation: a national before and after study in the Faroe Islands

PAPER III

**Shorter length of stay after first-time hospital accreditation: a national before and after study in the Faroe Islands**

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## ABSTRACT

**Background** The aim of accreditation is to improve quality of care and patient safety. However, studies on the effectiveness of accreditation on clinical outcomes are limited and inconsistent. Comparative studies have contrasted accredited with non-accredited hospitals or hospitals without a benchmark, but assessments of outcomes of patients treated at hospitals undergoing accreditation are sparse. The Faroe Islands hospitals were accredited for the first time in 2017, making them an ideal place to study the impact of accreditation. The objective was to investigate the association between first-time hospital accreditation and length of stay (LOS), acute readmission (AR) and 30-day mortality in the unique setting of the Faroe Islands.

**Methods** A before and after study based on medical record audits in relation to first-time accreditation. All three Faroese hospitals were voluntarily accredited using a modified second version of the Danish Healthcare Quality Program (DDKM) encompassing 76 standards. We included in-patients 18 years or older treated at a Faroese hospital with one of six clinical conditions (stroke/TIA, bleeding gastric ulcer, COPD, childbirth, heart failure and hip fracture) in 2012-2013 designated 'before accreditation' or 2017-2018 'after accreditation'. Main outcome measures were LOS, all-cause AR and all-cause 30-day mortality. We computed adjusted cause specific hazard rate ratios (HR) using Cox Proportional Hazard regression with before accreditation as reference. The analyses were controlled for age, sex, cohabitant status, in-hospital rehabilitation, type of admission, diagnosis and cluster effect at patient and hospital level.

**Results** The mean LOS was 13.4 days (95%CI: 10.8, 15.9) before accreditation and 7.5 days (95%CI: 6.10, 8.89) after accreditation. LOS of patients hospitalized after accreditation was significantly shorter (overall, adjusted HR=1.23 (95% confidence interval (CI): 1.04, 1.46)). By medical condition, only women in childbirth had a significantly shorter LOS (adjusted HR=1.30 (95%CI: 1.04, 1.62)). In total, 12.3% of in-patients before and 9.5% after accreditation were readmitted acutely within 30 days of discharge, and 30-day mortality was 3.3% among in-patients before and 2.8% after accreditation, respectively. No associations were found overall or by medical condition for AR (overall, adjusted HR=1.34 (95%CI: 0.82, 2.18)) or 30-day mortality (overall, adjusted HR=1.33 (95%CI: 0.55, 3.21)) after adjustment for potential confounding factors.

**Conclusion** First-time hospital accreditation in the Faroe Islands was associated with significant reduction in LOS, especially women in childbirth. Notably, the shorter LOS was not followed by an increased AR. There was no evidence that first-time accreditation lowered the risk of AR or 30-day mortality.

## INTRODUCTION

Hospitals worldwide employ accreditation to improve patient care [1-3]. However accreditation is time consuming and costly [4], and some health professionals have been sceptical as to its value [5]. To justify the efforts hospitals undertake to become accredited, earlier research on the effects of accreditation focused on organizational impacts, barriers and facilitators. More recently, clinical outcomes have been assessed [1, 6, 7]. This is an important step as it contributes to a wider understanding of the potential of hospital accreditation. By including evaluations of patients' outcomes, hospitals gain knowledge about their effectiveness as well as to what extent they provide safe and high-quality care. Some frequently used clinical outcomes are length of stay (LOS), acute readmission (AR) and 30-day mortality.

The literature on the association between accreditation and clinical outcomes is mixed and inconsistent. Some studies found treatment at fully accredited hospitals was associated with a shorter LOS [8-13] and lower risk of 30-day mortality [12, 14-17], whereas others uncovered no link [11, 18, 19]. The disparate findings may be due to different methodological approaches including the use of various accreditation models, but also distinct settings in which accreditation is carried out [8-10, 18]. Other studies have been limited by comparing accredited with non-accredited hospitals [20, 21] and not accounting for differences between the included hospitals. Furthermore, many hospitals participate in multiplicity quality improvement activities in parallel with accreditation, which makes it difficult to separate the impact of accreditation [7, 22]. Optimally, accreditation should be studied in a context isolated from other ongoing quality initiatives, thereby enabling a benchmark.

To expand the knowledge of the impact of accreditation on clinical outcomes, we conducted a before and after study in Faroese hospitals that have not previously participated in accreditation or other systematic quality improvement activities, which allowed us to benchmark accreditation in a general hospital population. Our study aimed to investigate the association between first-time hospital accreditation and LOS, AR and 30-day mortality. We hypothesized that in-patients treated after accreditation had a shorter LOS, lower AR rate and lower risk of dying within 30-days compared with in-patients treated before accreditation, as accreditation provides hospitals with a framework to optimize patient care.

## METHODS

### Study design

We conducted a nationwide before and after study based on medical record reviews on clinical outcomes among in-patients treated in Faroese public, non-psychiatric hospitals.

### Setting

The Faroe Islands are located in the North Atlantic and have approximately 52,700 inhabitants [23]. The Faroe Islands is a high-income [24] self-governing nation, including an independent healthcare system, under the external sovereignty of the Kingdom of Denmark. Treatment in hospitals is free of charge. There are three public hospitals; Klaksvik, Suderø and the National Hospital. Transfer of in-patients from Klaksvik and Suderø to the National Hospitals is a common procedure as some treatments are only provided there. In-patients needing highly specialized treatment are transferred to Denmark in accordance with binding agreements.

### Intervention

The three Faroese hospitals were voluntarily accredited using a modified second version of the Danish Healthcare Quality Program (DDKM) [25], which was originally used for the mandatory accreditation of Danish hospitals. The modification was designed in collaboration with Faroese stakeholders to fit Faroese legalization but also to respond to the criticism that the accreditation model had experienced in Denmark. Thus, the requirement for an established quality department and policies was changed and the number of indicators focusing on monitoring and evaluation was reduced. The final modified version encompassed 76 standards of which eight were considered critical for patient safety**.** A team of experienced surveyors assessed level of compliance through observations, interviews and documentation review. Each hospital was assessed individually during that same week in February 2017. Based on the assessment, an independent accreditation committee awarded Klaksvik Hospital ‘fully accredited’, while Suderø Hospital and National Hospital were awarded ‘partially accredited’. After submitting additional documentation, the latter were fully accredited in May and September 2017 respectively.

### Outcomes

Outcomes were LOS, AR and 30-day mortality. LOS was followed from the day of admission until the day of discharge. If an in-patient was transferred to another hospital for, e.g., rehabilitation, the date of discharge was noted as the day on which the in-patient had completed treatment and discharged. AR was defined as all-cause acute readmission within 30 days of

discharge. Thirty-day mortality was defined as all-cause mortality within 30 days of admission irrespective of place of death (hospital or at home).

**Participants**

We applied data from a previous study that investigated the impact of first-time accreditation on the delivery of recommended care [26] using a random sample of 601 in- and outpatients identified through an extract from the National Faroese Patient Register. We included patients 18 years or older, treated at a Faroese hospital before or after accreditation and diagnosed with one of eight conditions: stroke/TIA, bleeding gastric ulcer, perforated gastric ulcer, diabetes, COPD, childbirth, heart failure or hip fracture.

**Data collection**

Information on LOS, AR and 30-day mortality was obtained by medical record review and entered in a REDCap database. To validate 30-day mortality, the date of death entered in REDCap was subsequently checked with the date noted in the extract obtained from the Faroese National Patient Register.

