TIINA MÄENPÄÄ

The Outcomes of Regional Health Information Exchange in Health Care Delivery

■

ACADEMIC DISSERTATION
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Ulvila, October 2012

Tiina Mäenpää

Abstract

Tiina Mäenpää: The outcomes of regional health information exchange in health care delivery

The overall aim of this study was to clarify the outcomes, i.e. the benefits and effectiveness, of health information exchange (HIE) through regional health information system (RHIS) concerning patient service package and health care delivery in one hospital district area in the five-year period of 2004–2008.

Both qualitative and quantitative research methods were used for the empirical demonstration and evaluation of the benefits of HIE through RHIS. A systematic literature review was used to find out the outcomes of the different types of regional health information systems in health care delivery. Quantitative outcome measurement, a retrospective, comparative, longitudinal five-year follow-up study, was used to evaluate the impact of HIE on health care delivery. A qualitative themed interview study design was used to provide a deeper understanding of the research results and the outcomes obtained with the use of HIE through RHIS.

There were three different sets of data in this study. The first set of data consisted of 24 empirical studies. The second set of data consisted of selected outcomes obtained from registry-based statistical data, comprising data routinely obtained of total laboratory tests, radiology examinations, appointments, emergency department visits, primary care referrals and emergency referrals to special care, and the viewed references in the five-year follow-up period, 2004–2008, both in primary and special care. The third set was interview data of health care professionals (physicians, nurses, department secretaries), and administrative representatives, total (n=43) and chronically ill patients (n=10), who had the most experience of HIE.

Content analysis was used to analyse the review articles. Inductive content analysis was used to analyse both the review articles and the interview data. Additional deductive content analysis was used to categorize the interview data of chronically ill patients. Trend analysis was used for selected outcomes, and the t-test was used to determine the changes over the follow-up period. Linearity regression was used for modelling the link between the viewed references and selected outcomes during the five-year period. Analysis of Variance (ANOVA) was used to test the differences in averages between groups.

The main outcome areas found based on the literature review were flow of information, collaboration, process redesign, usability and factors affecting the organizational culture. Substantial changes in the selected outcomes were found in the follow-up period. The trends of HIE usage increased in each professional groups. There was also a significant association between the number of laboratory tests, radiology examinations, appointments, emergency visits, emergency referrals and the number of viewed references, i.e. HIE usage. When physicians made emergency referrals to special care, they viewed significantly more reference information and nurses used HIE significantly more in viewing reference information in emergency visits and when making emergency referrals. Also, the more appointments made with doctors there were, the more department secretaries viewed the reference information. HIE usage may have increased the efficiency of health care delivery in patient care by improving the professionals’ access to patient information across organization boundaries. However, the changes observed in the use of HIE services have many other explanations, and more research is needed to understand the impact of HIE on the efficiency of health care delivery.

Regional HIE changed the flow of information regarding the availability of information, exchange of information, and data protection after five-year usage. Regional collaboration improved between health care professionals, administrative staff and patients. HIE did not support the management of the patient service package, as patients were made more responsible for the management of their own service package and continuity of care. An improvement in the efficiency of working practices was observable among health care professionals, administrative staff and patients. The organizational commitment and management support of various stakeholders are needed for the necessary changes and a new way of working in health care delivery. The feedback from professionals is important for further development of health information systems.

In this study, a patient service package refers to one or several sets of health care services given to a patient, where health care service providers are concerned. Here health care delivery refers to health care services offered by primary care and special care providers to patients from municipalities and municipality federations. The professionals working in health care include health care professionals and administrative representatives. The term health care professionals refer to physicians, nurses and department secretaries.

The implementation of HIE through RHIS is a long-term process. In addition, investment in developing health information systems will continue. The study generated new knowledge about the the benefits and effectiveness of implementing health information exchange (HIE) through regional health information systems (RHISs) in health care delivery.

Key words: regional health information, health information exchange, regional health information system, outcome measure, health care delivery, patient service package

Tiivistelmä

Tiina Mäenpää: Alueellisesti yhteiskäyttöisten tietojen vaihdon vaikutukset terveydenhuollon palvelujärjestelmään

Tämän tutkimuksen tarkoituksena oli muodostaa selkeämpi näkemys aluetietojärjestelmän (engl. RHIS) mahdollistaman alueellisesti yhteiskäyttöisten tietojen vaihdon (engl. HIE) tuomista hyödyistä ja vaikutuksista potilaan palvelukokonaisuuteen ja palvelujärjestelmään yhden sairaanhoitopiirin alueella viiden vuoden seurantajakson aikana vuosina 2004–2008.

Tutkimuksessa käytettiin sekä kvantitatiivista että kvalitatiivista lähestymistapaa, jotta saataisiin empiirisesti tutkittua tietoa sekä arviointitietoa aluetietojärjestelmän mahdollistaman alueellisesti yhteiskäyttöisten tietojen vaihdon tuomista hyödyistä ja vaikutuksista. Systemaattisen kirjallisuuskatsauksen avulla pyrittiin löytämään erityyppisten alueellisten tietojärjestelmäpalveluiden vaikutukset ja hyödyt terveydenhuollon palvelujärjestelmässä. Kvantitatiivista outcome mittausta: retrospektiivistä, vertailevaa ja pitkittäistä viiden vuoden seurantatutkimusta vuosille 2004–2008 oli käytetty kuvaamaan alueellisesti yhteiskäyttöisten tietojen vaihdon vaikutuksia tutkimalla valittuja tulosmuuttujia terveydenhuollon palvelujärjestelmässä. Kvalitatiivista teemahaastattelua terveydenhuollon ammattilaisille ja potilaille käytettiin syventämään ymmärrystä aiempien tutkimusvaiheiden tuloksista alueellisesti yhteiskäyttöisten tietojen vaikutuksista.

Tutkimuksessa oli käytössä kolme eri tutkimusaineistoa. Ensimmäinen tutkimusaineisto koostui 24 empiirisestä tutkimuksesta. Toinen tutkimusaineisto koostui valituista tulosmuuttujista rekisteriaieaineistosta, jonka muodostivat terveydenhuollon potilastietojärjestelmien tietokantoihin rutiininomaisesti kertyneet tilastotiedot laboratoriotutkimusten, röntgentutkimusten, lääkärissäkäyntien, päivystyskäyntien ja lähetteiden sekä päivystyslähetteiden kokomaismääristä ja sekä perusterveydenhuollon että erikoissairaanhoidon katsottujen viitteiden määrät viiden vuoden seurantajakson 2004–2008 ajalta yhden sairaanhoitopiirin alueelta. Kolmas tutkimusaineisto oli haastatteluaineisto, jonka muodostivat terveydenhuollon eri ammattilaisten (lääkärit, hoitajat, osastosihteerit) ja hallinnon edustajien (yhteensä n = 43) haastattelut sekä niiden kroonisesti sairaiden potilaiden (n = 10) haastattelut, joilla oli eniten kokemusta alueellisesti yhteiskäyttöisestä tiedosta sairaanhoitopiirin alueelta.

Kirjallisuuskatsauksessa löydetyt artikkelit analysoitiin käyttäen sisällön analyysiä. Induktiivista sisällön analyysiä käytettiin kirjallisuuskatsauksen ja haastatteluaineiston analysointiin. Lisäksi deduktiivista sisällön analyysiä käytettiin luokittelemaan kroonisten potilaiden haastatteluaineistoa. Trendianalyysiä käytettiin valittujen seurattujen tulosmuuttujien analysoimiseen ja t-testiä käytettiin määrittelemään tapahtuneet muutokset niissä viiden vuoden seurantajakson ajalta. Lineaarista regressiota käytettiin mallintamaan yhteyttä katsottujen viitteiden eli alueellisen yhteiskäyttöisen tiedon käyttöasteen ja valittujen tulosmuuttujien välillä 5 vuoden periodilla tarkasteltuna. Varianssianalyysia (ANOVA) käytettiin testaamaan eri ryhmien välisiä keskiarvoja aineistossa.

Kirjallisuuskatsauksen mukaan alueellisesti yhteiskäyttöisten tietojen vaihtoon liittyvät päätulokset asettuvat sellaisille alueille kuin alueelliseen tiedonkulkuun, yhteistyöhön, toimintatapojen muutokseen, aluetietojärjestelmän käytettävyyteen sekä organisaatiokulttuuriin vaikuttaviin tekijöihin. Tutkimuksen mukaan valituissa tulosmuuttujissa oli löydettävissä merkittäviä muutoksia viiden vuoden seurantajakson aikana, mikä kuvastaa alueellisesti yhteiskäyttöisten tietojen käytön kasvua sairaanhoitopiirin alueella. Alueellisessa tiedonvaihdossa oli havaittavissa kasvava trendi kaikissa eri ammattiryhmissä. Tutkimuksessa löydettiin merkittävä yhteys katsottujen viitteiden määrien eli alueellisen tiedon hyödyntämisen ja röntgentutkimusten määrän, lääkärissäkäyntien, päivystyskäyntien ja päivystyslähetteiden välillä. Tutkimuksen mukaan alueellisella tiedonvaihdolla voi olla vaikutusta terveydenhuollon palvelujärjestelmään sairaanhoitopiirin alueella.

Kun lääkärit tekivät päivystyslähetteitä erikoissairaanhoitoon, he katsoivat merkittävästi enemmän viitetietoja ja käyttivät alueellisesti yhteiskäyttöistä tietoa. Tutkimuksen mukaan sairaanhoitajat käyttivät eniten aluetietojärjestelmää katsoessaan viitetietoja päivystyskäyntien yhteydessä ja tehdessään päivystyslähetteitä. Mitä enemmän oli lääkärissäkäyntejä, sitä enemmän osastosihteerit katsoivat viitetietoja aluetietojärjestelmästä. Alueellisesti yhteiskäyttöisten tietojen vaihto mahdollisti tehokkaamman potilaan hoidon parantamalla hoitohenkilökunnan potilaan tietoihin pääsyä yli organisaatiorajojen. Selittäviä tekijöitä havaittuihin muutoksiin alueellisessa tiedonvaihdossa on monia; tarvitaan edelleen enemmän tutkimusta alueellisen tiedonvaihdon merkityksestä terveydenhoidon tehokkuuteen.

Alueellisesti yhteiskäyttöinen tieto muutti tiedonkulkua ja se oli yhteydessä tietojen saatavuuteen, tietojen vaihtoon ja tietosuojaan parantaen hoitohenkilöstön ja potilaiden alueellista yhteistoimintaa. Alueellinen tiedonvaihto ei tukenut potilaan palvelukokonaisuuden hallintaa. Potilaat olivat enemmän vastuussa omasta jatkohoidostaan perusterveydenhoitoon, kun käytössä oli aluetietojärjestelmä ja kun tiedot arkistoituivat sinne. Toiminnan tehokkuuden paranemista oli havaittavissa terveydenhuollon ammattilaisten ja potilaiden mukaan, vaikka tehottomuuttakin edelleen ilmeni. Hallinnollista tukea ja eri sidosryhmien sitoutumista yhteisiin tavoitteisiin, välttämättömiin muutoksiin toimintatavoissa ja uuteen tapaan toimia tarvitaan, kun alueellisia tietojärjestelmiä otetaan käyttöön terveydenhuollossa.

Tässä tutkimuksessa palvelukokonaisuudella tarkoitetaan yhden tai useamman terveydenhuollon palvelujen antajien tuottamaa kokonaisuutta potilaalle siltä osin, kuin kyse on terveydenhuollon palvelujen antajista. Tässä tutkimuksessa palvelujärjestelmällä tarkoitetaan perusterveydenhuollon ja erikoissairaanhoidon tarjoamia terveydenhuollon palveluita kuntien ja kuntayhtymien asiakkaille. Lisäksi toimintaa tuetaan terveydenhuollon tietotekniikalla (engl. HIT) yhden sairaanhoitopiirin alueella. Terveydenhuollossa toimivat ammattilaiset ovat terveydenhuollon ammattilaisia ja hallinnon edustajia. Terveydenhuollon ammattilaisilla tässä tutkimuksessa tarkoitetaan lääkäreitä, hoitajia ja osastosihteereitä.

Aluetietojärjestelmän käytön leviäminen ja hyödyn saaminen on pitkäjänteinen prosessi, sillä viiden vuoden jälkeenkin sen käytössä tunnistettiin monia ongelmia. Terveydenhuollon eri ammattilaisilta saatavaa palautetta pidetään erittäin tärkeänä terveydenhuollon tietojärjestelmiä kehitettäessä, ja niiden edelleen kehittämiseen tulee jatkossa panostaa. Tutkimus tuotti uutta arviointitietoa alueellisesti yhteiskäyttöisen tiedon ja aluetietojärjestelmän tuomista hyödyistä ja vaikutuksista palvelujärjestelmään.

Avainsanat: alueellinen yhteiskäyttöinen tieto, alueellinen tiedonvaihto, aluetietojärjestelmä, outcome mittaus, terveydenhuollon palvelujärjestelmä, potilaan palvelukokonaisuus

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List of abbreviations

ANOVA	Analysis of Variance
D-RHIS	Decease Specific Regional Health Information System
EHR	Electronic Health Records
EU	European Union
GP	General Practice
HIE	Health Information Exchange
HIS	Health Information System
HIT	Health Information Technology
ICT	Information and Communication Technology
I-RHIS	Integrated Regional Health Information System
RHIO	Health Information Organization
RHIS	Regional Health Information System
US	United Sates

List of original publications

The thesis is based on the following papers, which are referred to in the text by their Roman numerals I – VI.

I Mäenpää T, Suominen T, Asikainen P, Maass M, Rostila I. 2009. The outcomes of regional healthcare information systems in health care: a review of the research literature. International Journal of Medical Informatics 78(11), 757–71.

II Mäenpää T, Asikainen P, Gissler M, Siponen M, Maass M, Saranto K, Suominen T. 2011. Outcomes assessment of the regional health information exchange: a five-year follow-up study. Methods of Information in Medicine 50(4), 308–18.

III Mäenpää T, Asikainen P, Gissler M, Siponen M, Maass M, Saranto K, Suominen T. 2012. The utilization rate of the regional health information exchange: how it impacts on healthcare delivery outcomes. Journal of Public Health Management and Practice 18(3), 215–23.

IV Mäenpää T, Asikainen P, Suominen T. 2012. Aluetietojärjestelmän käyttö ja merkitys tiedonkulkuun eri terveydenhuollon ammattilaisten ja hallinnon edustajien kokemana – viiden vuoden käytön jälkeinen tilanne. Hoitotiede 24(1), 70–81.

V Mäenpää T, Asikainen P, Suominen T. 2012. Aluetietojärjestelmän merkitys alueelliseen yhteistyöhön, toimintamallien muutokseen ja organisaatiokulttuuriin ammattilaisten ja hallinnon edustajien kokemana. Hoitotiede 24(2), 125–137.

VI Mäenpää T, Asikainen P, Suominen T. 2012. Potilaan kokemukset alueellisesta yhteiskäyttöisestä tiedosta. Tutkiva Hoitotyö. 10(3), 32–49.

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1. Introduction

Health care services today face many challenges because of the aging population, the increase in chronic diseases, fragmented nature of our health care delivery system and a lack of care coordination concerning the treatment of patients with chronic or multiple diseases (Korst et al. 2008; Marchibroda 2008; Demski et al. 2010; Patel et al. 2011). The need for developing health information exchange (HIE) between different professional groups and organizations and customer-oriented services is due to the problems of continuity of patient care and data transfer. The availability and functionality of health care services necessitate the regional cooperation of health care professionals and that patient health information is available to all involved across organizational boundaries (Hansagi et al. 2008; Hessler et al 2009; Fontaine et al. 2010; Hincapie et al. 2011). The Finnish national health programme emphasizes basic structural and functional changes in health care delivery. With the focus on patient-centred care, the driving force for health care has been the trend towards better care coordination and continuity of care (STM 2008; L1325/2010; STM 2012).

Prioritizing in health care is creating a trend towards shared or integrated, patient-centred health care, where responsible care emerges as co-operation between different health care professionals across organizational boundaries for the better management of health service packages. Developing regional health information systems with workable models requires behavioural changes in the working practices of health care professionals (Hansagi et al. 2008; Frisse 2010; Ross et al. 2010). Organizational culture-related factors have been found when implementing health information technology (HIT) in health care delivery (Protti 2009; Vest 2010; Melby & Hellesø 2010). Administrative support and commitment at organizational level to participation in health information exchange is essential. All stakeholders should be committed to the development project and its objectives (Frisse 2010; Lammintakanen et al. 2010; Korst et al. 2011).

Health information exchange through a regional health information system (RHIS) is intended to support a customer-centred, seamless service chain and regional co-operation across organizational boundaries and enable new types of health information technology, e.g. the implementation of action models for the development of health care processes (Bergmann et al. 2007; L159/2007; Patel et al. 2011). Electronic processing and transfer of patient data at regional or national level in different health care organizations has grown rapidly both internationally and nationally (Nykänen et al. 2008; Demski et al. 2010; Payne et al. 2011). Many EU countries are evolving HIT strategies for developing workable models of electronic patient information processing and data transmission at regional or national health care level. In 2007, there was an increase in RHISs in the majority of hospital districts (81%) in Finland (Aaltonen et al. 2009a; Protti 2009; STM 2012).

Previous studies indicate that regional health information exchange (HIE) between different health care organizations and professionals promotes the electronic transmission of patient health information and timely data access to different health information systems (HIS) in health care delivery (Vest 2009; Demski et al. 2010; Fontaine et al. 2010). Also, the majority of patients are now allowing providers other than their primary care doctor to view their medical information electronically via HIE (Wen et al. 2010; Patel et al. 2011). This study reflects the growing interest in clinical data exchange for improving health care quality and efficiency in health care delivery.

In addition, large-scale investments in HIS can also lead to possible changes in organizational behaviour. There is also a need to examine the improvements in health care that can be derived from the investment, by providing information that supports health care decision makers (Shekelle et al. 2006; Leonard et al. 2007; Labkoff et al. 2007). It is important to investigate how patients benefit from regional health information, and how the patient's comprehensive service package can be supported by health information systems that provide a functional management of services, communication and decision-making tools used by various health care professionals in a networked health service system. Patients' interest in better information for their own health is likely to increase (Kinnunen & Suominen 2007; Solomon 2007). Health information systems have focused on a broad evaluation of studies nationally and internationally. Nevertheless, there is a lack of substantial and consistent empirical demonstration of the effectiveness of HIE. The systematic assessment of the benefits of HIE is incomplete, and there are few accounts of real-world experiences and research on HIE (Marchibroda 2007; Adler-Milstein et al. 2009; Rudin et al. 2009). This study is significant nationally and internationally, since effective health information exchange (HIE) will become the main format for developing future health care services.

The research is an evaluation study of health care information system regarding a health care service system. In the context of the effectiveness of health information technology (HIT), we can examine how technology impacts our patients and health care system performance, efficiency and results in health care delivery (Kinnunen & Nykänen 1999; Rautava ym. 2009). Furthermore, measurements of the effectiveness of HIE on health outcomes should be part of the implementation process (Nahm et al. 2007; Shapiro et al. 2007; Hincapie et al. 2011). When evaluating health care information technology and regional health information system services, common evaluation research approaches can be used (e.g. Kinnunen & Nykänen 1999). Through selected outcomes, such as the frequency of laboratory tests or referrals, the benefits from HIE through RHIS can be analysed more carefully to assess how information systems can support the positive impact of health care delivery. In this study, evaluation research refers to the evaluation of effectiveness. The evaluation of outcome effectiveness means whether the desired changes or effects have been achieved by leveraging regional health information in health care delivery.