All patients had their diagnosis code validated before inclusion. As the medical records were written in Faroese, data was collected by native Faroe islanders with a bachelor's degree in medicine, two collectors before and four after accreditation. To test inter-rater reliability (IRR), two auditors independently entered data from 100 randomly selected records. IRR was assessed at 0.86 using Cohen's kappa.

**Statistical analysis**

Descriptive characteristics for in-patients treated before and after accreditation were presented as counts and percentages for categorical variables and as medians, means, range and interquartile ranges (IQR) for continuous variables where appropriate.

The associations between first-time hospital accreditation and LOS, AR, 30-day mortality were estimated using Cox Proportional Hazard regression with before accreditation as reference. All analyses were performed as a total for all clinical conditions and by stratifying according to clinical condition.

For 30-day mortality we reported hazard rate ratios (HR) with 95% CI and for LOS and AR we reported cause-specific HRs with 95% CI. LOS was calculated in days from admission to discharge or death, whichever came first. For technical reasons, time of discharge for in-patients admitted and discharged the same day were coded as 0.01. In-patients who died during hospitalization were censored. For AR, in-patients were followed from discharge until

administrative censoring (30 days follow-up), AR or death, whichever came first. In-patients who died during follow-up were censored. Thirty-day mortality was calculated in days from admission to death or administrative censoring whichever came first. For all outcomes in-patients were censored if they were transferred to specialized care in Denmark during follow-up. The assumption of proportional hazards was visually inspected by log-log plots. To account for LOS outliers, a sensitivity analysis was performed with administrative censoring at 31 days. To account for women in childbirth whose probability of AR and death differs from the other conditions, we performed a sensitivity analysis excluding that cohort. To complement the HR analyses, we estimated the relative risk (RR) and the risk difference (RD) for all outcomes at 30 days follow-up (Appendix 1). Risk estimates were obtained from adjusted Aalen-Johansen cumulative incidences using inverse-probability-of-treatment weights and bootstrapped to derive 95% CI of the estimates. All analyses were adjusted for potential confounding factors such as age, sex, cohabitant status, type of admission, in-hospital rehabilitation, diagnosis and cluster effect at patient and hospital level. Analyses were performed using StataSE, version 14.2. (StataCorp, 2015. College Station, TX: StataCorp LLC).

## RESULTS

A total of 277 in-patients before and 532 after accreditation was included in the LOS and 30-day mortality analyses. After exclusion of in-patients who died during admission and in-patients leaving the Faroe Islands after being discharged, 216 in-patients were included before and 516 after accreditation in the AR analyses (Figure 1).

Overall, there were significant differences in the baseline characteristics of in-patients treated before and after accreditation, except for the number of patients transferred to Denmark (Table 1). More women were included after accreditation (64% vs. 79%). The average age was higher among in-patients treated before accreditation (62 vs. 48 years) and more in-patients were living alone (17% vs. 7%) or at a nursing home (12% vs. 6%). Before accreditation, in-patients were more often transferred between hospitals (14% vs. 6%) whereas in-patients were more often treated at specialist departments after accreditation (33% vs. 84%).

### LOS

The mean LOS for all in-patients was 13.4 days (95%CI: 10.8, 15.9) before accreditation and 7.5 days (95%CI: 6.10, 8.89) after accreditation (Table 2). Compared with before accreditation, in-patients treated after accreditation had a significantly shorter LOS (overall, adjusted HR=1.23 (95%CI: 1.04, 1.46)). Correspondingly, the overall adjusted RD for a shorter LOS

after accreditation was 0.07 (95%CI: 0.01, 0.13) (Appendix 1, table 1). In a subgroup analysis, stratifying by condition, only women in childbirth had a significantly shorter LOS (adjusted HR=1.30 (95%CI: 1.04, 1.62)). The sensitivity analysis excluding in-patients with long LOS (8%) did not alter the result (overall, adjusted HR=1.26 (95%CI: 1.07, 1.49)).

### AR

In total 12.3% of the in-patients treated before and 9.5% after accreditation were readmitted acutely within 30 days of discharge (Table 3). No association was found in the risk of AR for in-patients before and after accreditation following adjustment for potential confounding factors (overall, adjusted HR=1.34 (95%CI: 0.82, 2.18)). Correspondingly, the overall adjusted RD for AR was not significant (overall, adjusted RD=0.02 (95%CI: -0.03, 0.06)) (Appendix 1, table 2). When examining the association by medical conditions, in-patients with acute bleeding gastric ulcer had a higher risk of AR after accreditation (adjusted HR=6.47 (95%CI: 1.12, 37.63)). The sensitivity analyses excluding women in childbirth, did not alter the overall result (overall, adjusted HR=1.37 (95%CI: 0.82, 2.27)).

### 30-day mortality

A total of 3.3% of the in-patients treated before and 2.8% after accreditation died within 30 days of admission, respectively (Table 4). No association was found between 30-day mortality risk, (overall, adjusted HR=1.33 (95%CI: 0.55, 3.21)) and (overall, adjusted RD=0.01 (95%CI: -0.01, 0.04)) (Appendix 1, table 3). Stratification by medical condition demonstrated no association between 30-day mortality and accreditation, when comparing in-patients treated after with before accreditation. The results did not change, when omitting women in childbirth in the sensitivity analyses (overall, adjusted HR=1.33 (95%CI: 0.55, 3.20)).

## DISCUSSION

### Statement of principal findings

We set out to investigate the impact of first-time hospital accreditation on outcomes in the Faroe Islands hospitals that had previously never participated in systematic quality improvement activities. Hospitalized patients had a significantly shorter LOS after accreditation than before, especially women in childbirth. We found no differences in AR and 30-day mortality before and after accreditation. Notably, shorter LOS after accreditation was not associated with an increase in AR.

**Strengths and limitations**

The strengths of this study included data collection in a setting experiencing no prior systematic quality improvement activities. To minimize the risk of selection bias, we included in-patients based on a random sample from the National Faroese Patient Register drawn by an administrative employee with no knowledge of the study aim. In addition, before beginning data collection, all eligible patients were randomized, ensuring an equal probability of having their medical record reviewed. To reduce information bias, the medical record review included a validation of diagnosis codes before inclusion. In addition, Faroese medical students with in-depth understanding of the Faroese language and healthcare system collected all data. Finally, to increase uniformity of the review process throughout the study period, one of the medical students participated in the data collections both before and after accreditation.

The study's limitations include a lack of a control group, impeding causal inferences about the impact of accreditation. Given the limited number of inhabitants of the 18 Faroe Islands who can only use the three hospitals, creating an adequate control group was practically impossible. Nonetheless, since none of the hospitals have previously participated in systematic quality improvement activities and no other major activities took place at the time of the accreditation, there are grounds for believing that the observed changes in LOS can be attributed to accreditation. A risk of confounding is inherent to the observational design. However, we adjusted for important clinical and patient characteristics such as sex, age, diagnosis, cohabitant status, in hospital rehabilitation and type of admission. The documentation in the patient files was too incomplete to adjust for disease severity. However, disease severity as a single factor is unlikely to substantially impact the results. Finally, we might have missed smaller changes in AR and mortality because of the relatively small sample size.