The study lies in the field of health sciences research, with the focus on nursing science (Johansson et al. 2006; Eriksson et al. 2012). Currently, many different kinds of approaches and viewpoints are employed in nursing science when studying a phenomenon. Additionally, the emphasis in nursing science research is on empirical and applied research, which supports the resolution of current and future problems in health care. (Elo & Kyngäs 2006; Johansson et al. 2006; Eriksson et al. 2012) Nowadays, nursing science accepts the simultaneous use of both quantitative and qualitative research methods. As in this study, the quantitative and qualitative research pahses complement each other, and enable a more in-depth examination of the phenomenon (e.g. Lauri & Kyngäs 2005; Melnyk & Fineout-Overholt 2011). There has been an increase in of multi-disciplinary and interdisciplinary research in nursing science (e.g. Lauri & Kyngäs 2005; Eriksson et al. 2012). The research subject is multi-disciplinary, and the phenomenon under investigation has been approached previously in this way from a nursing science (Asikainen et al. 2007, 2008), medical science (Jaatinen et al. 2007), business science (Maass et al. 2007, 2008, 2009) and social science (Rostila et al. 2007) viewpoints, using various research methods.

This study focuses on health service systems research and the area wihin it of promoting the usage of health care service technology and the field of organizational culture research in nursing science research. (Johansson et al. 2006; Eriksson et al. 2012.) Health care service systems research is important so that health care can be developed, basing the development on researched information. (Rautava et al. 2011.) Organization culture is defined in this study as the way to get things done, and this research studies the way that the usage of RHIS has impacted practices in primary and special care organizations. The phenomenon under examination is also approached from the viewpoint of the science of information systems and there the usability research of the RHIS is examined from the viewpoints of health care professionals and administrative staff. (Turunen 2001).

The overall aim of this study was to clarify the outcomes, i.e. the benefits and effectiveness, of health information exchange (HIE) through a regional health information system (RHIS) concerning the patient service package and health care delivery in one hospital district area in the five-year period of 2004–2008. This study generates evaluation knowledge on whether the regional health information or system under investigation has had an impact on health care delivery regarding patients, professionals and administrative representatives and health care organizations. The study offers implications for education, nursing practice and management and future research.

2. Theoretical framework

2.1. A customer-centered patient service package

The concept of customer centeredness in health care is used when talking about health care services in general. The term refers to the customers being the center of services and stresses customer participation in the planning of services. Tailored health care services are organized knowing the service package from the point of view of the customer's needs (Oja et al. 2010; Frampton et al. 2010; Steiger et al. 2010; Huang et al. 2012). Customer orientation is a way of connecting the customer and services together and highlights the continuity of services (Ruotsalainen 2000; Robinson et al. 2008). However, customer centeredness is not a new principle in health care, and has gained increasing attention in health care delivery. Guidelines on customer orientation are not only related to recommendations of the national but also regional strategies. Today, many national health care development projects are designed to increase customer focus (L811/2000; STM 2007; Aaltonen et al. 2009a; L1325/2010; STM 2012).

In international literature, the concept of a patient service package is not well defined. English terminology is not uniform and the concept has been described as a part of integrated care. Integrated health care management and integrated care pathway (Triska et al. 2005; Tanttu 2007) are widely in use together with shared care (Tsiknakis et al. 2002; Machan et al. 2006; Bergmann et al. 2007; Cruz-Correia et al. 2007) and seamless care (Kuhn et al. 2006; Nykänen & Karimaa 2006; Asikainen et al. 2009). The concepts above have been defined as the situation where an individual’s health care is the responsibility of a team of professionals across organizational boundaries within the health care system (Tsiknakis et al. 2002; Kuhn et al. 2006; Machan et al. 2006). The concept of the seamless service chain was introduced worldwide in the first half of the 1990s from European telemedicine projects (Winter et al. 2007) and the in Finnish health policy control concept (Kalpa & Kuusisto-Niemi 1997). The Finnish law (L2000/811) presented the seamless service chain as an action model, where the client-related service events are a combination of a customer-centred service package, regardless of which operating unit provides or implements the service. The service chain is defined generally as a regional overall service, and an agreement on how patients in a given situation are examined and treated at different levels of health care with sufficient quality (Ruotsalainen 2000; Nykänen & Karimaa. 2006; Tanttu 2007; L1325/2010).

Although the concept of the seamless service chain initially referred to the data transmission use of health information technology (HIT) between organizations, it also refers to coordination of continuity of care (Nohr et al. 2001; Machan al. 2006; Bergmann et al. 2007; Chronaki et al. 2007; Katehakis et al. 2007; Winter et al. 2007), and the development of care management in health services among health professionals and service providers and the rationalization and reorganization of health care processes (Abbott et al. 2006; Follen et al. 2007; Asikainen et al. 2008). The data transmission use has been extended to relate to functional changes. In other words, data transmission using HIT is understood as a reflection of change in work practices and developing new ways of producing health care services and new models of collaboration in health care delivery (Triska et al. 2005; Nykänen & Karimaa 2006; Solomon 2007; Korst et al. 2008; Huang et al. 2012). Coordination and continuity of care has been defined as an organizational principle, which requires the cross-institutional cooperation for one or more health care providers to deliver several health care services to the subject of care (Kuhn et al. 2006; Bergmann et al. 2007), and the interest in improving the communication of health care professionals in relation to data to support customer-centered health care (Cruz-Correia et al. 2007; Winter et al. 2007). Today, the seamless service chain in the Finnish law has been expanded to include the patient service package and corresponds to the previous service chain concept where health care services between services entities are concerned (L159/2007).

The patient service package means the individualized care service events provided by one or more health care service providers. A service package includes either the same or different health care service events by health care service providers, which forms the entirety of patient care. The package addresses the patient's specific problems, which may include a visit to the doctor or laboratory or X-ray, making up the patient's comprehensive care. The formulation of a patient service package by various health service providers requires the consent of the patient (L159/2007).

Fluent management of the patient's service package requires that health care professionals have effective and timely access to patient information across the boundaries of the different organizations' patient electronic health care records (EHR) in order to coordinate and support decision-making (Maass et al. 2007; Aaltonen et al. 2009a; Asikainen et al. 2009; Fontaine et al. 2010; Hincapie et al. 2011). The fragmented nature of the health care delivery system and other complex information management activities both within and across organizations and often customer support and services are poorly coordinated, and the care service chain breaks down easily. However, the focus has been changed from the health care institution to a patient-centred service package over institutional boundaries. (Overhage 2007; Solomon 2007; Winter et al. 2007; Korst et al. 2008). The aim is to support regional co-operation across organizational boundaries, which enables new the implementation of types of health information technology (HIT) supporting action models and health care process development. (L811/2000, STM 2007, Aaltonen et al. 2009a; STM 2008; STM 2012).

2.2. Regional health information

The attributes of regional health information include the following: *shared-used data, regionally limited data, fragmented information, distributed and shared knowledge,* according to the analysis based on Walker & Avant (2005). In empirical studies, the regional health information has been understood as *the shared-use data* of the *particular region* or as data access to medical records and an information management system *in a certain region* as a functioning health information network in *a particular area*. In addition, it is referred to as the shared use of patient-related information by functional service units and actors, with the hope of achieving both economic and efficiency benefits for services in health care delivery (Nykänen & Karimaa 2006; Solomon 2007; Asikainen 2008; Maass et al. 2008; Noblin et al. 2008). (Figure 1)

Previous studies found that *fragmented information* regarding the patient in different organizations needed to be available to all health care professionals collaborating in the patient care at different times. The sharing of patient health records with other health care service providers also supported patient-centered care. The studies also referred to *distributed and shared knowledge* in patient care as where two or more health care providers jointly co-operate to provide continuing health care services. (Triska et al. 2005; Kuhn et al. 2006; Machan et al. 2006; Asikainen et al. 2008; Maass et al. 2008; Noblin et al. 2008). The model *example of regional health information* can be presented as follows: regional health data is stored in a particular region in different information systems, such as electronic health records, and laboratory or radiology system archives. The regional health information can be shared between particular hospitals and regions (municipality's federations and hospital district) or actors at the regional or national level. The shared-use information may be of different tests results such as laboratory and radiology examinations or discharge summaries (Triska et al. 2005; Solomon 2007; Asikainen et al. 2008; Noblin et al. 2008).

Furthermore, the antecedents or terms that refer to the factors that preceded the present regional health information are: *data exchange, data transmission, information availability, system usability, health information technology, common heath data standards, integrated healt information system, reorganization of work activities, management commitment and organizational culture* according to the analysis based on Walker & Avant (2005). (Figure 1)

The usage of regional health information *requires data exchange* and *data transmission* from disparate data sources of providers such as regional hospitals, medical health centres, and medical group practices, independent laboratories, and radiology systems. In order for the regional health information to be used it must be in a shared-use database in the patient health care situation (Halamka et al. 2006; Machan et al. 2006; Solomon 2007; Korst et al. 2011). *Information availability* depends on reliability, accessibility and consistency, when the content of information is understandable by all actors. The content of information refers to the system's ability to generate the information required by the user needs (Knuuti 2002; Häyrinen 2011). In order for the regional health information to *be available*, information ought to be accessible, with timely and appropriate provision of up-to-date diagnostic information to all actors assisting in the treatment of patients (Overhage et al. 2005; Kuhn et al. 2006; Solomon 2006; Follen et al. 2007; Maass et al. 2008). If relevant information has not been available in the right place and right time for the professionals, the time spent looking for the information reduces the effectiveness of the work (Haukilahti et al. 2008; Nykänen et al. 2008; Asikainen et al. 2009; Vest, 2009; Hincapie et al. 2011). The degree of user satisfaction with information availability seems to correlate directly with the allocation of the actor's time to ensuring the accuracy and completeness of the data (Fehrenbach et al. 2004; Triska et al. 2005; Hanmer et al. 2007).

System usability is often combined with how a well-developed product will meet the user's expectations, and whether the use is sufficiently fluent or easy, and how much the system is used by the users (Nielsen 1993; Turunen 2001). A poorly designed health information system (HIS) may lead to usability problems and user reluctance to use the system, which at the same time disturbs normal professional work activities (Haukilahti et al. 2008; Nykänen et al. 2008; Ward et al. 2008; Gadd et al. 2011), and thus the expected benefits for health care delivery are not achieved (Horsky et al. 2010). HIS usability is positively related to factors such as the adequate training and organization of technical problems (Fontaine et al. 2010; Gadd et al. 2011.) Flexibility and usability of HIS should be paid attention to (Ward et al. 2008; Morton & Wiedenbeck 2009; Patel et al. 2011), and systems developers, policy makers and professionals should work together to participate in the development of health information systems in health care (Turunen 2001; Häyrinen et. al. 2008; Vänskä et al. 2010; Patel et al. 2011).

Health information technology (HIT) plays a key part in developing safer and more efficient regional health information delivery systems. Interoperable HIT systems improve the efficiency, quality, and safety of medical care delivery by making regional health information available throughout a health care network between hospitals and practitioners (Yasnoff et al. 2004; Sackett et al. 2006; Kuhn et al. 2006; Asikainen et al. 2008; Marchibroda 2007). Developing information and communication technology (ICT) in health care, also known as eHealth, has to be a potential and significant *enabler* in transforming health care delivery systems. ICT has been utilized in the development of *integrated health information system* solutions, such as a regional health information system (RHIS) for continuity of care by supporting integrated care or shared care where one or more health care providers deliver health care services (Machan et al. 2006; Follen et al. 2007; Shapiro et al. 2007; Solomon 2007; Asikainen et al. 2008; Mäenpää et al. 2009).

In the studies it was highlighted that before regional health information can be utilized, data management should be organized (Hammond 2005; Kuhn et al. 2006; Solomon 2007). Common regional health information requires that *common* and acceptable *health data standards* be interoperable. The use of standards facilitates the adaptation of the workflow and enables a consistent presentation of data from disparate source to the users (Alvarez 2004; Kuhn et al. 2006; Korst et al. 2008). Interoperable health information technology and interoperability interaction designs are still today's core problem. There is a real need to harmonize terminologies, concepts and classifications (Solomon 2007; Nykänen & Karimaa 2006; Häyrinen et al. 2009; Häyrinen 2011).

The usage of regional health information also requires the *reorganization of work* activities and behavioural changes between professionals and their work activities in order to coordinate workflow and communication among providers (Follen et al. 2007; Hansagi et al. 2008; Korst et al. 2008; Frisse 2010; Ross et al. 2010). Regional health information usage enables co-operation across organizational boundaries, allowing new types of technology-supported operating models and health care process development (Ross et al. 2009; Melby & Hellesø 2010).

Administrative support and hospital *management commitment* are essential to ensure success for regional health information, and all stakeholders have to commit themselves to any development project and objectives. Their commitment will be needed for possible functional changes in the reorganization of work activities (Hanmer et al. 2007; Protti 2009; Frisse 2010; Lammintakanen et al. 2010; Vest 2010; Korst et al. 2011). A new type of organization is needed for management to guide and change the strategic relationship with stakeholder organizations and commitments to implement regional health information. Technological health care development projects for the organization and coordination of strategic management should be supported (Solomon 2007; Lammintakanen et al. 2010). Changes in *organizational culture-related* factors have been found when health information technology is introduced in health care (Melby & Hellesø 2010; Vest 2010; Korst et al. 2011). It is important to note the different needs of work activities by professionals and government representatives, and the cultural differences between the various health organizations (Protti 2009; Melby & Hellesø 2010).

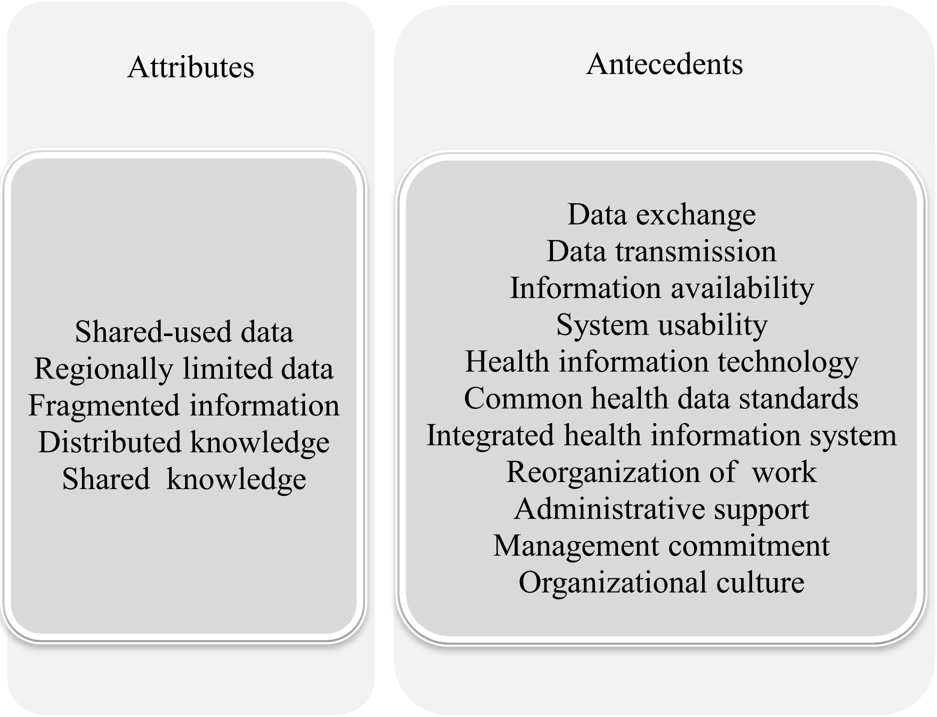


Figure 1. The attributes and antecedents of regional health information.

2.3. Health information exchange (HIE) through regional health information system (RHIS) support for patient service package

Health information exchange (HIE) is defined as the electronic mobilization of health information across organizations and disparate information systems within a region (Glaser & Lo 2006). HIE has also been defined as an exchange of clinical data such as clinically appropriate, patient-specific medical information from one provider organization (hospitals, health care centers, independent laboratories, radiology centers) to another (Stead et al. 2005; Walker et al. 2005; Shapiro et al. 2006; Adler-Milstein et al. 2009). Broadly speaking, HIE is likely to consist of many networks capable of communicating and exchanging information with each other, coordinating care and bringing together local stakeholders (Halamka et al. 2005; Cruz-Correia et al. 2007; Marchibroda 2008; Adler-Milstein et al. 2009; Tripathi et al. 2009). HIE promotes the collection of previously unavailable clinical data from patients' disparate health records, which may be spread over multiple provider and payer networks (Tripathi et al. 2009; Grossman et al. 2008; Vest 2009).

HIE provides health care professionals with immediate and effective access to more complete and timely information for treatment at the point of care where their patients need care the most (Yasnoff et al. 2004; Cruz-Correia et al. 2007; Mäenpää et al. 2009). The most commonly exchanged coded information among stakeholders comprises laboratory tests, radiology examinations, medication histories, discharge summaries, demographic and episode data on hospital patients, and administrative and financial data (Walker et al. 2005; Grossman et al. 2008; Adler-Milstein et al. 2009; Asikainen et al. 2009). HIE improves communication among providers and information processing to reduce re-appointments and fewer admissions for observation (Brailer et al. 2003; Shapiro et al. 2006; Miller & Miller 2007; Shapiro et al. 2007; Maass et al. 2008). Effective HIE delivery of test results to professionals should decrease the number of laboratory tests and radiographic examinations, reducing redundant and duplicate examinations (Garrido et al. 2005; Walker et al. 2005; Frisse & Holmes 2007; Kaelber & Bates 2007; Miller & Miller 2007; Shapiro et al. 2007; Sprivulis et al. 2007). The developments of regional HIE among health care organizations is the key to the many regional health information system (RHIS) initiatives (Solomon 2007; Korst et al. 2011).

Regional health information systems (RHIS) as a collaboration initiative, also known as regional health information organization (RHIO), are multi-stakeholder organizations working together in a given geographic area to facilitate effective HIE among the region's health care providers (Yasnoff et al. 2004; Sittig et al. 2005; Shapiro et al. 2006; Cruz-Correia et al. 2007; Protti 2008; Adler-Milstein et al. 2009). These stakeholders may include hospitals, primary care centers, physicians' offices, nursing facilities, laboratories, radiology facilities, pharmacies, health departments, and possibly the patients themselves (Sittig et al. 2005; Shapiro et al. 2006; Cruz-Correia et al. 2007; Tripathi et al. 2009). Generally, these stakeholders develop RHIS to provide secure access to complete health information electronically in the region without visible organizational boundaries, and provide health care through integrated services for seamless care and personalized, individual customer-centered care and information delivery (Sittig et al. 2005; Cruz-Correia et al. 2007; Protti 2008). RHIS will improve case management and care coordination, and communicable disease patient management through the quality, completeness, and timeliness of health data from clinical care settings. RHIS initiatives provide a capability to move from traditional paper-based retrospective data collection to real-time, interactive electronic data exchange in health care delivery. They may reduce health care costs, prevent medical errors, improve administrative efficiency, reduce paperwork, and increase access to affordable health care (Sittig et al. 2005; MacFarlane et al. 2006; Follen et al. 2007; Kass-Hout et al. 2007; Labkoff & Yasnoff 2007; Maass et al. 2008).

These RHIS initiatives cause new challenges such as acceptable interoperability standards, choice of technologies, applications, laws and jurisdictional boundaries, and risk to privacy and confidentiality (Solomon 2007; Adler-Milstein et al. 2009). Challenges also arise related to assessing the value of services that emerge from the health information exchange to various stakeholder groups such as health care providers and actors. In addition, leadership commitment and strong support from stakeholders is needed, along with the willingness of all participants to share and exchange medical information in order to translate their interest into an operational reality (Overhage et al. 2005; Glaser & Lo 2006; Solomon 2007; Marchibroda 2007; Grossman et al. 2008).

Many European Union (EU) countries and United States (US) have developed workable model processing of electronic patient information, and data transmission on a regional or national level of health care. (Solomon 2007; STM 2007; Jha et al. 2008; Melby & Hellesø 2010.) Health information exchange (HIE) through regional health information systems (RHIS) has been used in health care delivery via the key elements of a customer-centered seamless service chain and patient's health service package that goes across organizational boundaries. (L159/2007; Nykänen et al. 2008; Asikainen et al. 2009; Patel et al. 2011; Payne et al. 2011). According to the eHealth Initiative (2006), in the US there is an increasing level of maturity in the functionality of these RHIS efforts (Marchibroda 2007). In Finland, there was an increase of RHIS, as regional patient information was available in 17 hospital districts (81%) in 2007, whereas the corresponding figure two years earlier was 9 (43%). 141 health care centres (64%) used some RHIS in 2007, compared to the 2005 figures of 81 (45%) (Aaltonen et al. 2009a). However, across all nations, these HIE efforts are only in the early stages in several European countries and the US (Follen et al. 2007; Marchibroda 2007; Jha et al. 2008).

HIE has received substantial attention from national policymakers in European Union (EU) countries and the United States (US). Health care leaders and policymakers are realizing the importance of collaboration at the region level in driving improvements in health care quality, safety and efficiency, and they are particularly interested in the role of HIE (Miller& Miller 2007; Grossman et al. 2008; Jha et al. 2008; Adler-Milstein et al. 2009). However, decision makers require credible knowledge-based evidence on specific health interventions to influence health care for use in the decision-making process within HIE initiatives (Stead et al. 2005; Rashiq et al. 2006; Scales & Laupacis 2007; Andradas et al. 2008).

2.4. Outcome research in health care delivery

An outcome is described as a specific desirable result or quality of a health care delivery (Doran 2003; Kane 2006). The outcome refers to the end result, which is experienced as an impact on health or health care effects. The end results include effects that people experience and care about, such as a change in the ability to function (Polit & Beck 2006; Horner & Larmer 2006). However, when explaining the end results, the processes used to provide patient care must also be understood (Morley et al. 1996; Burns & Grove 2007; Melnyk & Fineout-Overholt 2011).

Outcome research is designed to document and assess the effectiveness of health care services and the end results of patient care. Outcome research seeks to understand the end results of particular health care practices and interventions (Polit & Beck 2006; Horner & Larmer 2006). Increasingly, outcomes research focuses both on patients and on the overall delivery system (Polit & Beck 2006.) Outcome research emerged as an important methodology for documenting the effectiveness of health care services in the 1980s and 1990s, and the quality assessments and assurances of function that originated with the professional standards review organization in the 1970s (Polit & Beck 2006; Burns & Grove 2007). Health care funders played a significant role in driving the development of outcome measures as a means of assuring that the treatment they were paying for was effective and high quality (Pringle & Doran 2003; Horner & Larmer 2006; Kane 2006).

Outcome measure is a term used by a large number of industries across the world to determine how well the specific goals of any business activity are met (Duckworth 1999; Horner & Larmer 2006). A health outcome measure is described as a measure of health change, at a defined point in time, usually before an intervention, to another point in time, usually following an intervention, as a result of more health care processes (Morley et al. 1996; Polit & Beck 2006; Kane 2006.) An evaluative outcome measure is used to aid measurement of the effectiveness of intervention to indicate whether there has been a change in status since the last measurements (Horner & Larmer 2006). Outcome measurement is a recognized and well-established part of health care evaluation activities with the development of new outcome measurements for different interventions, in different experimental research frameworks. Within health care, the measurement of outcomes has become increasingly widespread over the past decades (Doran 2003; Burns & Grove 2007; Melnyk & Fineout-Overholt 2011).

Outcome research is used with a variety of traditional design and analysis approaches, but is also developing a rich array of methods. The complex and multidisciplinary nature of outcomes research suggests that this evolving area will offer opportunities for methodologic creativity in the years ahead (Duckworth 1999; Polit & Beck 2006; Kane 2006). It is also difficult in some cases to determine a causal connection between outcomes and health care intervention because of factors outside the health care system that impact outcomes in complex ways. Nevertheless, outcome research has been gaining momentum, and at best at the outcomes can always suggest where to look for more information (Polit & Beck 2006; Kane 2006).

The selection of outcome measures should be based on a clear sense of what to measure and why. The conceptual model should clearly indicate what health outcomes are the focus of the analysis, as many different types of outcomes exist (Kane 2006). In the context of the effectiveness of health information technology (HIT), we can examine how technology impacts our patients and health care system performance, efficiency and results. The results (outcomes) of evaluating the effectiveness of the examined regional health information system, as an intervention, are for example, informational and cultural, or social and economic (Kinnunen & Nykänen 1999). Outcome management enables organizations to define and use specific indicators to continually measure how well services or programs are leading to the desired results. *In this study*, the evaluation of effectiveness (evaluative outcome) means whether the regional health information exchange or system under investigation have achieved impact in health care delivery regarding the patients, professionals and administrative representative and health care organizations (Figure 2). (See Figure 3.)

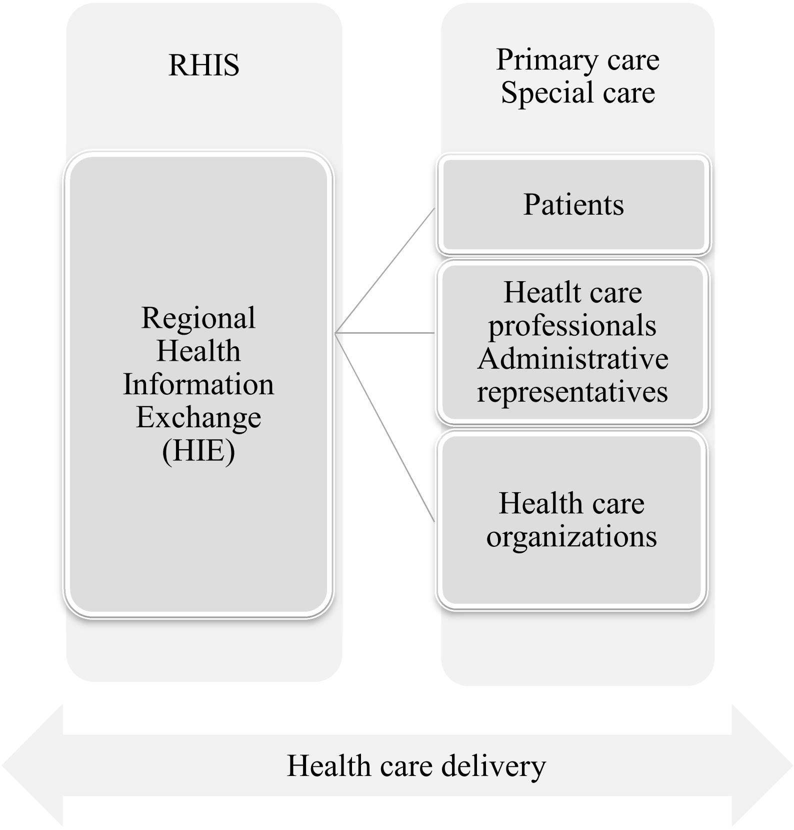


Figure 2. The theoretical framework of the study on regional HIE through RHIS.

3. Literature review

3.1. Outcomes of the regional health information systems

The review of the literature for the present study covered the time period from the beginning of four electronic databases: MEDLINE (from 1966 to May 2008), CINAHL (1982 to May 2008), the Cochrane Library, (from 1972 to December 2008), and PubMed/Medline (from 2000 to December 2008). An additional review was based on PubMed/Medline (from 2009 to December 2011) and the Cochrane Library (from 1972 to December 2011). (Papers II, III, IV, V, VI.) The findings of all the above literature reviews are summarized in the present literature review. The aim of this extensive review of the literature was to gain a picture of how regional health information systems (RHISs) have been investigated, and what has been investigated within patient health care and health care delivery. In addition, the aim was to find out the outcomes i.e. end results, and the effectiveness achieved of the different types of regional health information systems in terms of complete patient health care in health care delivery.

A systematic review was carried out firstly to focus on empirical research articles concerning all kinds of regional health information systems or organizations, and the implementation of regional health information exchanges. The employed search words used were the keywords that reflected the topic. The acceptance criteria were full English language papers published in peer-reviewed journals, and only empirical research articles concerning all kinds of regional health information systems or organization were included. Articles with a technological and architectural approach were excluded in this study. The search strategies of the literature were presented in Paper I. An additional update review of the literature was conducted on empirical research articles. The update review search used the same keywords as the systematic review search.

The empirical research articles included in the descriptive phase I literature search were published between 1996 and 2008 from the electronic databases covering 1966 to December 2008 (Paper I). Very little empirical research was found about national or regional health information systems or organizations, and no systematic review of the topic was found. A lot of the international literature on regional or national health information systems focuses on, discusses or describes the financial, technical and organizational factors (Yasnoff et al. 2004, Katehakis et al. 2007, Adler-Milstein et al. 2008), and political and privacy aspects (Zafar and Dixon 2007, Noblin 2007). The majority of the studies of regional health information systems have been done in the United States, and the rest of studies are from different European countries. The implementation of regional or national health information systems or organizations has been investigated in many different ways, using many study designs. (Paper I)

The content of the extensive literature search consisted of *five main outcomes,* i.e. end results, which are assosiated to the effectiveness of what has been achieved in health care delivery by means of the different types of regional health information systems for patient health care. These main outcome areas are as follows: *flow of information, collaboration, process redesign, system usability and organization culture*, and these are considered to be the basis of the advanced theoretical framework of the study. (Figure 3)

The first main outcome area was the **flow of information**, comprising three categories: *access to clinical data, timely patient information, and clinical data exchange*. (Paper I) The RHIS improved professionals' access to patient medical records and test results from external organizations (Nohr et al. 2001; Machan et al. 2006; Sackett et al. 2006; Shapiro et al. 2006; Solomon 2007; Bergmann et al. 2007; Ross et al. 2010), and provided timely patient information (Fehrenbach et al. 2004; Chronaki et al. 2007; Balfour et al. 2009; Melby & Hellesø 2010) as well as timely monitoring of disease-specific measures to improve health care delivery by health care professionals (Follen et al. 2007; Staff et al. 2010; Hincapie et al. 2011). The RHISs were found to improve the timeliness of patient information exchange between professionals and across organizational boundaries in a region (Walker et al. 2005; Cuggia et al. 2006; Machan et al. 2006; Shapiro et al. 2006; Noblin 2007; Chronaki et al. 2007; Adler-Milstein et al. 2008; Maass et al. 2008; Ross 2010). However, there was also limited and inadequate availability of timely access to clinical information and complexity in clinical data exchange both within and across organizations (Triska et al. 2005; Korst et al. 2008; Hincapie et al. 2011). Patients wanted access to see their own health information, and supported physicians' viewing their health information from regional providers across the community (Chronaki et al. 2007; Wen et al. 2010; O'Donnell et al. 2011; Patel et al. 2011). However, the number of barriers related to patient digital access and experiences as well as privacy and security caused concern (Patel et al. 2011).

The second main outcome area was **collaboration,** focusing on two categories: *communication and coordination*. (Paper I) The RHIS was found to improve communication and care coordination among health care providers within a region (Nohr et al. 2001; Walker et al. 2005; Bergmann et al. 2007; Maass et al. 2008; Balfour et al. 2009; Melby & Hellesø 2010). The RHIS improved care management and consultation with colleagues with multidisciplinary teamwork and support for the patient health care planning process and better understanding of the patient's situation (Triska et al. 2005; Follen et al. 2007; Kass-Hout et al. 2007; Staff et al. 2010; Patel 2011). The RHIS increased patient safety and satisfaction, and also the self-care behaviour of patients including family members, leading to better health outcomes (Follen et al. 2007; Fontaine et al. 2010; Patel et al. 2011). Also, patients believed that information exchange improved communication by their physician and supported HIE usage (Patel et al. 2010; Wen et al. 2010; O'Donnell et al. 2011).

The third outcome area of the review results was **process redesign,** which focused on clinical *effectiveness*. (Paper I) The RHIS improved the effectiveness of health care and decreased the duplication of services and redundant testing (Nohr et al. 2001; Machan et al. 2006; Shapiro et al. 2006; Bergmann et al. 2007; Chronaki et al. 2007; Follen et al. 2007; Hanmer et al. 2007; Noblin 2007; Hincapie et al. 2011), as well as decreasing the number of laboratory tests and radiology examinations (Walker et al. 2005; Frisse & Holmes 2007; Kaelber et al. 2007; Sprivulis et al. 2007; Staff et al. 2010), creating a net cost saving (Walker et al. 2005; Cuggia et al. 2006; Solomon 2007; Maass et al. 2008; Payne et al. 2011) and improved patient documentation (Nohr et al. 2001; Follen et al. 2007; Adler-Milstein et al. 2008). The RHIS improved communication among providers and public health service information processing, reducing the number of appointments, re-appointments and emergency department visits, (Overhage et al. 2002; Garrido et al. 2005; Frisse & Holmes 2007; Kaelber et al. 2007; Sprivulis et al. 2007; Maass et al. 2008) and improving the referrals processes (Frisse & Holmes 2007; Sprivulis et al. 2007). The RHIS saved time for professionals by supporting the effective workflow of clinical health care and the time saved benefited the patients (Sackett et al. 2006; Chronaki et al. 2007; Fontaine et al. 2010; Hincapie et al. 2010; Melby & Hellesø 2010). The RHIS and electronic data transmission improved the quality of patient care with better decision making (Machan et al. 2006; Noblin 2007; Solomon 2007; Follen et al. 2007, Maass et al. 2008).

The fourth main outcome area was **system usability,** which focused on two categories: *usefulness and reliability*. (Paper I) Both positive opinions of the system design, usefulness and satisfaction with use were found (Follen et al. 2007; Hanmer et al. 2007; Bonner et al. 2010; Gadd et al. 2011; Hincapie et al. 2011), and negative opinions: poor usability, and the complexity of the RHIS, technical difficulties with system functionality and the fact that it did not fulfil the practitioner's needs and was not user-friendly (Beynon-Davies & Lloyd-Williams 1999; Nykanen & Karimaa 2006; Follen et al. 2010; Gadd et al. 2011; Ross et al. 2011). There was also a lack of acceptable community standards and the non- interoperability of the regionwide management system (Halamka et al. 2006; Balfour et al. 2009; Horsky et al. 2010). The RHIS also raised concerns over security and confidentiality (Nohr et al. 2001; Halamka et al. 2006; Noblin 2007; Chronaki et al. 2007; Ross et al. 2011; Patel et al. 2011). It was felt that the needs and requirements of all professionals should be taken into account in the development of health care information systems (Häyrinen et al. 2008; Bonner et al. 2010; Lammintakanen et al. 2010).

The fifth main outcome area was **organizational culture**, associated with to *commitment and attitudes*. (Paper I) There was evidence of commitment to the RHIS with acceptance and a feeling of participation by organizations (Fehrenbach et al. 2004; Triska et al. 2005; Machan et al. 2006; Hanmer et al. 2007; Hessler et al. 2009). However, organizational challenges arose from differences in organizational culture, vision and expectations of leadership (Triska et al. 2005; Korst et al. 2008; Melby & Hellesø 2010), the non-existence of common rules and a strategic plan to share clinical data, and there was limited understanding, and the need to develop routines to take advantage of the technology (Beynon-Davies & Lloyd-Williams 1999; Triska et al. 2005; Halamka et al. 2006; Korst et al. 2008 Melby & Hellesø 2010). In addition, previous negative experiences with an RHIS were found to impact attitudes, there was resistance to change and the new technology was not always a high priority (Halamka et al. 2006; Sackett et al. 2006; Solomon 2007). Nevertheless, there was widespread participation by both providers and patients. One important aspect from the stakeholders' perspective included community-wide trust, strategic interest of individual health care providers and the medical community as a whole (Noblin 2007; Miller & Miller 2007; Grossman et al. 2008; Rudin et al. 2009; Patel et al. 2011).

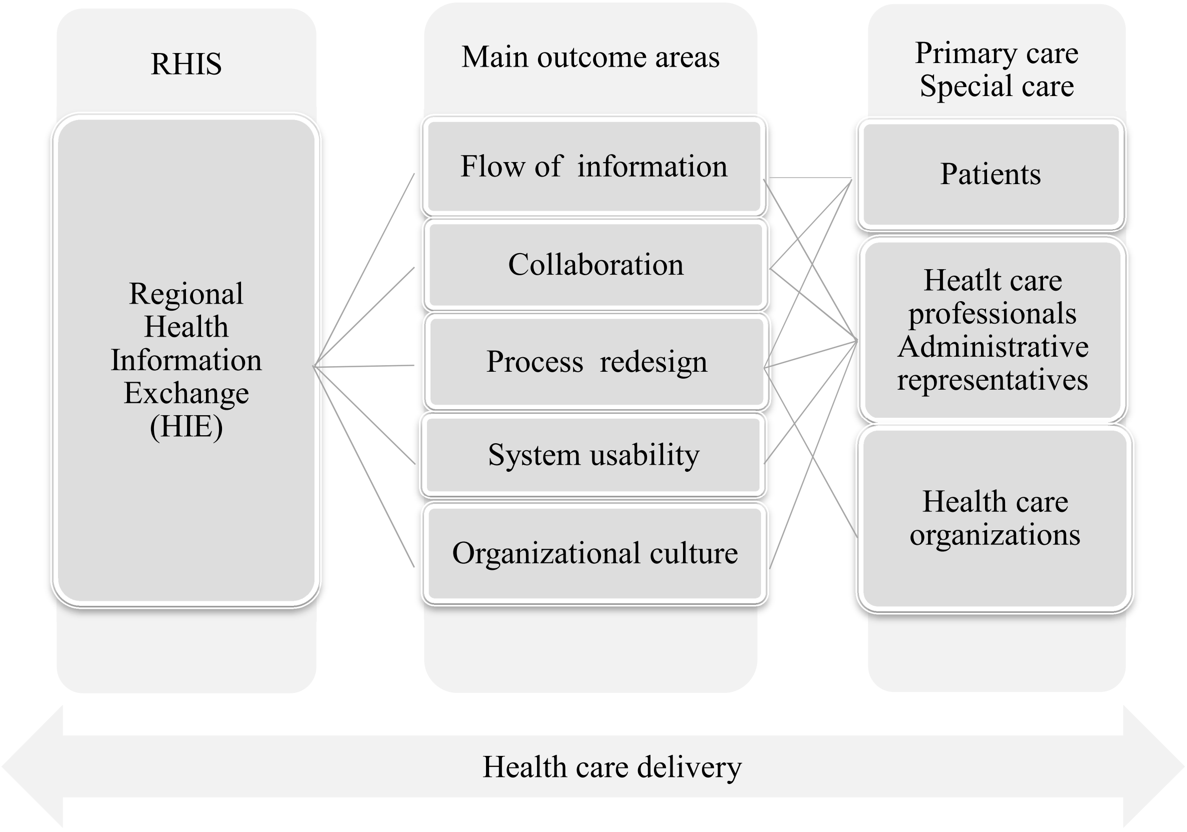


Figure 3. The advanced theoretical framework of the study on regional HIE through RHIS.