**Interpretation within the context of the wider literature**

The most notable finding was the association between accreditation and LOS. In-patients were on average hospitalized 5.9 days less after accreditation indicating that the hospitals had become more efficient which would potentially allow them to treat more patients. This result confirms studies that found similar results [8, 9, 13, 20]. Others have not found an association [14, 18] possibly because of unaccounted organisational differences between accredited and non-accredited hospitals. An explanation for the reduction in LOS might be that many of the accreditation standards in the modified DDKM model focus on this area. Another study investigating the original version of the Danish accreditation model, also found a reduction of LOS,

however the results were less pronounced than ours [11, 12]. In Denmark, several quality improvement initiatives were implemented prior to hospital accreditation, and LOS was declining beforehand. The strong reduction of LOS of women in childbirth might be explained by "harvesting low hanging fruit" in a generally healthy population. Importantly, we did not find an increased risk of AR after accreditation; undeniably an undesirable consequence of discharging patients too early. This is consistent with previous research [11, 12, 14]. The risk of AR is largely influenced by factors after discharge such as the patient's health status and socioeconomic situation and the primary healthcare system [27]. Accreditation standards would have to address these factors in order to reduce ARs. Contrary to previous research, accreditation on the Faroese islands was not associated with a reduction of 30-day mortality [8, 9, 12, 15, 16, 28, 29]. A possible explanation could be our comparatively small sample which precluded the detection of small differences given the *a priori* low mortality (~3%).

**Implications for policy, practice and research**

The Faroese hospitals became more efficient by reducing LOS without increasing ARs. This improvement was achieved in a setting without prior experience with systematic quality improvement activities. Against this background, this first cycle of accreditation of the Faroese hospitals focused on planning and implementing quality actions rather than on competencies to analyze, evaluate and act on the results of these activities. Accreditation planners can benefit from such a simplified approach of broader accreditation models in settings with little experience in quality improvement. We believe that this approach is transferable to "inexperienced" settings including some low-income countries.

Accreditation could benefit from developing or customizing standards including the identification of vulnerable patients [27] and the collaboration between the hospital and the primary care sector. Such cooperation should help to ensure that in-patients after discharge are treated in an integrated healthcare system with a framework for providing support and optimal care that consequently prevents AR.

In addition, accreditation research has focused on the effects of accreditation during admission or shortly after, and less on the sustainability of these effects over time. More studies are needed to explore this question because long-term studies may also reveal more outcomes, benefits or adverse effects not addressed in short-term studies [30]. Finally, future research should also focus on the cost of accreditation versus the potential gains, for example, through cost-benefit studies.

## CONCLUSIONS

First-time hospital accreditation in a setting without prior systematic quality improvement activities was associated with significantly shorter LOS, mainly among women in childbirth, without an increase in ARs of in-patients admitted to Faroese hospitals. We found no difference in 30-day mortality. We believe that our findings are transferable to similar settings including low-income countries.

## CONTRIBUTORSHIP

The study was designed and led by M.D.B and co-designed by all authors. Both data collections were coordinated by M.D.B. All statistical analyses were performed by M.D.B in collaboration with senior statistician J.B.V. All authors read and approved the final manuscript.

## ETHICS AND OTHER PERMISSIONS

All methods were carried out in accordance with relevant guidelines and regulations. The study was approved by the Danish Data Protection Agency (J # 2012-58-0004), the Faroese Data Protection Agency (J # 16/00135-12) and the Danish Patient Safety Authority (J # 3-3013-1648/1). According to Danish and Faroese law, the study did not need any ethics approval as human biological material is included in the project (J # 16018707). Access to the Faroese medical records was approved by the Danish Patient Safety Authority. Patient consent was not required.

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## CONFLICT OF INTERESTS

The authors declare that they have no competing interests.

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## DATA SHARING STATEMENT

The datasets generated and analysed during the current study are not publicly available due to the privacy of the individuals who participated in the study. According to Danish law access to data can only be granted by applying to The National hospital in the Faroe Islands, the Danish Patient Safety Authority and the Danish and the Faroese Data Protection Agency.

## REFERENCES


1. Greenfield D, Braithwaite J: **Health sector accreditation research: a systematic review**. *Int J Qual Health Care* 2008, **20**(3):172-183.
2. Jha AK: **Accreditation, Quality, and Making Hospital Care Better**. *JAMA* 2018, **320**(23):2410-2411.
3. Viswanathan HN, Salmon JW: **Accrediting organizations and quality improvement**. *Am J Manag Care* 2000, **6**(10):1117-1130.
4. Mumford V, Forde K, Greenfield D, Hinchcliff R, Braithwaite J: **Health services accreditation: what is the evidence that the benefits justify the costs?** *Int J Qual Health Care* 2013, **25**(5):606-620.
5. Hinchcliff R, Greenfield D, Westbrook JI, Pawsey M, Mumford V, Braithwaite J: **Stakeholder perspectives on implementing accreditation programs: a qualitative study of enabling factors**. *BMC Health Serv Res* 2013, **13**:437.
6. Alkhenizan A, Shaw C: **Impact of accreditation on the quality of healthcare services: a systematic review of the literature**. *Annals of Saudi medicine* 2011, **31**(4):407-416.
7. Brubakk K, Vist GE, Bukholm G, Barach P, Tjomsland O: **A systematic review of hospital accreditation: the challenges of measuring complex intervention effects**. *BMC Health Serv Res* 2015, **15**:280.
8. El-Menyar A, Mekkodathil A, Asim M, Consunji R, Strandvik G, Peralta R, Rizoli S, Abdelrahman H, Mollazehi M, Parchani A *et al*: **Maturation process and international accreditation of trauma system in a rapidly developing country**. *PLoS One* 2020, **15**(12):e0243658.
9. Sun P, Li J, Fang W, Su X, Yu B, Wang Y, Li C, Chen H, Wang X, Zhang B *et al*: **Effectiveness of chest pain centre accreditation on the management of acute coronary syndrome: a retrospective study using a national database**. *BMJ Qual Saf* 2020.
10. Al-Sughayir MA: **Effect of accreditation on length of stay in psychiatric inpatients: pre-post accreditation medical record comparison**. *Int J Ment Health Syst* 2016, **10**(1):55.
11. Falstie-Jensen AM, Norgaard M, Hollnagel E, Larsson H, Johnsen SP: **Is compliance with hospital accreditation associated with length of stay and acute readmission? A Danish nationwide population-based study**. *Int J Qual Health Care* 2015, **27**(6):451-458.
12. Falstie-Jensen AM, Bogh SB, Johnsen SP: **Consecutive cycles of hospital accreditation: Persistent low compliance associated with higher mortality and longer length of stay**. *Int J Qual Health Care* 2018, **30**(5):382-389.
13. Morton JM, Garg T, Nguyen N: **Does hospital accreditation impact bariatric surgery safety?** *Ann Surg* 2014, **260**(3):504-508; discussion 508-509.
14. Lee BY, Chun YJ, Lee YH: **Comparison of Major Clinical Outcomes between Accredited and Nonaccredited Hospitals for Inpatient Care of Acute Myocardial Infarction**. *Int J Environ Res Public Health* 2021, **18**(6).
15. Chun YJ, Lee BY, Lee YH: **Association between Accreditation and In-Hospital Mortality in Patients with Major Cardiovascular Diseases in South Korean Hospitals: Pre-Post Accreditation Comparison**. *Medicina (Kaunas)* 2020, **56**(9).
16. Ko T, Yang CH, Mao CT, Kuo LT, Hsieh MJ, Chen DY, Wang CY, Lin YS, Hsieh IC, Chen SW *et al*: **Effects of National Hospital Accreditation in Acute Coronary Syndrome on In-Hospital Mortality and Clinical Outcomes**. *Acta Cardiol Sin* 2020, **36**(5):416-427.
17. Gratwohl A, Brand R, McGrath E, van Biezen A, Sureda A, Ljungman P, Baldomero H, Chabannon C, Apperley J: **Use of the quality management system "JACIE" and**