4. The aim, purpose and research questions of the study

The overall aim of this study was to clarify the outcomes, i.e. the benefits and effectiveness, of health information exchange (HIE) through a regional health information system (RHIS) concerning patient service package and health care delivery in one hospital district area in the five-year period of 2004–2008. The purpose was to describe the main outcomes of various regional health information systems. The purpose was to describe and identify the impact of HIE on selected outcomes in health care delivery in the five-year follow-up period. The purpose was also to describe the experiences with regard to the main outcome areas of HIE through RHIS of health care professionals, administration representatives, and chronically ill patients after the five-year follow-up period in one hospital district.

The research questions were as follows:

1. What are the main outcomes of the different types of regional health information systems in health care delivery?

2. What is the impact of regional health information exchange (HIE) through Regional Health Information System (RHIS) on selected outcomes in health care delivery?

3. What kind of experiences do health care professionals, administration representatives, and chronically ill patients have of the main outcome areas of health information exchange (HIE) through regional health information system (RHIS) in health care delivery?

The whole research process during the period of 2008 to 2012 was divided into three phases (Table 1).

In phase I, a literature review was produced by content analysis, based on 24 articles on the main outcomes of regional health information systems (RHIS). The MEDLINE and PubMed/Medline, CINAHL, and the Cochrane Library databases were searched for English-language empirical research articles on RHIS.

In phase II, a retrospective, cross-sectional, and a comparative, longitudinal five-year follow-up study was conducted on the registry-based statistical data with selected outcomes for 2004–2008 for all primary care in municipality federations and special care in one hospital district in Finland.

In phase III, themed interviews regarding the main outcome areas were carried out with health care professionals (physicians, nurses, and department secretaries) and administrative representatives, total (n=43), and adult chronically ill patients (n=10) in one hospital district area.

Table 1. Phases, timing of study, research process, and articles.

Phases	Year	Research process	Articles
1	2008-2009	Describe the main outcomes that have been achieved by different regional health information systems (RHISs) in patient health care delivery.	I
2	2010-2011	Describe and identify the impact of regional health information exchange (HIE) on the selected outcomes within health care delivery from the point of view of the health care organization and professionals.	II, III
3	2011-2012	Describe the experiences of HIE through RHIS regarding on the main outcome areas by the health care professionals, administration representatives, and chronically ill patients.	IV-VI

***Phase I** Literature review (Paper I)*

Medline, CINAHL, the Cochrane Library, and PubMed/Medline from start of databases to December 2008			
1447 articles	521 abstracts	51 full texts	**24 research articles**

***Phase II** Retrospective, cross-sector, longitudinal five-year follow-up study (Paper II)*

Primary care	**Registry-based EHR statistical data for years 2004–2008**

Federations of municipalities (n=11)
Special care
Special care hospital (n=1)
	Process redesign:
	Selected outcomes:
	- total laboratory tests
	    - LBC, CRP, FPG
	- total radiology examinations
	    - Chest X-ray, Wrist X-ray, Lumbar spine X-ray
	- total appointments
	- total emergency appointments
	- total primary care referrals to special care
	- total emergency care referrals to primary care

Comparative, longitudinal five-year follow-up study (Paper III)

Primary care	**Registry-based EHR statistical data for years 2004–2008**	
	Process redesign; **Selected outcomes:**	**Viewed references**
Federations of municipalities (n=10), and of these: Federations of municipalities with high HIE usage (n=3), Federations of municipalities with low HIE usage (n=3) **Special care** Special care hospital (n=1)	- total laboratory tests - total radiology examinations - total appointments - total emergency appointments - total primary care referrals /emergency to primary care	- total viewed references - viewed by physician - viewed by nurses - viewed by department secretaries
--- five-year follow-up		

***Phase III** Themed interviews (Papers IV, V, and VI)*

Primary care	**Interviewees**	**Interview themes**

Federations of municipalities (n=10), and of these:
 	
Federations of municipalities with high HIE usage (n=3),
Federations of municipalities with low HIE usage (n=3)
 	
Special care
Emergency department unit (n=1),
Regional common emergency department unit (n=1),
Laboratory department unit (n=1),
Radiology department unit (n=1)
	Physicians (n=12),
	Nurses (n=12),
	Department secretaries (n=11),
	Head physician (n=8),
	Patients (n=10)
		Main outcome areas:
		- flow of information
		- collaboration
		- process redesign
		Selected outcomes:
		    - laboratory tests
		    - radiology examinations
		    - appointments
		    - emergency appointments
		    - primary care referrals /emergency to primary care
		- usability*
		- organization culture*

--- after five-year usage		

* *Not used in patient interview*

Figure 4. The empirical process of the study.

5. Material and methods

5.1. Design

The mixed methods approach was used to get a more comprehensive understanding of the health information exchange (HIE) through regional health information systems (RHIS) and both *qualitative and quantitative research methods* were used for the empirical demonstration and evaluation of the benefits of HIE through RHIS. A qualitative literature review was used *to find out the outcomes* of the different types of regional health information systems in health care delivery. Quantitative outcome measurement: was used to evaluate the impact of HIE within health care delivery. A qualitative themed interview study design was used *to find a deeper understanding* of the research results and the outcomes obtained with the use of the HIE through RHIS.

In phase I a descriptive *qualitative literature review* was conducted in order to find out the national and international empirical research on regional or national health information systems, and regional health information, and identify the kinds of outcomes and effects achieved in patient care. (Paper I) (Figure 4)

In phase II *a quantitative outcome measurement* design was used to evaluate the impact of HIE within health care delivery. A retrospective, cross-sectional five-year follow-up study for the period 2004–2008 was conducted to describe the impact of the regional HIE within health care delivery from the organizational point of view. The objective was to investigate the selected outcome data and to determine the changes that had occurred. (Paper II) A comparative, longitudinal five-year follow-up study for the same years was conducted to describe and identify the utilization rates of HIE, and its impact on selected outcomes in health care delivery. The objective compared federations of municipalities by usage of HIE in total and by different groups of health care professionals, and linked this information to the selected outcome data. The outcome research was designed to measure changes in outcomes differing from one point in time to another, and documents the effectiveness of health care services and the end results of patient care (Polit & Beck 2010; Melnyk & Fineout-Overholt 2011). (Paper III) (Figure 4)

In phase III *a descriptive qualitative themed interview* on the flow of information, collaboration, process redesign, usability and organizational culture was used to gain a deeper understanding of HIE outcomes in the two above research phases in health care delivery (Paper I, Paper II and Paper III.) The themed interview was selected as the research method, because the aim was to deepen understanding of the benefits of regional health information and the outcomes in health care delivery for health care professionals, administrative representatives and patients. It was therefore essential that the interviewees had both experience and opinions about the use of the system (Polit & Peck 2010). The study selected health care professionals (physician, nurse, and department secretary), administrative representatives, and chronically ill patients who supposedly had the most experience and perception in the usage of regional health information systems (Polit & Peck 2010). A themed interview was conducted to describe the interviewee's experiences regarding the main outcomes when the regional health information system (RHIS) had been in use for five years. The goal was to obtain diverse information on the phenomenon under study, so the themes used were broad. The themes of the interviews were composed on the basis of the previous research results from Paper I (Papers IV, V and VI.) (Figure 4)

5.2. Settings, sampling and participants

In phase I an extensive literature search was carried out in order to find previous research on regional health information systems, what had been investigated, and what kinds of outcomes had been achieved. The focus in the literature review was on English-language empirical research articles concerning all kinds of regional or national health information systems or organizations in Medline, CINAHL, the Cochrane Library, and PubMed/Medline, covering the period from the beginning of these databases to December 2008. Keywords were used that reflected regional health information systems and integrated electronic health information systems. Studies made with a technological and architectural approach were excluded. (Paper I)

In phase II the study was implemented throughout primary care in all municipality federations and in special care in one hospital district area in Finland. There are a total of twenty hospital districts in Finland, and the one in this study had a medium-size population of about 234 000 inhabitants. A federation of municipalities may include one or more municipalities, totalling 23 member municipalities. The RHIS was implemented in 2004–2008 and had been in use for five years by the start of the study period. The three out of the ten primary care federations of municipalities which used HIE the most, the three with the lowest use of HIE and special care in the hospital district area were selected for comparative research during the study period. (Paper III) The statistical data on the viewed references and selected outcomes were reviewed from the time of implementation of the regional health information system (RHIS) in the study area. The selection of outcomes was based on availability and the theoretical knowledge that they are expected to have an impact through HIE (e.g. Shapiro et.al 2007; Sprivulis et al. 2007; Asikainen et al. 2009). (Paper II and Paper III)

In phase III the primary care organizations were the primary health care centers in the four federations of municipalities that used HIE the most, and the one special care organization including the emergency department and both laboratory departments and radiology department units, and common regional emergency department units in the hospital district area. (Paper IV, Paper V, Paper VI) The health care professionals were selected as follows: two from each professional group (physicians, nurses, department secretaries), and one administrative representative (head physician, managing physician) from each organization. (Paper IV, Paper V)

Two patients were selected from each of the primary care health care centers in the four federations which used HIE the most. The patient selection criteria were that they were adults, and that they had a chronic disease that was diagnosed at least five years previously. (Paper VI)

The study consisted of 43 selected health care professionals and administrative representatives (Paper IV, Paper V.) Almost half of the group (professionals and government representatives) were 50 years or older and a quarter were between 40 and 49 years of age, and the majority of interviewees (74%) were women. Interviewees comprised nurses (31%), doctors (26%), department secretaries (24%), and administrative representatives (19%). The professionals had an average of 18 years work experience, and administrative representatives had 9 years experience. The RHIS had been used in the organizations for an average of five years. (Paper IV, Paper V)

The study included 10 chronically ill patients, who had agreed to use the HIE service when seeing a doctor, and had the most experience of the HIE through RHIS usage. The average age of these patients was 69 (ranginge from 61 to 83) and 60% were male. All of the interviewed patients had several chronic conditions to take care of, and most patients were suffering from cardiovascular diseases and diabetes. In the interview situation, the majority (80%) of patients had visited a primary care physician's office. All patients had frequently been asked to give their consent to view the patient information data area of the RHIS. (Paper VI)

5.3. Data collection

In phase I the Medline (from 1966 to May 2008), CINAHL (from 1982 to May 2008), the Cochrane Library, and PubMed/Medline (from 2000 to December 2008) databases were searched using the keywords that reflected regional health information systems and integrated electronic health information systems. The specific keywords are presented in Paper I. The initial search produced a total of 1447 studies. After checking, 521 abstracts and a further 51 full-text articles met the inclusion criteria. First, the titles that matched the research questions and the keywords were retrieved, and English text papers published in peer-reviewed journals were selected for further review. Second, all abstracts that addressed the research question were retrieved, regardless of their study design. Thirdly, after proper examination of the full texts, a list of the studies included and excluded was compiled for content analysis. A summary of the search strategy is shown in (Paper I, Figure 1.) The extensive literature study consisted of the final sample of 24 empirical research studies that were selected for content analysis.

In phase II a quantitative outcome measurement was made with a retrospective, cross-sectional and comparative, longitudinal five-year follow-up study for 2004-2008 for all federations of municipalities in primary care and for special care in one Finnish hospital district area with 234 000 inhabitants. (Paper II, Paper III) The quantitative statistics data for the follow-up period in the hospital district were collected in spring 2009. Statistical information using routine collected data concerning selected outcomes from the electronic patient health care records

(EHRs) was collected in all 11 primary care municipality federations and one special health care in one hospital district area. The selected outcomes were data obtained from all municipal federations' databases of total laboratory tests and radiology examinations, appointments, emergency department visits, and primary care referrals and emergency referrals to special care. (Appendix 1) In addition, the selected outcomes regarding laboratory tests and radiology examination were also reviewed on the level of the clinical chemistry department (LBC, CRP, FPG) and selected radiology examinations in the imaging department (Chest X–ray, Wrist X–ray, Lumbar spine X–ray) were carried out, since these tests and examinations are the ones performed the most in both primary care and special health care.

In phase II statistical data on the selected outcomes were gathered at primary care level in municipal health care centers by a contact person who forwarded the data to the researcher. The data were collected manually because each primary care health care center's electronic health records (EHRs) produced its own statistical data with a variety of statistical reporting systems. However, the statistics were comparable both across the years and across various municipalities. At the special health care level, the data of the selected outcomes were gathered on the statistics of the special health care EHR by the researcher. (Paper II) The statistical data on the viewed references (one viewed reference means one instance of using the HIE) and selected outcomes in the follow-up period were collected in all 10 primary care municipality federations and one special health care in one hospital district area. The data of the amount of viewed references in the whole hospital district by groups of health care professionals (physicians, nurses, departmental secretaries) were ordered from the supplier of the RHIS. The statistical data on references were sorted by year and by different health care professional group (physicians, nurses, and department secretaries). The viewed references data included specialist information on patients, e.g. surgery or internal medicine information, laboratory and radiology results, and nursing summary. The selected outcomes data obtained all the municipal federations' databases on the total laboratory tests and radiology examinations, appointments, emergency department visits, and primary care referrals and emergency referrals to special care using routinely collected information from the electronic patient health care record (EHR) databases. (Paper III)

In phase III data were collected through themed interviews of health care professionals (physicians, nurses, department secretaries), and administration representatives (n=43), who had the most experience of HIE in May–July 2010 (Paper IV, Paper V) and from the chronically ill patients (n=10) who had given permission for data viewing in HIE in July–September 2010. (Paper VI) (Figure 6) The goal was to obtain extensive information about the phenomenon under study, so the themes used were quite broad. The interview situations were face-to-face and the questions could be repeated and clarifications made (Burns & Grove 2007). The interview themes were based on the previous research results of the first research phase. (Paper I) The interview themes for health care professionals, administration representatives and patients were the flow of information, collaboration, process redesign (including the number of laboratory tests, radiology examinations, appointments, primary care referrals to special care). (Paper IV, Paper V, and Paper VI) Additional interview themes were system usability and organizational culture for health care professionals and administrative representatives, when the RHIS had been in use for five years. (Paper IV, Paper V)

The organization of head physicians named the contact person and a representative of its administrational. The contact person submitted a briefing on the research and a consent form to the professional in their own organization who had used the RHIS the most, and supplied the researcher with contact details of those willing to take part in the interview study. The researcher contacted those interested in being interviewed and arranged a time and place for the interview. The interviews, lasting on average 30 minutes, were recorded with the consent of the interviewees and transcribed. The material began to be saturated for the last two professionals and administration representative and the same for the patients. (Polit & Peck 2004). Regarding the *patient interviews*, a contact person was agreed upon from the organizations participating in the research, who was a doctor at the primary care health center in question, and who also recruited patients for interview. When the doctor, i.e contact person was asking a patient for consent to use the RHIS, he/she told the patient about the interview study and asked the patient if he/she would be willing to take part. The researcher contacted the patients who agreed to join the study and arranged a time and place for the interview, which was a peaceful place of the administrative area at the health center. The researchers' interview method was made more specific by pre-testing the body of the interview on a single patient, and on the basis of this it was emphasized that, if the interview went off topic, it was brought back on topic as quickly as possible. Interviews, which lasted on average 44 minutes, were recorded with the interviewee's consent and transcribed. (Burns & Grove 2007.)

5.4. Data analysis

In phase I *inductive content analysis* of the included studies was used to analyze and synthesize the content of the study articles (Polit & Peck 2006; Burns & Grove 2007). (Paper I) Content analysis is a research method for making replicable and valid inferences from data to their context with the purpose of providing knowledge, new insight, representation of facts, and practical guiding action (Krippendorff 1980; Neundorf 2002). A scoping review was conducted of the final sample of 24 articles (Paper I.) The criteria for the exclusion and inclusion of studies were based on their relevance rather than the quality of the studies (Polit & Beck 2010). The data were presented as follows: authors, year, country, sample, research design, type of regional health information system, and the outcomes of regional health information systems. The inductive content analysis included open coding, creating categories, and abstraction, then reconstituting them in some new form, such as description, interpretation, or theory (Melnyk & Fineout-Overholt 2011). Inductive content analysis is recommended for use in cases where there are no previous studies dealing with the phenomenon or when knowledge is fragmented (Graneheim & Lundman 2004; Kyngäs & Elo 2007). (Paper I)

In phase II *trend analysis* was used for selected outcomes in the retrospective five-year follow-up study. These rates were plotted over time for visualization of the trend data, and both the annual and total changes of these rates were calculated. (Paper II) Trend analysis is used in public health surveillance for forecasting, program evaluation, policy analysis, and etiologic analysis. The most general goal of trend analysis for public health surveillance is to discern whether the level of health status or rate of health information exchange, or system indicators, (e.g. laboratory tests or radiology examinations) has increased or decreased over time (Rosenberg 1997; Slutsky & Clancy 2005). Comparing one time period to another time period, trend analysis is carried out in order to assess the level of an indicator before and after an intervention (Polit & Peck 2006.) Regardless of which statistical techniques will be used for analyzing data over time, the most straightforward first step in assessing a trend is to plot the actual observed numbers or rates of interest by year (Rosenberg 1997).