**outcome after hematopoietic stem cell transplantation**. *Haematologica* 2014, **99**(5):908-915.
18. Kurichi JE, Vogel WB, Kwong PL, Xie D, Bates BE, Stineman MG: **Factors associated with total inpatient costs and length of stay during surgical hospitalization among veterans who underwent lower extremity amputation**. *Am J Phys Med Rehabil* 2013, **92**(3):203-214.
19. Chandra A, Glickman SW, Ou FS, Peacock WF, McCord JK, Cairns CB, Peterson ED, Ohman EM, Gibler WB, Roe MT: **An analysis of the Association of Society of Chest Pain Centers Accreditation to American College of Cardiology/American Heart Association non-ST-segment elevation myocardial infarction guideline adherence**. *Ann Emerg Med* 2009, **54**(1):17-25.
20. Telem DA, Talamini M, Altieri M, Yang J, Zhang Q, Pryor AD: **The effect of national hospital accreditation in bariatric surgery on perioperative outcomes and long-term mortality**. *Surg Obes Relat Dis* 2015, **11**(4):749-757.
21. Mikami M, Shida M, Shibata T, Katabuchi H, Kigawa J, Aoki D, Yaegashi N: **Impact of institutional accreditation by the Japan Society of Gynecologic Oncology on the treatment and survival of women with cervical cancer**. *J Gynecol Oncol* 2018, **29**(2):e23-e23.
22. Shaw C: **Toolkit for Accreditation Programs**. In: *The international Society for Quality in Health Care, Australia.* 2004.
23. **Statistics Faroe Islands** [https://hagstova.fo/en/population/population/population Accessed 14 September 2021]
24. **World Bank Open Data** [https://data.worldbank.org/country/faroe-islands Accessed 14 September 2021]
25. **Akkrediteringsstandarder for de færøske sygehuse** [https://www.ikas.dk/deltagere-i-ddkm/faeroeske-sygehuse/ Accessed 14 September 2021]
26. Bergholt MD, Falstie-Jensen AM, Hibbert P, Eysturoy BJ, Guttesen G, Róin T, Valentin JB, Braithwaite J, von Plessen C, Johnsen SP: **The association between first-time accreditation and the delivery of recommended care: a before and after study in the Faroe Islands**. *BMC Health Serv Res* 2021, **21**(1):917.
27. Kangovi S, Grande D: **Hospital readmissions--not just a measure of quality**. *JAMA* 2011, **306**(16):1796-1797.
28. Falstie-Jensen AM, Larsson H, Hollnagel E, Norgaard M, Svendsen ML, Johnsen SP: **Compliance with hospital accreditation and patient mortality: a Danish nationwide population-based study**. *Int J Qual Health Care* 2015, **27**(3):165-174.
29. Fan F, Li Y, Zhang Y, Li J, Liu J, Hao Y, Smith SC, Jr., Fonarow GC, Taubert KA, Ge J *et al*: **Chest Pain Center Accreditation Is Associated With Improved In-Hospital Outcomes of Acute Myocardial Infarction Patients in China: Findings From the CCC-ACS Project**. *J Am Heart Assoc* 2019, **8**(21):e013384.
30. Øvretveit J, Gustafson D: **Evaluation of quality improvement programmes**. *Qual Saf Health Care* 2002, **11**(3):270-275.

# TABLES

**Table 1. Patient characteristics before and after first-time accreditation**

| | Before Accreditation 2012 and 2013 | After Accreditation 2017 and 2018 |
|---|---|---|
| **Characteristic** | N = 277 | N = 532 |
| **Sex, n (%)** | | |
| Male | 100 (36) | 112 (21) |
| Female | 177 (64) | 420 (79) |
| **Age (years)** | | |
| Mean (range) | 62 (18;97) | 48 (19;96) |
| **Age, n (%)** | | |
| < 50 years | 82 (30) | 323 (61) |
| 50-75 years | 84 (30) | 95 (18) |
| > 75 years | 111 (40) | 114 (21) |
| **Cohabitant status, n (%)** | | |
| Cohabitant | 160 (58) | 251 (47) |
| Living alone | 47 (17) | 37 (7) |
| Other, i.e. Nursing home | 34 (12) | 34 (6) |
| Undisclosed | 36 (13) | 210 (40) |
| **Employment status, n (%)** | | |
| Working | 56 (20) | 87 (16) |
| Not working | 91 (33) | 84 (16) |
| Undisclosed | 130 (47) | 361 (68) |
| **Type of admission, n (%)** | | |
| Acute | 254 (92) | 463 (87) |
| Scheduled | 23 (8) | 69 (13) |
| **Clinical condition, n (%)** | | |
| Stroke/TIA | 27 (10) | 62 (12) |
| Bleeding gastric ulcer | 12 (4) | 3 (1) |
| COPD | 70 (25) | 76 (14) |
| Childbirth | 77 (28) | 315 (59) |
| Heart failure | 23 (8) | 52 (10) |
| Hip fracture | 68 (25) | 24 (4) |
| **Department, n (%)** | | |
| Surgical | 66 (24) | 27 (5) |
| Medical | 92 (33) | 8 (2) |
| Specialist | 92 (33) | 447 (84) |
| Mixed (surgical/medical) | 27 (10) | 50 (9) |
| **Transfer between hospitals, n (%)** | | |
| Yes | 38 (14) | 33 (6) |
| No | 239 (86) | 499 (94) |
| **Treatment in Denmark, n (%)** | | |
| Yes | 4 (1) | 4 (1) |
| No | 273 (99) | 528 (99) |
| **Rehabilitation during hospitalization, n (%)** | | |
| Yes | 35 (13) | 22 (4) |
| No | 242 (87) | 510 (96) |
| **Treating hospital, n (%)** | | |
| The National hospital | 211 (76) | 459 (86) |
| Klaksvik hospital | 34 (12) | 46 (9) |
| Suderø hospital | 32 (12) | 27 (5) |

**Table 2. Length of stay and hazard rate ratio for a shorter length of stay when treated in a hospital after accreditation**

| | | Mean | | Median | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|---|---|---|
| | N | in days | 95% CI | in days | IQR | HR | 95% CI | HR | 95% CI |
| **ALL CLINICAL CONDITION** | | | | | | | | | |
| Before accreditation[a] | 277 | 13.4 | 10.8, 15.9 | 6 | 3, 13 | 1.00 | | 1.00 | |
| After accreditation | 532 | 7.5 | 6.1, 8.9 | 4 | 2, 6 | **1.59** | **1.38, 1.83** | **1.23** | **1.04, 1.46[b]** |
| **BY CLINICAL CONDITION** | | | | | | | | | |
| **STROKE/TIA** | | | | | | | | | |
| Before accreditation[a] | 27 | 24.4 | 11.6, 37.1 | 9 | 4, 35 | 1.00 | | 1.00 | |
| After accreditation | 62 | 20.7 | 11.0, 30.4 | 8 | 2, 11 | 1.17 | 0.76, 1.81 | 1.07 | 0.72, 1.59[e] |
| **BLEEDING GASTRIC ULCER** | | | | | | | | | |
| Before accreditation[a] | 12 | 9.7 | 4.5, 14.9 | 6 | 3.5, 11.5 | 1.00 | | 1.00 | |
| After accreditation | 3 | 10.7 | 5.6, 15.8 | 11 | 5, 16 | 0.85 | 0.36, 2.03 | 0.93 | 0.45, 1.92[e] |
| **COPD** | | | | | | | | | |
| Before accreditation[a] | 70 | 8.8 | 6.5, 11.1 | 6 | 3, 9 | 1.00 | | 1.00 | |
| After accreditation | 76 | 7.0 | 5.2, 8.9 | 5 | 3, 9 | 1.20 | 0.87, 1.65 | 1.27 | 0.88, 1.83[e] |
| **CHILDBIRTH** | | | | | | | | | |
| Before accreditation[a] | 77 | 6.3 | 3.8, 8.7 | 4 | 3, 5 | 1.00 | | 1.00 | |
| After accreditation | 315 | 3.8 | 3.5, 4.2 | 3 | 2, 4 | **1.43** | **1.15, 1.78** | **1.30** | **1.04, 1.62[e]** |
| **HEART FAILURE** | | | | | | | | | |
| Before accreditation[a] | 23 | 11.8 | 6.3, 17.3 | 6 | 2, 14 | 1.00 | | 1.00 | |
| After accreditation | 52 | 8.6 | 5.4, 11.8 | 4 | 2.5, 10.5 | 1.41 | 0.82, 2.41 | 0.95 | 0.53, 1.71[e] |
| **HIP FRACTURE** | | | | | | | | | |
| Before accreditation[a] | 68 | 20.9 | 15.3, 26.5 | 14 | 6.5, 24 | 1.00 | | 1.00 | |
| After accreditation | 24 | 21.5 | 11.2, 31.8 | 12 | 6, 16.5 | 1.02 | 0.58, 1.81 | 1.36 | 0.81, 2.28[e] |