Firstly, the primary care outcomes of all the federations of municipalities were collected annually. (Appendix 1) The outcomes were proportioned to the total number of appointments and to the number of inhabitants of the municipality federation for each year. The special care outcomes related to the inhabitants of the hospital district were collected annually for the five-year period. (Appendix 1) Outcomes were proportioned to the total number of appointments and the number of inhabitants of the hospital district. Proportional annual change figures were calculated for the outcomes per total appointments, the number of municipality inhabitants in primary care and the hospital district inhabitants per year in special care. The total change in outcomes in the five-year period was calculated for both primary and special care. (Appendix 2) In addition, the figures were calculated for the proportional annual change in all the selected laboratory tests and radiology examinations per number of municipality inhabitants, and hospital district inhabitants per year. The *t-test* was used to determine the statistical significance and confidence intervals of the changes in rates over the five-year follow-up period. (Appendix 2) In the t-tests, p-values of 0.05 were interpreted as statistically significant (Polit & Beck 2004; Burns & Grove 2007). (Paper II)

The number of viewed references was adjusted in *proportion* to the number of appointments for each municipality federation and per year. In addition, the percentage shares of the amount of viewed references were calculated by health care professional group in different municipality federations for the follow-up period. (Appendix 3) The statistical difference was tested to see whether there was a statistically meaningful difference in HIE utilization between professional groups in the different municipality federations and whether there was a difference between the professional groups. *Analysis of variance* (ANOVA) was used to test the differences in averages between groups (Polit & Peck 2006; Burns & Grove 2007). (Paper III)

Secondly, the municipality federations were divided by the level of their use of HIE (Paper III.) *Linearity regression* was used for modeling the link between response variables and explanatory variables (Uhari & Nieminen 2001; Polit & Beck 2004). *For modeling purposes*, the federations of municipalities were divided into *lower* and *upper quartiles* in terms of the number of viewings per number of inhabitants. The upper quartile limit was 0.39 and the lower quartile limit was 0.65 for viewed references per inhabitants. Three municipalities were chosen, both in the lowest and in the highest quartile. There was no substantial change in the lower and upper quartiles when investigating the number of references viewed in 2008. (Paper III) (Figure 5)

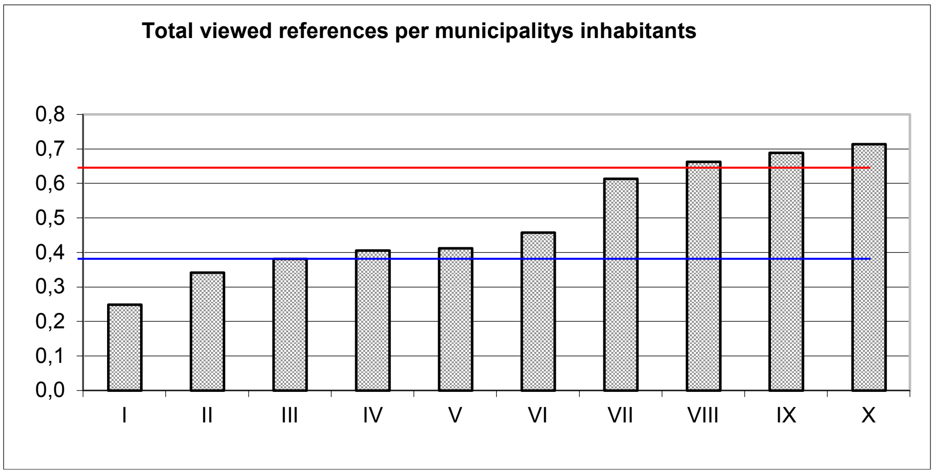
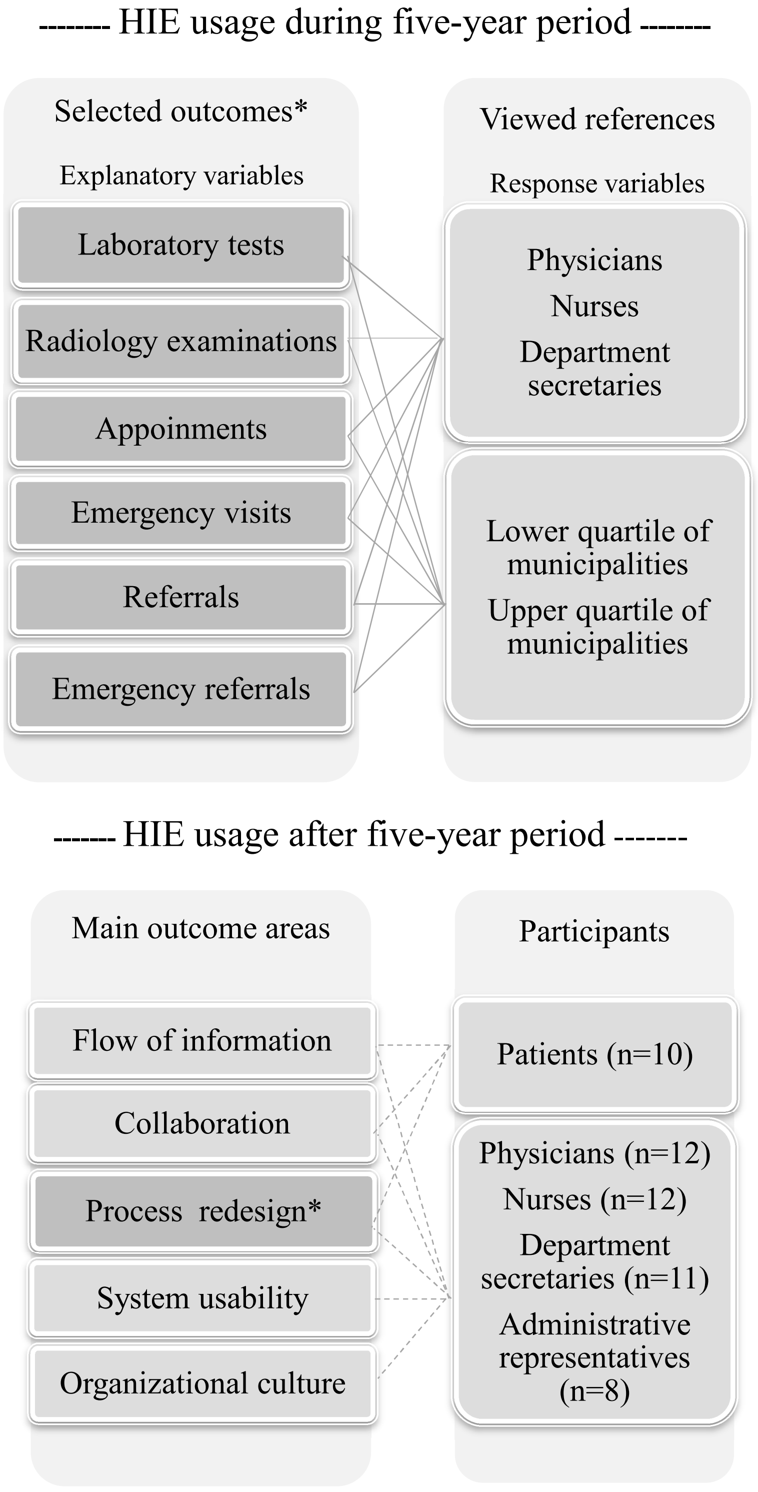


Figure 5. The lower and upper quartiles of federations of municipalities.

Thirdly, the *response variables,* i.e. *the viewed references*, were modeled as predictors of the result variables. A negative binomial distribution with a log-link function was used, and the values were proportioned to the population. The default distributions of the lower and upper quartiles were investigated for modeling purposes. For both lower and upper quartiles, the negative binomial default distributions were valid ($p > 0.005$, Pearson $Chi^2=0.377$ and 1.407 df=6 and 6) (Polit & Beck 2007). (Paper III) (Figure 6)

Finally, the *response variables,* i.e. *the viewed references by professional group,* were *modeled* as the explanatory result variables. The default distribution is a negative binomial distribution and the link function log-link, and the values are proportioned to the population for all professional groups ($p > 0.005$, $Chi^2=18.754$ with df=38 for physicians, 37.482 with df=36 for nurses and 15.470 with df=15 for ward secretaries). The explanatory result variables in both models were the total number of laboratory tests, radiology examinations, appointments, emergency visits, and referrals during the five-year follow-up period from 2004 to 2008 (Polit & Beck 2007). (Paper III) (Figure 6)

In phase III *inductive content analysis* was used to categorize interview data for the *health care professionals, and administrative representatives* for research purposes (Paper IV, Paper V). Content analysis is connected with procedures that involve breaking down data e.g. coding, comparing, contrasting, and categorizing bits of information, and then reconstituting them in a new form as a description or interpretation (Kyngäs & Elo 2007; Polit & Beck 2010; Melnyk & Fineout-Overholt 2011). The unit of analysis in the study was a chosen word or phrase in a combination package, which corresponded to the research purpose. All the data terms are given the same value regardless of their frequency. The data were reduced from the original terms into simplified expressions, which were then tabulated. The reduced expressions were coded in numeric code, to be retrieved later. The coded words were grouped by content into sub-categories, the contents of which were given a descriptive name. The analysis was guided by the objective of the study and research tasks. Similar content sub-categories were formed among the upper categories. The upper categories were then formed into combined categories. The data classification into the categories for professionals and administrative representatives is presented in (Paper IV, Table1, Table 2, Paper V).



* interviewed on selected outcome area

------- Qualitative themed interviews with patients, physicians, nurses, department secretaries and administrative representatives were made concerning the main outcome areas.

—— Quantitative linearity regression was used for modelling the link between response variables and explanatory variables. The statistical difference was tested between HIE utilization, i.e. viewed references in professional groups, in the lower and upper quartile municipalities, and the selected outcomes during the 5-year follow-up period.

Figure 6. Mixed method, both qualitative and quantitative research methods were used for the evaluation.

Both *deductive* and *inductive content analysis* was used to categorize the interview data of chronically ill *patients* (Paper VI.) The *deductive content analysis* was guided by a categorization matrix, based on earlier research, for the different health care professionals and administrative representatives who were interviewed using the same questions. First, interview data was organized according to an earlier study's classifications into upper categories, which include data availability, data exchange, data protection, cooperation, coordination of care, and communications as well as more efficient service or inefficient service. They formed the connecting category of regional communication and cooperation as well as process redesign (Paper VI., e.g. Table 2.) Secondly, the data were analyzed using the inductive content sub-category levels. The *inductive content analysis* proceeded similarly to the interview data of health care professionals and administrative representatives above (see Paper IV, V), (Paper IV). The data classification into the categories for patients is presented in Paper VI, Table 2. (Appendix 4) The frequencies, averages, ranges, and percentages were then calculated of the background variables for health care professionals, administrative representatives and patients (Paper IV, V, VI) (Polit & Beck 2010).

5.5. Ethical considerations

In phase I, a scoping literature review was done. The review of literature provides an objective and thorough summary of the current state of evidence on the topic. Search strategies were carefully documented and all the articles based on the inclusion criteria were analysed. (Paper I)

In phase II, approval for the study was obtained from medical directors in all the municipality federations in primary care and from hospital district managers in special care to research and view their statistics of the selected outcomes for 2004–2008. None of the individual data from the municipality federations or hospital district is revealed in the study, nor is any individual patient data. All municipalities were represented by random numbering, and not identified by name. (Paper II, Paper III)

In phase III, the ethical research committee of the Satakunta hospital district approved the interviewing of patients (Paper VI). In addition, permission was also granted by the medical directors in all the municipality federations in primary care and hospital district managers in special care for the interviews of different health care professionals and administrative representatives (Paper IV, Paper V). All participants received oral information and more detailed written information about the study in a covering letter before the interviews explaining the principles of voluntary participation. Participants signed consent forms, and were able to withdraw from the study at any stage or contact the researcher if they had any further questions. The data was coded so that respondents could only be identified by the researcher. The data was treated and reported confidentially. In addition, the results were reported openly and honestly. All ethical research standards were observed and the privacy and anonymity of the participants was protected throughout the research phases (Paper IV, Paper V, Paper VI) (ETENE 2001; Burns & Gove 2011; World Medical Association Declaration of Helsinki 2004).

6. Results

6.1. Main outcomes of different regional health information systems

The outcomes of different types of regional health information systems focused on five main outcome areas: *flow of information, collaboration, process redesign, system usability, and organizational culture*. (Paper I, Table 2) The *first* main outcome of the regional health information systems was the information flow and focused on three categories: access to clinical data, timely information, and clinical data exchange. The *second* main outcome was collaboration, in two categories: communication and coordination. The *third* main outcome was process redesign, focusing on the effectiveness of care. The *fourth* was system usability, focusing on usefulness and reliability. The *fifth* main outcome was organizational culture, concerning commitment and attitudes to the most important issues of RHIS. (Paper I, Table 2)

The results above were found based on scoping review. It was noticed that total of 13 studies on regional health information systems have been done in European countries and 11 studies in the United States. The implementation of regional health information systems or health information exchanges has been investigated in many different ways, and with many different study designs. In these 24 studies, the most common type of study design was survey research (n=11) and the second was case study (n=9); there were also examples of evaluation research with two constructive evaluation studies (n=3) and one (n=1) study was multi-methodological triangulation. (Paper I)

The data collection concerning regional health information systems was carried out using various methods. There were *no studies that used only one data collection* method. There were interviews or semi-structured interviews (n=11), group interviews (n=3) and workshops (n=1), structured or semi-structured questionnaires (n=5), group teleconference questionnaire (n=1), observation (n=4), document analysis (n=4), comparisons (n=2) or other means of collection. (Paper I, Table 1)

In these 24 studies, *four different types* of regional health information system were identified: Regional Health Information Systems (RHIS), Regional Health Information Organizations (RHIO), Disease Specific Regional Health Information Systems (D-RHIS) and Integrated Regional Health Information Systems (I-RHIS). (Paper I, Figure 2)

The Regional Health Information Systems (RHISs) were very different in size and in the stage of development, and there was no standardized name for the system. There are examples of Regional Information System Plans (RISP) with integration across a health care region, linking all hospital wards, general practice (GP) surgeries, and district nurses. The Regional Health Information Organizations (RHIOs) researched were instances of collaboration or alliances involving community health centres, health departments and hospitals. There were different types of Disease Specific Regional Health Information Systems (D-RHISs), for example integrated chronic disease management systems focused on providing care for hypertension and diabetes. Also, various types of Integrated Regional Health Information Systems (I-RHISs) were found, such as the Childhood Immunization Registry (CIR) linked to the Women, Infants, Children (WIC) system and the Medicaid Management Information System (MMIS). These were integrated in a regional Department of Community Health application, which interoperates with a number of other systems internal and external to the infrastructure. (Paper I, Figure 2)

6.2. HIE impact on process redesign in the hospital district

6.2.1. Changes in selected outcomes in the hospital district

There was a noticeable *change in selected outcomes* concerning process redesign in laboratory tests, radiology examinations, appointments and referrals in the five-year follow-up period 2004–2008. There was an *increase* in the amount of *total laboratory tests* in the reviewed municipality federations in the hospital district (Paper II, Table 1). The *total number of primary care laboratory tests* per total appointments *increased* by 19.0% and 19.0% per inhabitant of municipality federations in the review period. Compared to the starting point, the number of laboratory tests increased by 0.46 tests per appointment ($p<0.05$,CI:[0.16,0.75]), and 0.89 laboratory tests per municipality federation inhabitant ($p<0.05$,CI:[0.72,1.05]) % (Paper II, Figure 1). (Figure 7)

The *total number of special care laboratory tests* per appointment *increased* by 7.0% and by 17.9% per hospital district inhabitant in the five-year period. Compared to the starting point, the increase was 0.36 laboratory tests per appointment ($p<0.05$,CI:[0.28,0.43]) and 0.78 tests per inhabitant of the hospital district ($p<0.05$,CI:[0.65,0.90]). A review of *laboratory tests on* the *level of clinical chemistry* found an *increase* by 6.6% per appointment and 17.5% per inhabitant of the hospital district (Paper II, Table 1). The number of clinical chemistry laboratory tests increased by 0.33 per appointment ($p<0.05$,CI:[0.20,0.46]) and 0.73 tests per inhabitant of the hospital district ($p<0.05$,CI:[0.65,0.81]) during the study period (Paper II, Figure 1). (Figure 7)

A deeper analysis of the *level of individual laboratory tests* revealed that the largest change that occurred in the review period was in Low Blood Count *(LBC) tests*. LBC tests *increased* by 11.9% per 100 appointments *in primary* care but *decreased in special care* by 6.9%. In comparison with the starting point, in primary care the number of LBC tests increased by 1.7 tests per 100 appointments, and correspondingly in special care the decrease was 2.4 tests per 100 appointments. (p<0.05,CI:[-3.85,-0.91]) (Paper II, Figure 3a).

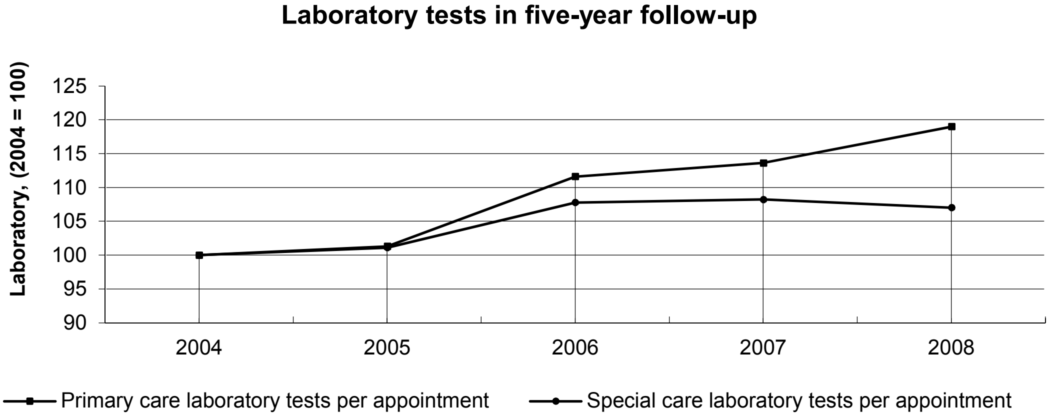


Figure 7. The five years follow-up trends of the primary and special care total laboratory tests.

The number of *total radiology examinations decreased* in every review year of the five-year period. The number of radiology examinations *in primary care* per appointment *decreased* by 16.4% and by 18.9%, per inhabitant for the municipality federations in each year of the five-year review period. Compared to the starting point, the *number of radiology examinations decreased* by 0.02 per appointment (p<0.05,CI:[-0.04,-0.01]) and 0.05 examinations per inhabitant of the region (p<0.05,CI:[-0.09,-0.01]) (Paper II, Figure 1). The total number of *special care* total radiology examinations per appointment *decreased* by 11.0% and decreased by 1.9% per inhabitant. Compared to the starting point, the decrease was 0.03 radiology examinations per appointment (p<0.05,CI:[-0.04,-0.03] and 0.9 examinations per 100 inhabitants of the hospital district (p<0.05,CI:[-1.2,-0.5]). (Figure 8)

A review of *radiology examinations on* the *level of X–-ray imaging* revealed that the amount of X–ray imaging *decreased* by 11 % per appointment and by 2.0% per inhabitant (Paper II, Table I). The decrease in X–ray imaging examinations was 0.04 imaging examinations per appointment (p<0.05,CI:[-0,05,-0.03]) and 0.8 X–ray imaging examinations per 100 inhabitants of the hospital district (p<0.05,CI:[-1.3,-0.3]) (Paper II, Figure 1).

A review on the *level of individual radiology examinations* revealed that the *most common* radiology examinations were C*hest X–ray examinations*, which *decreased* by 17.6% per appointment in primary care and by 20.7% in special care during the review period. Compared to the starting point, the number of C*hest* X–ray examinations *decreased* by 1.0 C*hest* X–ray examination per 100 appointments p<0.05,CI:[-1.38,-0.61]) and in special care by 1.4 C*hest* X–ray examinations per 100 appointments (p<0.05,CI:[-2.33,-0.55]) (Paper II, Figure 3b).

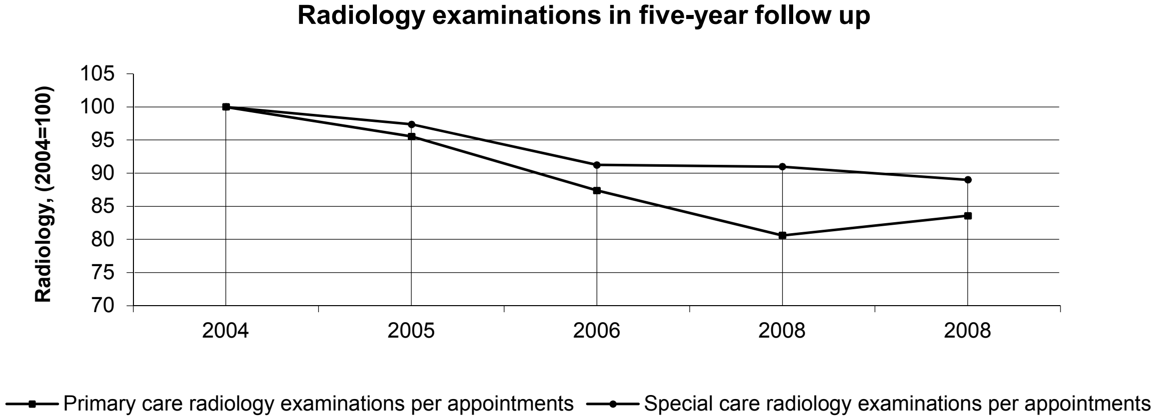


Figure. 8. The five years follow-up trends of the primary and special care total radiology examinations.

Appointments decreased in the municipality federations in every year of the five-year review period. However, the special care appointments of the *hospital district increased* in the same reviewed period. The *number of primary care appointments* per inhabitant of the municipality federations in primary care *decreased*, by 3.0% (Paper II, Table II). If the final situation in 2008 is compared to the starting point, the number of appointments *decreased* by 0.07 appointments per inhabitant ($p<0.05$,CI:[-0.04,-0.11]) (Paper II, Figure 2). The *number of primary care emergency department* visits per 100 inhabitants of the municipality federations *decreased* in the same period by 1.0% (Paper II, Table II).

The *number of special care appointments* per inhabitant of the hospital district *increased* in each year, by 10.2%. The *number of special care emergency department visits* per 100 inhabitants of the hospital district *decreased* by 16.2% (Paper II, Table 2). Compared to the starting point, this represents an *increase* of 0.08 *appointments* per hospital district inhabitant ($p<0.05$,CI:[0.05,0.12]), while the number of *emergency department visits decreased* by 2.38 visits per 100 inhabitants of the hospital district ($p<0.05$,CI:[-1.60,-3.17]) (Paper II., Figure 2).

The *referrals increased* in every year of the five-year review period. The *number of primary care referrals to special* care per 100 appointments *increased* by 43.6%, and by 35.2% per 100 inhabitants in every year (Paper II, Table 2). The *number of primary care emergency referrals to special care increased* per emergency department visit by 12.8%, and per 100 inhabitants of the municipality federations by 12.2% altogether (Paper II, Table II). Compared to the starting point, the *number of referrals increased* by 1.77 referrals per 100 appointments ($p<0.05$,CI:[1.12,2.41]) and 2.10 referrals per 100 inhabitants of the region ($p<0.05$,CI:[1.71,2.49]). The *increase* was 0.023 *emergency referrals* per emergency department visit and 0.54 per 100 inhabitants of the municipality federations ($p<0.05$,CI:[0.29,0.78]) (Paper II, Figure 2).

6.2.2. Impact of HIE utilization rates on selected outcomes in the hospital district

The speed of RHIS implementation varied within the study area in 2004–2008 follow-up period. The HIE utilization rate *increased annually* in all the federations of municipalities *in primary* care, and it was in use throughout the whole hospital district area by 2008. HIE usage differed greatly between the federations of municipalities in primary care. The data for 2008 describes the HIE utilization rate best. By that time, HIE was being used substantially more (8.7–21.9 viewed references/100 appointments) in all the federations of municipalities compared to usage two years earlier (0.6–6.2 viewed references/100 appointments) (Paper III, Table 1).

The RHIS was implemented *in special care* one year after primary care, in 2005, and the HIE *utilization rate increased considerably* after that. The total utilization rate of HIE in special care (16.3/100 appointments) exceeded the average usage in primary care (13.3 viewed references/100 appointments) at the end of the follow-up period (Paper III, Table 1). There was no statistically meaningful difference in the number of physician appointments proportioned to the number of viewed references (p=0.890) between different federations of municipalities analysis of variance (ANOVA) (Paper III). (Figure 9)

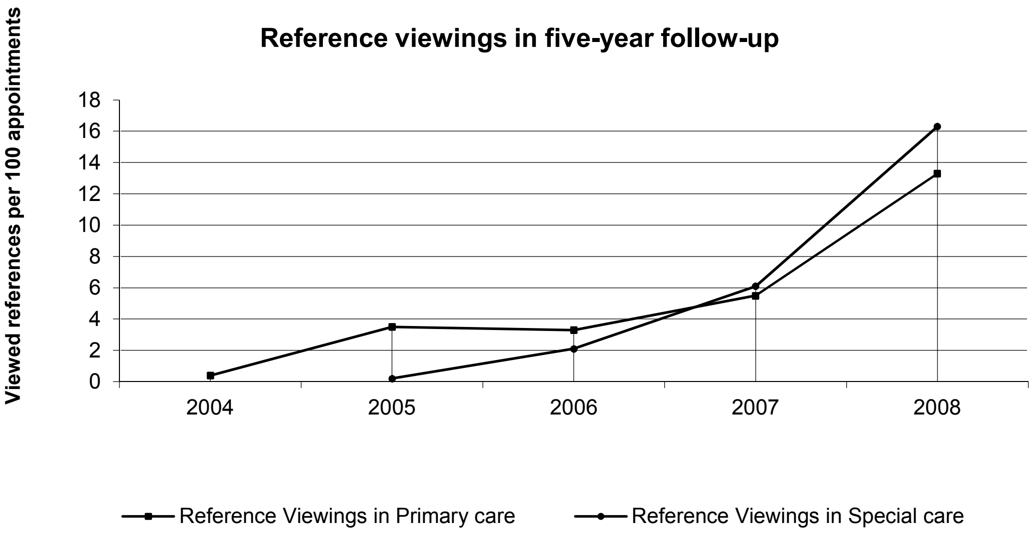


Figure 9. The reference viewings in primary and special care per appointments, five years follow-up period 2004–2008.

At the beginning of the follow-up period, clinicians viewed reference information more (84%) than nurses (16%) in primary care. In special care, reference information was viewed (85%) by clinicians, (10%) by nurses, and (5%) by department secretaries. The viewed references increased steadily for each professional group in the five-year period. At the end of the follow-up period in 2008, the viewers were clinicians (48%), nurses (39%) and department secretaries (13%) in primary care. In special care the shares were 9% by clinicians, 57% by nurses and 33% by department secretaries (Paper III, Figure 1). No statistically significant difference was founf in the number of viewed references between the municipality federations when examining the differences in averages among the different professional groups (p=0.916, p=0.583 and 0.103) using analysis of variance (ANOVA) (Paper III).

HIE *utilization rates* in terms of viewed references in all the municipality federations by selected health care delivery outcome revealed no statistically significant explanations. For the three upper quartile federations with high HIE utilization rates, there were not any outcomes interpreted in the model. For the lower quartile of federations, statistically significant associations were observed for the *number of laboratory tests* (p=0.016) and *radiology examinations* (p=0.023) per inhabitant. The *more laboratory* and *radiology tests there were*, the *more reference information was viewed* (Paper III, Table 2). The HIE utilization rates of the lower quartile federations of municipalities in viewed references varied from 36 to 8819 times a year. Comparably, for the upper quartile federations the variation was slightly smaller, with a minimum of 441 and maximum of 7819 viewed references a year (Paper III, Table 3). (Figure 10)

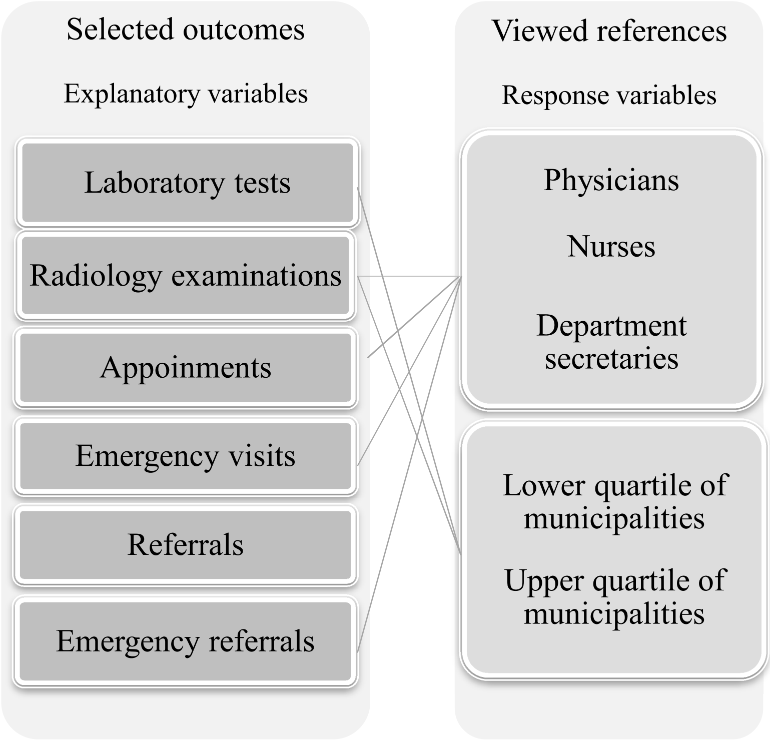


Figure 10. — Statistical associations between the viewed references and lower and upper quartile federations of municipalities in primary care, and between different professional groups.

The HIE *utilization rates* in terms of viewed references differed by professional health care group. For *physicians*, the viewed reference information was statistically significantly associated with primary care *emergency referrals to special care* (p=0.045). The more referrals the physicians made, the more they utilized HIE. For *nurses*, viewed reference information was associated with statistical significance to *radiology examinations* (p=0.001), *emergency visits* (p=0.044) and *emergency referrals to special care* (p=0.001) per inhabitant. Nurses used HIE significantly more when the number of emergency visits and emergency referrals increased. For *department secretaries*, viewed references were statistically significantly associated with *appointments* (p=0.028), and were *close to statistical significance* regarding *emergency visits* (p=0.073) *and laboratory tests* (p=0.073), i.e. the increased number of appointments, emergency visits and laboratory tests was linked to increased use of HIE among department secretaries (Paper III, Table 2). Physicians used HIE to view references the most, at an average of 1333 per year; nurses viewed reference information nearly half as often as physicians, at an average of 758 times per year; and department secretaries the least, with 497 times per year (Paper III, Table 3). (Figure 10)

6.3. Experiences of HIE outcomes by different health care professionals, administrative representatives and patients

6.3.1. Flow of information

HIE usage had changed the flow of information in terms of the *availability of information, exchange of information and data protection* so that it benefited the patient, but still not sufficiently, by the time the system had been in use for five years, according to health care professionals, administrative representatives and patients. (Paper V, Paper VI)

HIE usage had improved the availability of information in the opinion of the *health care professionals and administrative representatives*. A better overall picture of the patient was obtained when it was possible to gather patient data together from the system. On the other hand, access to patient information was difficult when the patient data was hard to find and fragmented around the system, and it was time-consuming. However, it was possible to obtain useful and timely information on the status of the patient care, even though entry of treatment information was incomplete and the health care summary was missing. (Paper IV) *Patients* were satisfied that the primary care doctor was able to see their special care information directly from the system and that better use was made of test results. The timeliness of the information varied and there were deficiencies in entering patient data, since not all patient information could be found. (Paper VI)

The exchange of information between different organizations had improved. On the other hand, HIE usage was experienced by the *health care professionals and* *administrative representatives* to have worsened the exchange of information of patient data between the different organizations. Patient data was mostly found archived in the RHIS. Transfer of patient data about follow-up treatment had in fact become more the responsibility of the patient. The discharge summary from special care was sent to the patient's home, and the patients were more responsible for forwarding data on their own follow-up treatment to the follow-up care facility. Patient data was still being transmitted via phone and fax, and patients gave the information to the professionals or family members were also asked. (Paper IV) *Patients* had observed that regional HIE had improved and facilitated the flow of information within the hospital district compared to the sending of patient documents in paper form. On the other hand, patients felt that the transmission of patient data between the different organizations had deteriorated, since data on special care appointments were not transferred to primary care. Patients felt that *transferring data on follow-up treatment was their responsibility*. Discharge summary information on special care appointments was sent home and the patient was instructed to take it to the facility providing the follow-up treatment. Responsibility for transferring patient follow-up treatment data had also been passed on to family members. (Paper VI)

Consent practices regarding data protection had made the availability of data on the system more complicated, according to the *professionals and administrative representatives*. Consent for viewing data had not always been transferred to the follow-up treatment facility, and there was a breach of patient data protection when patient data was viewed without consent. (Paper IV) *Patients* knew their rights and were aware that they had given permission to view their data, even though it was not clear whether their permission had been asked. In fact, they wondered why they were often asked for permission to view their data. (Paper VI)

6.3.2. Collaboration

HIE usage had *improved regional collaboration* in patient health care after the five-year follow-up period in the hospital district. The health care professionals, administrative representatives and patients highlighted *co-operation, coordination of care and communication* in regional collaboration. (Paper V, Paper VI)

According to the *professionals and administrative representatives*, HIE had improved regional collaboration, and HIE usage had improved inter-organizational co-operation, enabling viewing of patient information about what had been done and planned in the other organization regarding patient care. In contrast, HIE usage was not experienced to be a significant factor in collaboration. The professionals and administrative representatives highlighted the conditions imposed on HIE through RHIS in terms of co-operation between professions, even though it had provided what was required to complete missing patient data. (Paper V) According to *patients*, collaboration was a matter of co-operation between the health centre and central hospital or outpatient departments, as well as viewing patient data from another professional on the computer. Patients believed that inter-organizational collaboration and regional co-operation were working well enough. (Paper VI)

The overall situation of a patient's care was easier to perceive, which improved the coordination of the patient service package according to the *health care professionals and administrative representatives*. Patient safety increased when patient data on follow-up treatment and data from the previous health care provider was available. However, patients now felt they had to take more responsibility for their own follow-up treatment when the RHIS was used, which at the same time made the continuity of care and follow-up treatment worse. Electronic patient data was available for use by all those involved in the care. However, the updating of patient data could take several days. (Paper V) On the other hand, the *patients* had the feeling that nobody was in control of their service package because patients with multiple illnesses had a lot of appointments at different units of special care, and treatment was divided between them. Patients felt *they were more in control of their own follow-up treatment* even when HIE was in use. (Paper VI)

According to *the health care professionals and administrative representatives*, there were shortcomings in communication between organizations, when patient data from a patient's appointment at special care was not transmitted to primary care, and when the follow-up treatment data was not addressed to the relevant doctor. Communication between health care professionals and the patient was highlighted in association with patient guidance. (Paper V) With regard to communication, *patients* highlighted the fact that the professionals could see the health care summaries written by their colleagues and, in addition, that other professionals could see information for the patient on computer. Also, patients expressed the wish to have access to their own patient records. (Paper VI)

6.3.3. Process redesign

After five years of using HIE through RHIS, both improved efficiency and lack of improvement could be observed in process redesign in the follow-up period in the hospital district. The health care professionals, administrative representatives and patients commented on changes in work practices under the point *improved efficiency and lack of improvement*. (Paper V, Paper VI)

According to the *health care professionals and administrative representatives*, improvements in work practices could be seen with usage of the HIE, since the amount and sending of papers had decreased, and were no longer ordered from the archives. Working practices had become clearer within the hospital district when transferring patients of a certain type from special care to primary care. Patient records were checked more when searching for further information about previous illnesses and test results. Redundant tests and treatments had been reduced because it was known what had been done to the patient during the previous clinical visit. Data protection practices were made clearer since it was possible to view the patient records upon the oral consent of the patient. (Paper V) According to the *patients,* improved service efficiency was seen in that ordering of patient records had ended, there was a lot of patient data available, and the doctor could see what had previously been done to the patient or recorded about treatment elsewhere, and that the patient did not need to carry their records with them. (Paper VI)

According to the *health care professionals and administrative representatives*, lack of changes in working practices was shown in that patient records were still being sent by post five years after the implementation of the RHIS. There was still duplication between the functioning of the organizations, and the same tests were repeated on patients. New inefficient practices had also evolved, when patient records were printed off from the RHIS, and archived in the patients' files. Nurses and department secretaries printed and collected patient records ready for the doctor, which was time-consuming for the clinical representatives. Data protection had deteriorated when the Patient Act was not adhered to in situations where nurses looked at information for the doctor without the patient's consent. Data protection had also deteriorated since patient data was copied manually from the RHIS for a separate patient records system without complying with patient privacy. Working practices in the hospital district area had not been harmonized at the time of the interviews, since working practices in other organizations were not always known. Clarification and harmonization of working practices were, however, desired. (Paper V) According to the *patients*, inefficiency in the service situation was due to the fact that there had been no changes in practices. According to the patients, the information system was not utilized enough. Patients were subjected to redundant tests, as they visited various outpatient clinics in the central hospital at weekly intervals. (Paper VI)

When process redesign was investigated in *more detail regarding selected outcomes in health care delivery*, an increase in the number of laboratory tests was found, whereas there was a decrease in radiology examinations. There was a decrease in appointments but an increase in the number of referrals. (Paper II, Paper III)

The increased *number of laboratory tests* in the study period (Paper II) was associated, according to *the health care professionals and administrative representatives*, with the duplicated tests carried out when tests made by another organization were not taken into account. The increase in the number of tests was related to ingrained practices, where patients were subjected to routine tests, control tests, follow-up tests and examination packages that included certain laboratory tests. The increased number of tests was linked to the growing importance of laboratory tests. The experience and turnover of doctors also had an association with the increased number of laboratory tests. The cost-effectiveness approach had not been sufficiently addressed with regard to the profitability and necessity for tests. (Paper V) According to the *patients*, the increase in the number of laboratory tests during the five-year period was also associated with overlapping tests, ingrained practices and the importance of laboratory tests with regard to patient care. Patients with multiple conditions often visited different outpatient clinics at the central hospital, which followed familiar practices with their own routine and control tests, including laboratory tests regardless of the tests taken at another unit. (Paper VI)

The reduction in the *number of radiology tests* during the five-year follow-up period (Paper II) was associated, according to the *health care professionals and administrative representatives*, to radiation protection regulations, cost-effectiveness and availability of radiology tests. Some radiology tests were replaced by ultrasound tests, and some rapid changes, as for example shown in laboratory tests, would not show up in X-ray images. Radiology tests are expensive and their necessity was evaluated more carefully than that of laboratory tests. (Paper V) The reduction in the number of radiology tests was, according to the *patients*, associated with specifying the necessity for the test, cost-effectiveness and the availability of the radiology test. According to the patients, the duplication of X-rays had decreased when existing X-rays had been utilized. The availability of radiology testing was limited, because there were few appointments available. (Paper VI)