*[a] Reference group; [b] Adjusted for age, sex, cohabitant status, diagnosis, type of admission, in hospital rehabilitation and cluster effect at patient and hospital level; [e] Adjusted for age, sex, cohabitant status, type of admission and cluster effect at patient and hospital level*

**Table 3. Acute readmissions and hazard rate ratio for acute readmissions when treated in a hospital after accreditation**

| | | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|
| | N | % (n) | HR | 95% CI | HR | 95% CI |
| **ALL CLINICAL CONDITIONS** | | | | | | |
| Before accreditation[a] | 261 | 12.3 (32) | 1.00 | | 1.00 | |
| After accreditation | 516 | 9.5 (49) | 0.77 | 0.47, 1.27 | 1.34 | 0.82, 2.18[b] |
| **BY CLINICAL CONDITION** | | | | | | |
| **STROKE/TIA** | | | | | | |
| Before accreditation[a] | 26 | 11.5 (3) | 1.00 | | 1.00 | |
| After accreditation | 54 | 9.3 (5) | 0.80 | 0.19, 3.37 | 1.03 | 0.24, 4.36[e] |
| **BLEEDING GASTRIC ULCER** | | | | | | |
| Before accreditation[a] | 12 | 8.3 (1) | 1.00 | | 1.00 | |
| After accreditation | 3 | 33.3 (1) | 4.90 | 0.36, 66.57 | **6.47** | **1.12, 37.63[f]** |
| **COPD** | | | | | | |
| Before accreditation[a] | 62 | 19.4 (12) | 1.00 | | 1.00 | |
| After accreditation | 72 | 36.1 (26) | 2.06 | 1.03, 4.15 | 1.70 | 0.83, 3.50[e] |
| **CHILDBIRTH** | | | | | | |
| Before accreditation[a] | 77 | 2.6 (2) | 1.00 | | 1.00 | |
| After accreditation | 314 | 1.6 (5) | 0.61 | 0.12, 3.14 | 0.77 | 0.14, 4.15[e] |
| **HEART FAILURE** | | | | | | |
| Before accreditation[a] | 19 | 21.1 (4) | 1.00 | | 1.00 | |
| After accreditation | 50 | 18.0 (9) | 0.91 | 0.28, 2.96 | 0.96 | 0.25, 3.78[e] |
| **HIP FRACTURE** | | | | | | |
| Before accreditation[a] | 65 | 15.4 (10) | 1.00 | | 1.00 | |
| After accreditation | 23 | 13.0 (3) | 0.83 | 0.24, 2.82 | 0.83 | 0.22, 3.13[e] |

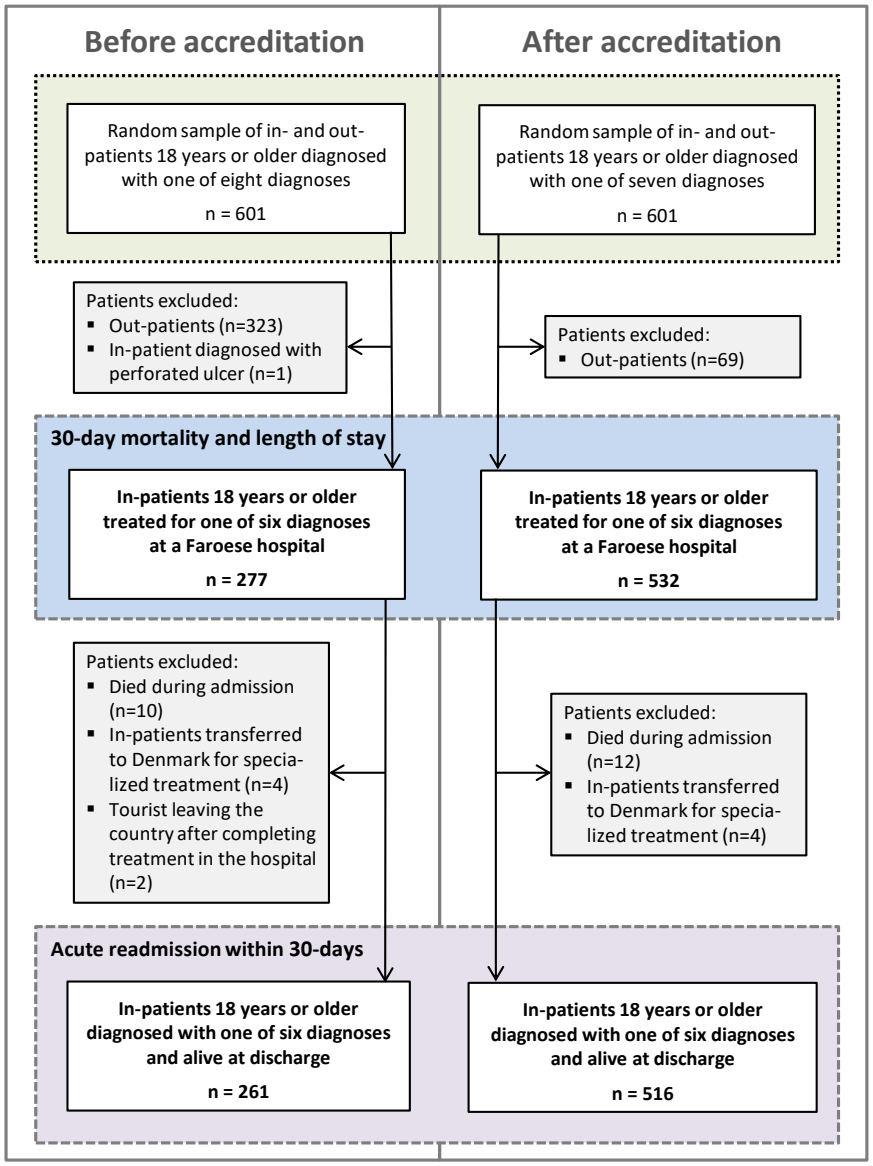
*[a] Reference group; [b] Adjusted for age, sex, cohabitant status, diagnosis, type of admission and cluster effect at patient and hospital level*
*[e] Adjusted for age, sex, cohabitant status and cluster effect at patient and hospital level; [f] Adjusted for age, sex and cluster effect at patient and hospital level*