The reduction in the *number of appointments* with a doctor during the five-year period under examination (Paper II) was association, according to the *health care professionals and administrative representatives*, to the reduced number of repeated appointments, the insufficiency of appointment times, the experience or inexperience of the doctors, and increased appointments with nurses, telephone appointments and the increased use of the private sector. Wasted check-up appointments could be avoided when the patient’s problems could be taken care of using the patient records on the RHIS. The insufficiency of appointments reduced the number of appointments when there were long queues for an appointment with a doctor. Nowadays patients also tend to be older, and more and more patients with multiple conditions are being treated. (Paper V)

According to the *patients*, the reduction in *number of appointments* with a doctor was likewise linked to the reduced number of repeated appointments, the insufficiency of appointment times, the experience or inexperience of the doctors in handling patient affairs, increased appointments with nurses, telephone appointments and the increased use by patients of the private sector. The patients believed that repeat appointments could be avoided when the doctor was able to view the patient’s follow-up treatment and previous treatment data on the RHIS. It was not necessary to book a new appointment because of missing information or ordering patient records. There were long queues at the doctor’s surgery and for appointments, and there were not enough doctors at the health centres, which decreased the number of appointments. (Paper VI)

According to the *health care professionals and administrative representatives*, the increased *number of referrals* from primary care to special care (Paper II) was related to compiling the required referral, the doctors’ experience, the transfer of responsibility and making a referral to special care to keep the patient satisfied, the fact that patients had transferred more to the private sector, and also space problems caused an increase in referrals. Several referrals to special care were made concerning the same complaint in order to speed up the patient’s access to further treatment. Responsibility was passed on, and people did not dare make decisions without a consultation from special care. New treatment options had increased and patients were treated and tested more thoroughly than before. The aging of the population and the increase in illnesses added to the quantity of referrals. Patients were given referrals and placed in special care even though the treatment of the patient would not always have required this due to space problems and the lack of beds on the health centre wards. (Paper IV) According to the *patients*, the increased number of referrals was associated with compiling the referral, the doctors’ experience, the transfer of responsibility, pleasing the patient, the private sector, and space problems. The increase in number of illnesses added to the number of referrals made. On the other hand, a referral to special care was sometimes difficult to obtain, and the doctors wrote a referral upon the demand of the patient. Patients received a referral to special care more easily from the private sector. (Paper VI)

6.3.4. Usability

The usability of the RHIS after five years was reasonable. When examining the usability of the system, the health care professionals and administrative representatives highlighted the importance of *user experience, data security, system support, and the need for system development*. (Paper IV)

The RHIS was considered relatively easy to use. Nevertheless, the system had drawbacks, and it was felt by some to be awkward to use. The *health care professionals and administrative representatives* stressed the technical problems with the system. The treatment feedback program in the RHIS did not function as it should, and often the treatment feedback data was not transmitted to the right professional. In fact, they wished they had the opportunity to use an effective treatment feedback system. Logging into the RHIS was difficult, because there were various systems and user authentications, and they expressed a wish for the adoption of single sign-on. There were not always enough computers and devices available. The organizing of system support was unclear at times. The professionals were not satisfied with the amount of training they received, and the need for retraining was raised. The RHIS should be made more user-friendly. The RHIS was considered a tool worth developing. The health care professionals and administrative representatives felt it important that they should also have the opportunity to be involved in the further development of the system. (Paper IV)

6.3.5. Organization culture

After five years of use, the attitude towards usage of the RHIS in the organizations had changed in the positive direction and was viewed positively. After using the RHIS for five years in the hospital district, *health care professionals and administrative representatives* highlighted the *attitude* towards and *commitment* to the RHIS as factors related to organization culture. (Paper V)

Regarding the attitude towards the RHIS, the *health care professionals and administrative representatives* highlighted the attitudes taken and resistance to change. Health care professionals and administrative representatives took a positive attitude to usage of the RHIS, and no-one was completely against using the system, although there was some resistance to using the system. In relation to commitment to the RHIS, points raised were the embracing of the RHIS as part of the work activities and organization practices. Positive experiences with usage of the RHIS facilitated its adoption as part of the work activities. There were large differences in usage among doctors, as some used it and some never had. There were different practices regarding usage of the RHIS in the organizations, in how to work with the system. (Paper V)

6.4. Summary of the findings on regional health information exchange

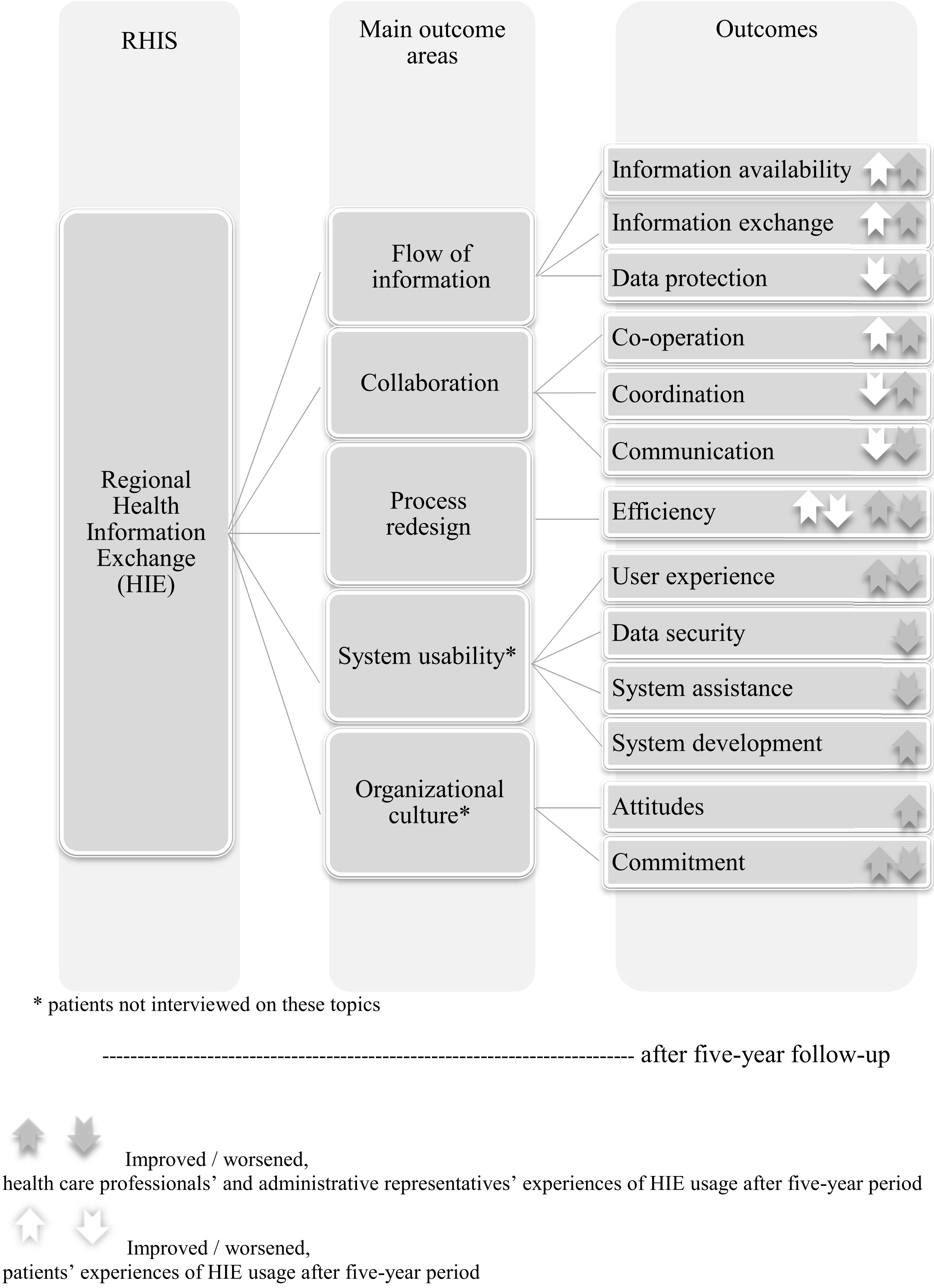
The regional health information exchange (HIE) through different types of regional health information systems (RHIS) focused on five main outcome areas: the flow of information, collaboration, process redesign, system usability, and organizational culture. These areas were found based on the scoping review. (Figure 11)

HIE usage had changed the flow of information by the time the system had been in use for five years according to health care professionals, administrative representatives and patients. HIE usage had *improved the availability of information* for obtaining a better overall picture of the patient. Patients were satisfied that physicians had *access* to their health records directly from the system. *Exchange of information* between different organizations had *improved*, and patients had observed that regional HIE had facilitated the flow of information within the hospital district. However, *data protection* had made the availability of data on the system more complicated.

HIE usage had *improved regional collaboration* in patient health care after five years according to health care professionals, administrative representatives and patients. HIE usage improved inter-organizational *co-operation* through viewing of patient information *from other organizations* involved in the patient’s care. The *coordination* of the patient service package in overall patient care was improved according to the health care professionals and administrative representatives. However, *patients with multiple illnesses* had the feeling that *nobody was in control* of their service package and they had a lot of appointments at different units of special care. There were *shortcomings in communication* between organizations according to the health care professionals and administrative representatives.

After five years of using HIE through RHIS, both *improved efficiency* and *inefficiency could be observed* in process redesign during follow-up period in the hospital district. Improvements in work practices could be seen with usage of the HIE according to the health care professionals and administrative representatives, and patients noticed improved service efficiency in the fact that ordering of patient records had ended. *New inefficient practices* had also evolved, when patient records were printed off from the RHIS, and archived in the patients’ files. According to the patients, there was inefficiency due to the fact that there had been no changes in practices and the information system was not exploited enough.

The RHIS was considered relatively easy to use. The health care professionals and administrative representatives felt it important to be involved in the *further development* of the system. The *attitude* towards usage of the RHIS in the organizations had changed after five years of use in the *positive direction*, and no-one was completely against using the system.



* patients not interviewed on these topics

-- after five-year follow-up

Improved / worsened,
health care professionals' and administrative representatives' experiences of HIE usage after five-year period

Improved / worsened,
patients' experiences of HIE usage after five-year period

Figure 11. The summary of the findings on regional health information exchange after five-year usage of HIE.

7. Discussion

7.1. Validity and reliability of the study

The adequacy of the study process was examined by assessing the *validity* and *reliability* of the results. The validity of the present study reflects the truthfulness and accuracy with which the study findings reflect the phenomenon being studied. The validity of the present study is considered in terms of internal validity, external validity, and objectivity (Kane 2006; Polit & Beck 2006; Burns & Grove 2011.) Internal validity is related to how reliable the phenomenon is in terms of the research involved and how reliable the conclusions made are. External validity refers to the truth of the conclusions. Validity of the results refers to objectivity. Validity is considered a single broad method of measurement, and it is essential that the results and conclusions of the study are based on data (Pringle & Doran 2003; Burns & Grove; 2011; Melnyk & Fineout-Overholt 2011). Reliability reflects how well the method works by analysing the material and producing results which are not random, and relates to the dependability of measurement. They come out a different way, for quantitative and qualitative research methods (Polit & Beck 2006; Burns & Grove 2011). It was difficult to set up a control group for the phenomenon under research and this lack of control group was major limitations of this study. Comparative design was not appropriate in this study situation because of different sizes and function of hospitals districts, and they may have different information systems in use. The research subject was approached using mixed methods from different angles, and was designed to obtain different viewpoints about the subject matter. This made it possible to make the quantitative and qualitative data equivalent, using the data and findings in a single report (Polit & Beck 2006; Melnyk & Fineout-Overholt 2011).

7.2. Validity and reliability of the data

In the first phase, a literature review was conducted using only medicine and nursing science databases MEDLINE, CINAHL (1982–2008), the Cochrane Library, (1972–2008), and an additional search on PubMed/Medline (from 2000 to December 2011). These were the most comprehensive and useful sources for health information systems and approaching regional health information systems (RHIS) from the functional point of view (Polit & Beck 2006; Burns & Grove, 2011; Melnyk & Fineout-Overholt 2011). A further review was carried out based on PubMed/Medline (from 2009 to December 2011) and the Cochrane Library (from 1972 to December 2011). (Papers II, III, IV, V, VI) One exclusion criteria was the technological approach in this study, and the fact that it only covered studies in the

English language. However, some relevant articles may have remained undetected. The investigated phenomenon was complicated to approach, because there were numerous different sites, and different phases in the development of RHISs. The papers were reviewed by co-operation with other scholars. An information specialist was consulted on finding the right key words for the database when the search became challenging. The reported methodologies in the systematic review appear to be heterogeneous, which limits their comparability. RHISs have been investigated in many different forms, and with many different study designs, and the quality of the studies included could not be determined. (Paper I)

In the second phase, a purposive sampling was conducted (Polit & Beck 2010.) A quantitative statistical register of data was used, of routinely collected information concerning selected outcomes from the electronic patient health care records (EHRs) in primary and special health care in the follow-up period 2004–2008 in one hospital district in Finland. The selected outcomes obtained from the regional databases included total laboratory tests and radiology examinations, appointments, emergency department visits and referrals. The data was reviewed from the starting point of the usage of an RHIS in one hospital district. All outcome results had to be collected manually by searching the statistical reports because the EHRs were different in the various federations of municipalities and the follow-up outcome results were in different statistical report formats. However, the statistics were comparable both across the years and across the various municipalities. In addition, there were usually only a few contact persons in the municipalities who knew how to use the differing statistical systems associated with the electronic health records.

Purposive sampling was used and the amount of viewed references were ordered from the supplier of the RHIS, in terms of health information exchange (HIE) utilization rates, for all federations of municipalities in the hospital district by groups of health care professionals (physicians, nurses, department secretaries) in the whole hospital district. The statistical data from the provider was sorted by year and by professional group (physicians, nurses, and department secretaries). The research data is central to quantitative research, where research proceeds to research material under certain conditions. All the data was collected using similar inclusion criteria and instructions (Burns & Grove 2011). An integrated register of statistics was created by combining information that already existed in a statistical register in the system (Wallgren & Wallgren 2007).

In the third phase, purposive sampling was used (Polit & Beck 2010; Melnyk & Fineout-Overholt 2011). The data was collected from different health care professionals, administrative representatives and patients, who had used health information exchange (HIE) through the RHIS the most. The interviewees were selected as follows: two interviewees from each different professional group (physicians, nurses and department secretaries), one administrative representatives (head physician, managing physician), totalling 43 interviewees (Paper IV, Paper V) and ten chronically ill patients with a chronic disease diagnosed at least five years earlier (Paper VI) in a hospital district organization, once the regional health information system (RHIS) had been in use for five years. The organizations were the four municipality federations primary health care centres which used HIE the most, and the special care emergency department and the common regional emergency department unit, both laboratory departments and radiology department units in the hospital district. (Papers IV, V and VI) The interviewees was supposed to be those with the most experience and opinions on the use of HIE through the RHIS. The qualitative research saturation principle means that data collection can be terminated when new cases fail to provide any new information (Melnyk & Fineout-Overholt 2011). Data began to be saturated during the last two interviewees in each set of health care professionals, administrative representatives and patients, which shows that the amount of interviewees had been sufficient.

7.3. Validity and reliability of the research process

In the first phase, a content analysis was made of the 24 articles included in the scoping literature review. Content analysis is designed to classify data by the characteristics deemed of theoretical importance (Burns & Grove 2011). The data was classified using the research question criteria. The criteria were the scope of studies of regional health information systems, the type of regional health information systems, and regional health information system outcomes in health care. Credibility deals with the focus of the research and refers to confidence in how well the data and processes of the analysis address the intended focus. (Polit & Beck 2006; Melnyk & Fineout-Overholt 2011.) Classification of the studies according to their purpose was difficult, because they rarely provided explicit accounts of the purpose of the systematic review and had to be inferred by the researcher. Only a few studies examined the effectiveness or outcomes areas of the systems directly. However, regardless of the study design, the systematic review results were parallel. (Paper I)

In the second phase, the *external and internal validity* of the research process was investigated. External validity indicates a representative sample size. Internal validity of a quantitative study is based primarily on the measurement of the success of the phenomenon, and on appropriate research methods and material selection. Reliability reflects how well the method works by analysing the data. (Kane 2006). Trend analysis was used in the retrospective cross-sector five-year follow-up study for the years 2004–2008 for all the federations of municipalities in one hospital district, looking at the overall pattern of change in the selected outcomes over time. The goal of trend analysis for health care delivery is to discern whether the level of services or systems indicators (selected outcomes) has increased or decreased over time (Slutsky & Clancy 2005; Polit & Beck 2006). When comparing the level of an indicator (selected outcomes) across geographic areas, looking at only one point in time can be misleading. The trends over several years give a more precise comparison of the areas. The follow-up period could have been longer than five years. However, all the federations of municipalities in the hospital district area participated in the study and several measuring points for a trend analysis of the follow-up period were obtained. This study focused on all the municipality federations in one hospital district, which improves the reliability of the study. Tables, graphs and statistical analysis are tools for examining and analysing trend data, which are being presented Paper II. In this study, graphs were an effective tool for presenting the change in selected outcomes over time. (Appendices 3) The *t-test* was used to determine the statistical significance and confidence intervals of the changes in rates over time (Burns & Grove 2011). (Paper II)

A comparative, longitudinal five-year follow-up study for the same years was made for all federations of municipalities. The statistical difference was tested to see whether there was a statistically significant difference in HIE utilization between different professional groups in the different federations and whether there was a difference between the professional groups. The differences in averages between groups were tested using *variance analysis* (ANOVA) (Burns & Grove 2011). The default distributions of the lower and upper quartiles were also investigated for modelling purposes. For the study design, it was clear that all the federations of municipalities should be divided into quartiles, which gave a clear set of those that used the system more and those that used it less. The response variables, i.e. the viewed references by different professional group, were modelled as the explanatory result variables, which was done for all viewed references. The explanatory result variables in the model were the numbers of laboratory tests, radiology examinations, physician appointments and referrals in the five-year follow-up period from 2004 to 2008. (Paper III)

In this study, the chosen methods of analysis were consistent with the answers to the research questions, so the reliability of this point can be considered good. Reliability examines, in turn, the extent to which the method includes measuring a measurable phenomenon. The researcher has taken into account when selecting methods of analysis of statistical methods such requirements and the variables in the form of distributions of the measuring plane. However, the internal validity of conclusions from the study would need to be supported by statistical control or a baseline analysis of the utilization of HIE. In addition, the numbers of duplicate laboratory tests or radiology exams or repeat admissions etc. were not available, even though it would have been important to have them for comprehensive analysis of the development. The small number of observations may partially explain why significant explanatory factors were not found. However, this study deals with more than one model, different responses and different quartiles, and the similar models can be compared. Since human behaviour affects the use of HIE in the early stages, it is challenging to find a clear explanation. (Paper II, Paper III)

The area of *external validity* concerns the generalizability or representative nature of the study results (Kane 2006; Polit & Beck 2010). The results are limited in scope geographically to one hospital district in Finland. However, the data covers the total numbers of inhabitants and appointments, as the number of tests or examinations and referrals per appointment or per inhabitant were unavailable. Therefore access to the variability of test rates is limited. Although there were no regional structural changes in the follow-up period of 2004–2008 in the hospital district area, there was organizational pressure to reduce the use of ambulatory care, which could have caused similar effects to HIE usage. For example, better emergency department triage may have led to fewer admissions. Also, a picture archiving and communication system (PACS) that uses digital data in distributed databases and is accessible through a network offers interfaces to the health care service could have caused a decrease in the number of radiology examinations, and could have caused similar effects to HIE usage. In addition, other developments in science, technology and treatments and service may have contributed and caused similar effects to HIE. (Paper II, Paper III)

In the third phase, themed interviews were chosen as the research method, because the aim was to deepen understanding of the benefits of HIE from the perspective of health care professionals and administrative representatives (Paper IV, Paper V) and patients (Paper VI). The interviewees were assumed to have experience and opinions regarding usage of the RHIS. The aim was to obtain as varied information as possible on the phenomenon under study, so the themes used were broad, and the informants spoke openly of their experiences. (Burns & Grove 2011). The interviewees were successfully interviewed by means of themed interviews and proved to be a rich source of data. The interview method and interview themes were pilot-tested before the data collection. After the pilot tests, the researcher's way of proceeding was stressed in that, if the discussion went off topic, it should be brought back to the subject quickly. The interview themes were found to be wide-ranging enough as they produced rich data concerning different experiences on the part of the health care professionals, administrative representatives and patients. (Paper IV, Paper V) (Burns & Grove 2011).