**Table 4. 30-day mortality and hazard rate ratio for 30-day mortality when treated at a hospital after accreditation**

| | | | Unadjusted | | Adjusted | |
|---|---|---|---|---|---|---|
| | N | % (n) | HR | 95% CI | HR | 95% CI |
| **ALL CLINICAL CONDITIONS** | | | | | | |
| Before accreditation[a] | 277 | 3.3 (9) | 1.00 | | 1.00 | |
| After accreditation | 532 | 2.8 (15) | 0.86 | 0.37, 1.99 | 1.33 | 0.55, 3.21[b] |
| **BY CLINICAL CONDITION** | | | | | | |
| **STROKE/TIA** | | | | | | |
| Before accreditation[a] | 27 | 3.7 (1) | 1.00 | | 1.00 | |
| After accreditation | 62 | 9.7 (6) | 2.67 | 0.32, 22.58 | 3.23 | 0.33, 31.45[e] |
| **BLEEDING GASTRIC ULCER** | | | | | | |
| Before accreditation[a] | 12 | 0 | - | - | - | - |
| After accreditation | 3 | 0 | - | - | - | - |
| **COPD** | | | | | | |
| Before accreditation[a] | 70 | 7.1 (5) | 1.00 | | 1.00 | |
| After accreditation | 76 | 9.2 (7) | 1.25 | 0.39, 4.05 | 1.05 | 0.30, 3.65[e] |
| **CHILDBIRTH** | | | | | | |
| Before accreditation[a] | 77 | 0 | - | - | - | - |
| After accreditation | 315 | 0 | - | - | - | - |
| **HEART FAILURE** | | | | | | |
| Before accreditation[a] | 23 | 4.4 (1) | 1.00 | | 1.00 | |
| After accreditation | 52 | 1.9 (1) | 0.43 | 0.03, 6.68 | 0.27 | 0.02, 3.52[e] |
| **HIP FRACTURE** | | | | | | |
| Before accreditation[a] | 68 | 2.9 (2) | 1.00 | | 1.00 | |
| After accreditation | 24 | 4.2 (1) | 1.37 | 0.13, 14.55 | 1.07 | 0.20, 5.98[e] |

*[a] Reference group; [b] Adjusted for age, sex, diagnosis, type of admission and cluster effect at patient and hospital level;*
*[e] Adjusted for age, sex, type of admission and cluster effect at patient and hospital level*

**Figure 1. Flowchart of in-patients included in the study**



**APPENDIX 1.**

The relative risk (RR) and risk difference (RD) was implemented to complement the cause specific hazard rate ratio (HR). While RR and RD compares observed proportions, cause-specific HRs compares rates, which reflects the effect if death did not occur under the assumption of no unadjusted common cause of death and event of interest.

**Appendix table 1.**
**The relative risk and risk difference for a shorter length of stay when treated in a hospital after accreditation**

| | | Unadjusted | | Adjusted | | Adjusted | |
|---|---|---|---|---|---|---|---|
| | N | RR | 95% CI | RR | 95% CI | RD | 95% CI |
| **ALL CLINICAL CONDITIONS** | | | | | | | |
| Before accreditation[a] | 277 | 1.00 | | 1.00 | | **0.07** | **0.01, 0.13[b]** |
| After accreditation | 532 | **1.11** | **1.04, 1.17** | **1.08** | **1.01, 1.16[b]** | | |
| **BY CLINICAL CONDITION** | | | | | | | |
| **STROKE/TIA** | | | | | | | |
| Before accreditation[a] | 27 | 1.00 | | 1.00 | | 0.07 | -0.18, 0.32[e] |
| After accreditation | 62 | 1.14 | 0.88, 1.49 | 1.11 | 0.75, 1.63[e] | | |
| **BLEEDING GASTRIC ULCER** | | | | | | | |
| Before accreditation[a] | 12 | 1.00 | | 1.00 | | **-0.20** | **-0.36, -0.04[f]** |
| After accreditation | 3 | 0.91 | 0.76, 1.11 | **0.78** | **0.63, 0.97[f]** | | |
| **COPD** | | | | | | | |
| Before accreditation[a] | 70 | 1.00 | | 1.00 | | 0.09 | -0.03, 0.23[e] |
| After accreditation | 76 | 1.06 | 0.96, 1.18 | 1.12 | 0.96, 1.30[e] | | |
| **CHILDBIRTH** | | | | | | | |
| Before accreditation[a] | 77 | 1.00 | | 1.00 | | 0.02 | -0.01, 0.05[e] |
| After accreditation | 315 | 1.04 | 0.99, 1.09 | 1.02 | 0.99, 1.05[e] | | |
| **HEART FAILURE** | | | | | | | |
| Before accreditation[a] | 23 | 1.00 | | 1.00 | | 0.04 | -0.13, 0.20[e] |
| After accreditation | 52 | 1.21 | 0.99, 1.48 | 1.04 | 0.86, 1.27[e] | | |
| **HIP FRACTURE** | | | | | | | |
| Before accreditation[a] | 68 | 1.00 | | 1.00 | | 0.07 | -0.12, 0.25[e] |
| After accreditation | 24 | 1.01 | 0.79, 1.28 | 1.09 | 0.85, 1.40[e] | | |

*[a] Reference group; [b] Adjusted for age, sex, cohabitant status, diagnosis, type of admission, in hospital rehabilitation and cluster effect at hospital level; [e] Adjusted for age, sex, cohabitant status, type of admission and cluster effect at hospital level; [f] Adjusted for age, sex and cluster effect at hospital level*

**Appendix table 2.**
**The relative risk and risk difference for acute readmission when treated in a hospital after accreditation**

| | | Unadjusted | | Adjusted | | Adjusted | |
|---|---|---|---|---|---|---|---|
| | N | RR | 95% CI | RR | 95% CI | RD | 95% CI |
| **ALL CLINICAL CONDITIONS** | | | | | | | |
| Before accreditation[a] | 261 | 1.00 | | 1.00 | | 0.02 | -0.03, 0.06[b] |
| After accreditation | 516 | 0.77 | 0.53, 1.14 | 1.16 | 0.72, 1.89[b] | | |
| **BY CLINICAL CONDITION** | | | | | | | |
| **STROKE/TIA** | | | | | | | |
| Before accreditation[a] | 26 | 1.00 | | 1.00 | | 0.03 | -0.09, 0.15[e] |
| After accreditation | 54 | 0.81 | 0.17, 3.81 | 1.33 | 0.27, 6.57[e] | | |
| **BLEEDING GASTRIC ULCER** | | | | | | | |
| Before accreditation[a] | 12 | 1.00 | | 1.00 | | 0.11 | -0.08, 0.29[f] |
| After accreditation | 3 | 3.54 | 1.57, 7.98 | **2.51** | **1.03, 6.12**[f] | | |
| **COPD** | | | | | | | |
| Before accreditation[a] | 62 | 1.00 | | 1.00 | | 0.07 | -0.12, 0.27[e] |
| After accreditation | 72 | 1.86 | 1.01, 3.39 | 1.29 | 0.60, 2.76[e] | | |
| **CHILDBIRTH** | | | | | | | |
| Before accreditation[a] | 77 | 1.00 | | 1.00 | | -0.002 | -0.03, 0.02[e] |
| After accreditation | 314 | 0.62 | 0.15, 2.45 | 0.87 | 0.18, 4.32[e] | | |
| **HEART FAILURE** | | | | | | | |
| Before accreditation[a] | 19 | 1.00 | | 1.00 | | 0.006 | -0.25, 0.26[e] |
| After accreditation | 50 | 0.86 | 0.23, 3.18 | 1.03 | 0.28, 3.82[e] | | |
| **HIP FRACTURE** | | | | | | | |
| Before accreditation[a] | 65 | 1.00 | | 1.00 | | -0.05 | -0.23, 0.14[e] |
| After accreditation | 23 | 0.84 | 0.26, 2.75 | 0.74 | 0.21, 2.62[e] | | |

*[a] Reference group; [b] Adjusted for age, sex, cohabitant status, diagnosis, type of admission and cluster effect at hospital level; [e] Adjusted for age, sex, cohabitant status, type of admission and cluster effect at hospital level; [f] Adjusted for age, sex and cluster effect at hospital level*

**Appendix table 3.**
**The relative risk and risk difference for 30-day mortality when treated in a hospital after accreditation**

| | | Unadjusted | | Adjusted | | Adjusted | |
|---|---|---|---|---|---|---|---|
| | N | RR | 95% CI | RR | 95% CI | RD | 95% CI |
| **ALL CLINICAL CONDITIONS** | | | | | | | |
| Before accreditation[a] | 277 | 1.00 | | 1.00 | | 0.01 | -0.01, 0.04[b] |
| After accreditation | 532 | 0.86 | 0.36, 2.05 | 1.53 | 0.66, 3.72[b] | | |
| **BY CLINICAL CONDITION** | | | | | | | |
| **STROKE/TIA** | | | | | | | |
| Before accreditation[a] | 27 | 1.00 | | 1.00 | | 0.068 | -0.05, 0.19[e] |
| After accreditation | 62 | 2.66 | 0.71, 10.05 | 2.68 | 0.69, 10.35[e] | | |
| **BLEEDING GASTRIC ULCER** | | | | | | | |
| Before accreditation[a] | 12 | - | - | - | - | - | - |
| After accreditation | 3 | - | - | - | - | | |
| **COPD** | | | | | | | |
| Before accreditation[a] | 70 | 1.00 | | 1.00 | | -0.01 | -0.12, 0.09[e] |
| After accreditation | 76 | 1.28 | 0.39, 4.15 | 0.88 | 0.23, 3.40[e] | | |
| **CHILDBIRTH** | | | | | | | |
| Before accreditation[a] | 77 | - | - | - | - | - | - |
| After accreditation | 315 | - | - | - | - | | |
| **HEART FAILURE** | | | | | | | |
| Before accreditation[a] | 23 | 1.00 | | 1.00 | | -0.03 | -0.09, 0.04[e] |
| After accreditation | 52 | 0.43 | 0.13, 1.45 | 0.47 | 0.15, 1.50[e] | | |
| **HIP FRACTURE** | | | | | | | |
| Before accreditation[a] | 68 | 1.00 | | 1.00 | | -0.001 | -0.07, 0.07[f] |
| After accreditation | 24 | 1.38 | 0.46, 4.19 | 0.96 | 0.21, 4.47[f] | | |

*[a] Reference group; [b] Adjusted for age, sex, cohabitant status, diagnosis, type of admission and cluster effect at hospital level; [e] Adjusted for age, sex, cohabitant status, type of admission and cluster effect at hospital level; [f] Adjusted for age, sex and cluster effect at hospital level*

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# Declaration of co-authorship concerning article for PhD dissertations

Full name of the PhD student: Maria Daniella Bergholt

This declaration concerns the following article/manuscript:

| | |
|---|---|
| Title: | The association between first-time accreditation andf the delivery of recommended care: a before and after study in the Faroe Islands |
| Authors: | Maria Daniella Bergholt, Anne Mette Falstie-Jensen, Peter Hibbert, Barbara Joensen Eysturoy, Gunnvá Guttesen, Tóra Róin, Jan Brink Valentin, Jeffrey Braithwaite, Christian von Plessen and Søren Paaske Johnsen |

The article/manuscript is: Published ☒ Accepted ☐ Submitted ☐ In preperation ☐

If published, state full reference: https://doi.org/10.1186/s12913-021-06952-w

If accepted or submitted, state journal: BMC Health Services Research

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

## Your contribution

Please rate (A-F) your contribution to the elements of this article/manuscript, **and** elaborate on your rating in the free text section below.

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B. Has done most of the work (67-90 %)
C. Has contributed considerably (34-66 %)
D. Has contributed (10-33 %)
E. No or little contribution (<10%)
F. N/A

| Category of contribution | Extent (A-F) |
|---|---|
| The conception or design of the work: | A |
| *Free text description of PhD student's contribution* ***(mandatory)*** The overall design including drafting the protocol was undertaken by the PhD student. | |
| The acquisition, analysis, or interpretation of data: | A |
| *Free text description of PhD student's contribution* ***(mandatory)*** The PhD student was responsible for the development of a database for the data collections. In addition, the cleaning of the register extract from the Faroese National Patient register was also performed by the PhD student. The data collections were conducted by five medical students under the guidance of the PhD student. All coding and analysis work was performed by the PhD student with statistical support from a senior statistician. In addition, the interpretation of the data was performed by the PhD student. | |
| Drafting the manuscript: | A |

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| |
|---|
| *Free text description of PhD student's contribution* ***(mandatory)***<br>The drafting of the manuscript was performed by the PhD student |
| Submission process including revisions: A |
| *Free text description of PhD student's contribution* ***(mandatory)***<br>The submission of the manuscript was completed by the PhD student. In addition, the PhD student also provided responses to reviewer comments and subsequently implemented changes to the manuscript |

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| 24.09.2021 | Maria Daniella Bergholt | |
| 29.09.2021 | Søren Paaske Johnsen | |
| 29.09.2021 | Mette Nørgaard | |

Date: 29/09-2021

Signature of the PhD student

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# Declaration of co-authorship concerning article for PhD dissertations

Full name of the PhD student: Maria Daniella Bergholt

This declaration concerns the following article/manuscript:

| | |
|---|---|
| Title: | Patients experience more support, information and involvemnt after first-time hospital accreditation: a before and after study in the Faroe Islands |
| Authors: | Maria Daniella Bergholt, Anne Mette Falstie-Jensen, Jan Brink Valentin, Peter Hibbert, Jeffrey Braithwaite, Søren Paaske Johnsen and Christian von Plessen |

The article/manuscript is: Published ☐ Accepted ☐ Submitted ☒ In preperation ☐

If published, state full reference:

If accepted or submitted, state journal: International Journal for Quality in Health Care

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

## Your contribution

Please rate (A-F) your contribution to the elements of this article/manuscript, **and** elaborate on your rating in the free text section below.

A. Has essentially done all the work (>90%)
B. Has done most of the work (67-90 %)
C. Has contributed considerably (34-66 %)
D. Has contributed (10-33 %)
E. No or little contribution (<10%)
F. N/A

| Category of contribution | Extent (A-F) |
|---|---|
| The conception or design of the work: | A |
| *Free text description of PhD student's contribution* ***(mandatory)***<br>The overall design including drafting the protocol was undertaken by the PhD student | |
| The acquisition, analysis, or interpretation of data: | A |
| *Free text description of PhD student's contribution* ***(mandatory)***<br>The development of a database for the data collections was carried out by the PhD student. In addition, the PhD student also collected all data in 2016 and 2018.<br>All coding and analyses was performed by the PhD student under the supervision of a senior statistician. Furthermore, the interpretation of data was also performed by the PhD student. | |
| Drafting the manuscript: | A |
| *Free text description of PhD student's contribution* ***(mandatory)***<br>The drafting of the manuscript was performed by the PhD student | |

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| Submission process including revisions: | A |
|---|---|
| *Free text description of PhD student's contribution* ***(mandatory)***<br>The submission of the manuscript was completed by the PhD student. No revisions has been completed yet. | |

**Signatures of first- and last author, and main supervisor**

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| 27.09.2021 | Christian von Plessen | |
| 29.09.2021 | Mette Nørgaard | |

Date: 29/09-2021

Signature of the PhD student

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# Declaration of co-authorship concerning article for PhD dissertations

Full name of the PhD student: Maria Daniella Bergholt

This declaration concerns the following article/manuscript:

| | |
|---|---|
| Title: | Shorter length of stay after first-time hospital accreditation: a national before and after study in the Faroe Islands |
| Authors: | Maria Daniella Bergholt, Christian von Plessen, Søren Paaske Johnsen, Peter Hibbert, Jeffrey Braithwaite, Jan Brink Valentin and Anne Mette Falstie-Jensen |

The article/manuscript is: Published ☐ Accepted ☐ Submitted ☐ In preperation ☒

If published, state full reference:

If accepted or submitted, state journal:

Has the article/manuscript previously been used in other PhD or doctoral dissertations?

No ☒ Yes ☐ If yes, give details:

## Your contribution

Please rate (A-F) your contribution to the elements of this article/manuscript, **and** elaborate on your rating in the free text section below.

A. Has essentially done all the work (>90%)
B. Has done most of the work (67-90 %)
C. Has contributed considerably (34-66 %)
D. Has contributed (10-33 %)
E. No or little contribution (<10%)
F. N/A

| Category of contribution | Extent (A-F) |
|---|---|
| The conception or design of the work: | A |
| *Free text description of PhD student's contribution* ***(mandatory)*** The overall design including drafting the protocol was undertaken by the Phd student | |
| The acquisition, analysis, or interpretation of data: | A |
| *Free text description of PhD student's contribution* ***(mandatory)*** The PhD student was responsible for the development of a database for the data collections. In addition, the cleaning of the register extract from the Faroese National Patient register was also performed by the PhD student. The data collections were conducted by five medical students under the guidance of the PhD student. All coding and analysis work was performed by the PhD student with statistical support from a senior statistician. In addition, the interpretation of the data was performed by the PhD student. | |
| Drafting the manuscript: | A |
| *Free text description of PhD student's contribution* ***(mandatory)*** The drafting of the manuscript was performed by the PhD student | |

| Submission process including revisions: | N/A |
|---|---|
| *Free text description of PhD student's contribution* ***(mandatory)***<br>The manuscript has not yet been submitted | |

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| 29.09.2021 | Mette Nørgaard | |

Date: 29/09-2021

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## Reports/PhD theses from Department of Clinical Epidemiology

1. Ane Marie Thulstrup: Mortality, infections and operative risk in patients with liver cirrhosis in Denmark. Clinical epidemiological studies. PhD thesis. *2000*.

2. Nana Thrane: Prescription of systemic antibiotics for Danish children. PhD thesis. *2000*.

3. Charlotte Søndergaard. Follow-up studies of prenatal, perinatal and postnatal risk factors in infantile colic. PhD thesis. *2001*.

4. Charlotte Olesen: Use of the North Jutland Prescription Database in epidemiological studies of drug use and drug safety during pregnancy. PhD thesis. *2001*.

5. Yuan Wei: The impact of fetal growth on the subsequent risk of infectious disease and asthma in childhood. PhD thesis. *2001*.

6. Gitte Pedersen. Bacteremia: treatment and prognosis. PhD thesis. *2001*.

7. Henrik Gregersen: The prognosis of Danish patients with monoclonal gammopathy of undertermined significance: register-based studies. PhD thesis. *2002*.

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9. Søren Paaske Johnsen: Risk factors for stroke with special reference to diet, Chlamydia pneumoniae, infection, and use of non-steroidal anti-inflammatory drugs. PhD thesis. *2002*.

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15. Kronisk obstruktiv lungesygdom i Nordjyllands, Viborg og Århus amter 1994-2004. Forekomst og prognose. Et pilotprojekt. *2005*.

16. Lungebetændelse i Nordjyllands, Viborg og Århus amter 1994-2004. Forekomst og prognose. Et pilotprojekt. *2005*.

17. Kort- og langtidsoverlevelse efter indlæggelse for nyre-, bugspytkirtel- og leverkræft i Nordjyllands, Viborg, Ringkøbing og Århus amter 1985-2004. *2005*.

18. Kort- og langtidsoverlevelse efter indlæggelse for udvalgte kræftsygdomme i Nordjyllands, Viborg, Ringkøbing og Århus amter 1995-2005. *2005*.

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    Særtryk: Klinisk Epidemiologisk Afdeling - De første 5 år. *2006*.

21. Blindtarmsbetændelse i Vejle, Ringkjøbing, Viborg, Nordjyllands og Århus Amter. *2006*.

22. Andre sygdommes betydning for overlevelse efter indlæggelse for seks kræftsygdomme i Nordjyllands, Viborg, Ringkjøbing og Århus amter 1995-2005. *2006*.

23. Ambulante besøg og indlæggelser for udvalgte kroniske sygdomme på somatiske hospitaler i Århus, Ringkjøbing, Viborg, og Nordjyllands amter. *2006*.

24. Ellen M Mikkelsen: Impact of genetic counseling for hereditary breast and ovarian cancer disposition on psychosocial outcomes and risk perception: A population-based follow-up study. PhD thesis. *2006*.

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31. Kort- og langtidsoverlevelse efter indlæggelse for udvalgte kræftsygdomme i Region Midtjylland og Region Nordjylland 1995-2006. *2007*.

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41. Kort- og langtidsoverlevelse efter indlæggelse for udvalgte kræftsygdomme i Region Midtjylland og Region Nordjylland 1996-2007. *2008*.

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42. Akutte indlæggelsesforløb og skadestuebesøg på hospiter i Region Midtjylland og Region Nordjylland 2003-2007. Et pilotprojekt. *Not published*.

43. Peter Jepsen: Prognosis for Danish patients with liver cirrhosis. PhD thesis. *2009*.

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61. Kort- og langtidsoverlevelse efter hospitalsbehandlet kræft. Region Midtjylland og Region Nordjylland 1998-2009. *2010*.

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78. Risiko for kræft blandt patienter med kronisk obstruktiv lungesygdom (KOL) i Danmark. (Online publication only). *2013*.

79. Kirurgisk fjernelse af milten og risikoen for efterfølgende infektioner, blodpropper og død. Danmark 1996-2005. (Online publication only). *2013*.

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92. Jonathan Montomoli: Short-term prognosis after colorectal surgery: The impact of liver disease and serum albumin. PhD thesis. *2014*.

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101. Thomas Lyngaa: Intensive care at the end-of-life in patients dying of cancer and non-cancer chronic diseases: A nationwide study. Research year report. *2015*.

102. Lone Winther Lietzen: Markers of immune competence and the clinical course of breast cancer. PhD thesis. *2015*.

103. Anne Høy Seemann Vestergaard: Geographical Variation in Use of Intensive Care in Denmark: A Nationwide Study. Research year report. *2015*.

104. Cathrine Wildenschild Nielsen: Fecundability among Danish pregnancy planners. Studies on birth weight, gestational age and history of miscarriage. PhD thesis. *2015*.

105. Kathrine Dyhr Lycke: Preadmission use of antidepressants and quality of care, intensive care admission and mortality of colorectal cancer surgery – a nationwide population-based cohort study. Research year report. *2015*.

106. Louise Bill: Hyponatremia in acute internal medicine patients: prevalence and prognosis. PhD thesis. *2015*.

107. Kirstine Kobberøe Søgaard: Risk and prognosis of venous thromboembolism in patients with liver disease. PhD thesis. *2015*.

108. Rikke Nørgaard Pedersen: Reoperation due to surgical bleeding in breast cancer patients and breast cancer recurrence: A Danish population-based cohort study. Research year report. *2015*.

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110. Anne Mette Falstie-Jensen: Hospital accreditation – what's in it for the patients? PhD thesis. *2016*.

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