Assessment of the reliability of the qualitative research was done for the entire research process, using Lincoln and Gubas' (1985) evaluation criteria of *credibility, dependability, transferability and confirmability* (Melnyk & Fineout-Overholt 2011). In this research, the *material was credible*, because all the health care professionals, administrative representatives and patients taking part in the research were those with the most experience of HIE. When selecting participants for this research, health care professionals and administrative representatives were selected from those hospital district organizations that had used the RHIS the most, and likewise it was established that the patients had multiple illnesses, and that their condition had been diagnosed at least five years earlier, i.e. before the start of the follow-up period, and who had experience of regional HIE and pertinent information about the phenomenon under study. In this study, the experience and knowledge of the phenomenon by the participants in the study increase the credibility of the research results. (Paper IV, Paper V, Paper VI)

The *dependability* of the research can be checked from the aspect of the permanence of the material. The researcher affects the research and its results throughout the research process. The way the researcher understands the phenomena being studied affects the research the whole time (Melnyk & Fineout-Overholt 2011). The researcher has striven consciously to avoid preconceptions of the phenomena being studied, and in addition another researcher evaluated the progress of the analysis. The results are derived from original material. Applicability as a criterion of reliability appears as the *transferability* of the research results (Melnyk & Fineout-Overholt 2011). Geographically speaking, this research concerned the perceptions of health care professionals and administrative representative and patients in one hospital district, regarding one system and those who had experience of using the system, so the results are not transferable to all professionals in the whole of Finland. The opinions of ten patients were collected from a single hospital district as material. The results obtained from the research can be utilized in developing health care information systems. The key reliability criteria in the analysis stage were to show that the connection between material and results was preserved. *Confirmability* occurs when it is possible to evaluate the research process sufficiently (Melnyk & Fineout-Overholt 2011). The connection between material and results was confirmed by returning to the original material frequently during the analysis and by the fact that two other researchers confirmed the analysis. The progress of the analysis was described carefully and original expressions from the material were presented in support of the analysis. The analysis was also depicted in tabular form. (Appendices 4) Reliability is indicated by the fact that the interpretations made are supported by corresponding earlier studies. (Paper IV, Paper V, Paper VI)

7.4. Discussion of the findings

7.4.1. Main outcome areas of different regional health information systems

This study provides new information in that the same main outcome areas can be found in different types of regional health information systems. Previous empirical studies have focused on only one or a few of the main outcome areas. The main outcomes of the different types of regional health information systems (RHISs) in the systematic literature review focused on five main areas. The main outcome areas of RHIS were *flow of information*, *collaboration*, *process redesign*, *usability* and *organization culture,* but they have not previously been reported in the same study. RHISs means more timely and patient-centered information for the clinical decision processed when needed, fewer redundant tests and better management of chronic ill patient care (Marchibroda 2008; Protti 2009; Staff et al. 2010; Wen et al. 2010). The literature review revealed that the *flow of information* was meant for improved data access, timely patient information, and clinical data exchange (e.g. Follen et al. 2010). However, there was also limited and inadequate access to patient records and complexity in clinical data exchange across organization boundaries (e.g. Korst et al. 2008; Hincapie et al. 2011) that reduced work efficiency when the information needed was not available, due to the time spent searching for data on the RHIS (e.g. Hincapie et al. 2011). The patients also wanted access to their own health information, and supported physicians' viewing of patient health information from health providers in the region to support clinical decision making and enhance their own health care (e.g. Wen et al. 2010; O'Donnell et al. 2011; Patel et al. 2011), although patients were concerned about privacy and security issues (e.g. Wen et al. 2010). Patients with several illnesses and chronic conditions often have many caregivers, require multiple medical tests, and take more than one medication (e.g. Balfour et al. 2009.) The RHIS fosters regional *collaboration* with the purpose of facilitating electronic exchange of clinical data on a patient's disparate health records among stakeholders in a given region (Kass-Hout et al. 2007; Shapiro et al. 2007; Grossman et al. 2008; Protti 2009). The literature review highlighted the fact that the RHIS improved communication and coordination within the studied region, and enhanced empowerment, multidisciplinary teamwork by health care professionals (e.g. Nohr et al. 2001), and had the potential to increase the efficiency of health care (e.g. Fontaine et al. 2010; Demski et al. 2010). Similarly, patients believed that regional health information exchange improved communication with their physicians and supported RHIS usage for a better quality of patient-centered care (e.g. Patel et al. 2010; O'Donnell 2011).

The literature review indicates that RHIS supports *redesigned health care processes* and improves effectiveness of health care delivery while decreasing the duplication of services and redundant testing (e.g. Hincapie et al. 2011) and the number of laboratory tests or radiology examinations (e.g. Walker et al. 2005; Frisse & Holmes 2007; Kaelber et al. 2007.) RHISs also improved information processing, reduced re-appointments and emergency department visits (e.g. Kaelber et al. 2007; Maas et al. 2008) and improved referrals processes (e.g. Frisse & Holmes 2007). The RHIS promise to redesign health care processes to be more patient-centred includes customizing care based on patients needs and values, which can achieve better personalized care (Haux 2006; Marchibroda 2008; Protti 2009; Wen et al. 2010).

In the literature review both usefulness and satisfaction with use (e.g. Hincapie et al. 2011), along with poor *usability* of the RHIS were found (e.g. Halamka et al. 2006), lack of acceptable community standards (e.g. Balfour et al. 2009) and non-interoperability regionwide of the system (e.g. Halamka et al. 2006). Poor usability of an RHIS delays adoption by professionals and limits potential improvements to efficiency and safety of care (Ward et al. 2008; Horsky et al. 2010; Gadd et al. 2011). In the literature review, concern was also raised over the security and confidentiality of the RHIS (e.g. Chronaki et al. 2007; Patel et al. 2011). The needs and requirements of all professionals must be taken into consideration in developing the HIS in health care delivery (Häyrinen et al. 2008; Bonner et al. 2010; Patel et al. 2011).

In the literature review the most important issues of *organizational behaviour* that were found were commitment and attitudes concerning RHIS with the acceptance and participation of both professionals and patients (e.g. Hanmer et al. 2007). It is necessary to take into account different professionals' needs and differences in cultures in various parts of health care (Protti 2009; Melby & Hellesø 2010; Korst et al. 2011). Attitudes of regional representatives are significant factors in the acceptance and efficient use of HIT in health care practice (Ward et al 2008; Koivunen 2009; Vest 2010). However, in the literature review there were also found differences in organizational culture, vision and expectations of leadership, non-existence of common rules and policies to share clinical data and limited understanding of the system concerning the RHIS (e.g. Korst et al. 2008). In order to make substantial changes in work practices, strong leadership commitment and support from stakeholders is required for collective action and clear goals for successful efforts (Hessler et al. 2009; Frisse 2010; Korst et al. 2011). Health care professionals have become increasingly aware of the need for long-term work in changing internal work processes (Melby & Hellesø 2010).

The regional health information systems (RHISs) investigated were heterogeneous and in different development phases, and there is no standardized name for the systems. There were also differences in system functionalities with very large associations of many regional providers and some small ones, such as a few district hospitals integrated with external actors like laboratory or radiology entities. There were *four different types* of regional health information systems: Regional Health Information System (RHIS), Regional Health Information Organization (RHIO), Disease Specific Regional Health Information Systems (D-RHIS) and Integrated Regional Health Information Systems (I-RHIS). However, the core philosophy of health information exchange (HIE) is the electronic transfer of patient-centred information between organizations through RHIS to facilitate the movement of health care information within or across organizations at the point of care (Jha et al. 2008; Ross et al. 2010; Saff et al. 2010; Frisse 2010; Vest 2010).

Most empirical studies of regional health information systems have been made in the US and the rest in various European countries. According to the literature review, very little empirical research into RHIS was found. Most of the international literature focused on discussing or describing the financial, technical, organizational or privacy aspects. The approach of the studies to the RHIS was both functional and technological, and studies with only a technological or architectural approach were excluded in the systematic review. RHIS and health information exchange (HIE) have received substantial attention from national policymakers in Europe and US. In many countries, health care was seen to improve through health information technology and they are moving forward to start developing HIE among health care organizations (Adler-Milstein et al. 2008; Jha et al. 2008; Kern et al. 2009). There is a need for evaluation and research to understand the effectiveness and value of services and benefits that emerge from an RHIS (Kuhn et al. 2007; Rudin et al. 2009; Marchibroda 2007). RHISs have been investigated in many different ways, mostly using different combinations of methodologies. The most common study design was a survey research and case study. Machan et al. (2006) have reported that triangulation, mixing quantitative and qualitative methods, can make a valuable contribution to the further improvement of evaluation research in health care informatics (Ross et al. 2010).

7.4.2. HIE impact on process redesign in the hospital district

Based on this study, it cannot be unequivocally concluded that using HIE improves process redesign and brings efficiency in health care delivery. According to this study, health information exchange (HIE) may have had an impact on health care delivery in the hospital district. *Substantial changes in the selected outcomes* in health care delivery were found in both primary and special care in one hospital district area in a five-year follow-up period by investigating the impact of HIE. There also be *associations* between the regional HIE and the number of radiology examinations, appointments and emergency department visits in the same period. The HIE through RHIS have an impact on health care delivery in the hospital district. This study indicates that the efficiency of patient care may have increased by timely access to clinical information. In previous studies, HIE holds out the promise of collecting patient data across sites of care to provide more complete information for patient treatment and improve efficiency in the region (Halamka et al. 2006; Grossman et al. 2008; Jha et al. 2008; Tripathi et al. 2009).

In this study, the conclusion was supported by a decreasing trend observed in outcomes such as radiology examinations, number of appointments and emergency department visits in the hospital district area. Maass et al. (2007) also estimated a 20% reduction in redundant examinations and re-appointments in the same system. The availability of complete laboratory test results would eliminate redundant testing (e.g. Garrido et al. 2005.) In this study no conclusive evidence of a decreasing trend was found for laboratory tests. Garrido et al. (2005) also estimated that an examination of the ordering patterns for specific tests may better reflect the effectiveness of laboratory systems than overall trends. However, the changes observed in HIE usage may have many other possible explanations. More research is needed to understand the impact of HIE on the efficiency of health care delivery (Rashiq et al. 2006; Hripcsak et al. 2007; Scales et al. 2007). Decision makers are also interested in the role of HIE and require knowledge-based evidence of specific health interventions in health care that they can use in the decision-making processes. (Grossman et al. 2008; Andradas et al. 2008).

The *number of radiology examinations decreased substantially* in the five-year review period, which may indicate the impact of HIE both in primary and special care. According to the previous results, radiology services decreased by 14 % in the two years after the implementation of HIE (Garrido et al. 2005). Several studies indicate that HIE could improve radiology information processing (Kaelber et al. 2007; Sprivulis et al. 2007), and decrease radiology examinations (Shapiro et al. 2007; Frisse & Holmes 2007; Vest 2009). Investigating the impact of regional HIE on the *number of laboratory tests* in primary and special care revealed an increasing trend in the five-year review period. Similarly to previous studies, *no clear evidence was found* between HIE usage and the improved availability of complete laboratory tests in the decreased ordering of the laboratory tests or elimination of redundant testing (Overhage et al. 2002; Garrido et al. 2005). However, studies indicate that HIE usage may have decreased laboratory tests and the number of redundant tests (Shapiro et al. 2006; Miller & Miller 2007).

The one reviewed outcome that may have an HIE impact was *appointments* in primary and special care. The trend in primary care appointments showed a *decrease* in the five-year follow-up period. Correspondingly, the number of special care appointments increased during the study period. According to previous studies, HIE should improve communication among providers and health services information processing, reducing re-appointments and having fewer admissions for observation (Cruz-Correia et al. 2007; Kaelber et al. 2007; Maass et al. 2008; Vest 2009). Another investigated outcome was the *emergency department visits* in primary and special care. The frequency of emergency department visits *decreased* in the five-year follow-up period. Shapiro et al. (2007) reported that one quarter of patients could benefit from external health information, and one fifth would benefit according to Maass et al. (2007). Smith et al. (2005) reported that between 14% and 25% of emergency department visits were due to missing information stored in another hospital system in the region. Overhage et al. (2002) in a randomized controlled HIE pilot found that emergency department visits would benefit from an HIE system. Access to HIE information was associated with the number of emergency department room visits (Vest et al. 2009). An increasing trend was observed in primary health care referrals and emergency referrals to special care in all the reviewed follow-up years. No other findings of HIE impacts were observed. However, according to previous research, referrals processes should be improved by using HIE (Walker et al. 2005; Sprivulis et al. 2007).

A growing interest in this study was found in clinical data exchange for improving health care quality and efficiency in health care delivery. The HIE utilization rates *increased annually* during the study period in both primary and special care. The trends of viewing reference information increased steadily in each professional group over the five-year period in the hospital district. At the beginning of the follow-up period, physicians viewed reference information more than nurses and department secretaries in both primary and special care. However, the last year of the five-year follow-up period describes HIE utilization rates the best, as HIE had become a part of the normal workflow. By the end of the follow-up period, amount of viewed references by other groups of health care professionals had increased. In particular, it is to be noted that in special care physicians' usage of HIE fell to below that of nurses and department secretaries. This decreased trend in physicians' HIE usage can be explained by the fact that the physicians felt the system was unsuitable for medical work, and take time away from patient work in special care. According to previous studies, there was an obvious need for an easier information flow among service providers and practices, and for improved access to patient information. All participants were willing to make their patients' data available from HIE (DeBor et al. 2006; Shapiro et al. 2007; Rudin et al. 2009).

Over recent years, many communities developing HIE capabilities or the mobilization of health information electronically across health care delivery boundaries within a given region have shown a potential improvement in health care (Labkoff et al. 2007; Adler-Milstein et al. 2009; Vest 2009). HIE utilization rates, i.e. viewed references in the federations of municipalities in primary care, were investigated by means of selected outcomes. In these federations, a significant association was found between the number of laboratory tests and radiology examinations and a statistical increase in the number of viewed references. For example, the more laboratory tests made, the more HIE was used. Hripcsak et al. also (2007) was reported that laboratory and radiology data were the most frequently exchanged information, and they were also the most commonly used HIE functionality.

In this study, the HIE utilization rates *different professional groups* were *associated* with the selected outcomes of health care delivery. The selected outcomes in health care delivery were meaningfully explained by the number of viewed references. Even though the results do not completely explain the phenomenon, they are indicative. The making of *referrals* by physicians was associated with using HIE. When physicians made emergency referrals to special care, they viewed significantly more reference information. Similarly, nurses used HIE significantly the most in viewing reference information in *emergency visits* and when making *emergency referrals*. The more emergency visits there were, the more nurses used the HIE. Also the more *appointments* were made, the more significantly the department secretaries viewed the reference information. The increased trends for nurses and department secretaries were a result of looking for patient information before appointments, and take up working time. Similarly to findings in previous studies, some users needed the support of medical assistants to search for and retrieve, print and provide patient information in RHIS to the physician before the patients' appointments. (Hincapie et al. 2011.)

7.4.3. Experiences of HIE outcomes by different health care professionals, administrative representative and patients

Experiences of the benefits in the main outcome areas were quite similar between the patients and health care professionals and administrative representatives. Patel et al. (2011) also reported that professionals and patients experienced benefits from regional health information exchange. In this study, the regional HIE had changed the *flow of information* regarding the availability of information, exchange of information, and data protection after five-year usage. The HIE had improved health care professionals' and administrative representatives' timely access to patient information, and the exchange of clinical information between different organizations improved but problems also occurred. The patients were also satisfied that their primary care physician was able to view their special care information. According to previous research, patients allowed their care providers to view health information electronically through HIE (Tripathi et al. 2009; Patel et al. 2010; Wen et al. 2010; O'Donnell et al. 2011). The patients were aware that they were more responsible for their future care and its continuity when data was archived in the system. According to previous studies, the electronic HIE between organizations has been shown to improve the flow of information, and physicians were even supported by the patients to use HIE (Hincapie et al. 2011; Gadd et al. 2011; Payne et al. 2011). Privacy protection is not always adhered to. The patients were aware of the fact that their permission had to be requested in order to view their clinical data. In previous studies, patients were very concerned about privacy protection in using HIE (e.g. Simon et al. 2009).

Regional *collaboration* improved after five years of using HIE between health care professionals, administrative representatives and patients. Coordination of care was improved although problems still occurred. Electronic recorded patient information improved communication and co-operation between different professionals and organizations within the hospital district. Previous studies showed that HIE had improved care coordination and management, when the patients visited different organizations for treatment (Hessler et al. 2009; Bjerkan et al. 2010; Patel et al. 2011). On the other hand, patients had the perception that their health service package was out of control, because patients with several illnesses and chronic conditions had had many visits to various specialists in the hospital district. The HIE was not seen as sufficient to support the management of the patient service package. The patients felt that they were now more responsible for the management of their health services package and continuity of care. However, patients were found to be willing to participate in their own care and allow viewing of their regional medical records in the health care information system (Marchibroda 2008; O'Donnell et al. 2011).

Evidence of *process redesign* was found after five years of HIE usage in the hospital district. An improvement in the efficiency of working practices could be observed among health care professionals, administrative representatives and patients. The data protection practices had been clarified, which increased the reliability of patient data and patient safety. The same results were also reported by Protti et al. (2009) and Ross et al. (2010) regarding data protection. Information from patients' previous health care organizations was available, which removed duplication of examinations and treatments making the service package more effective. According to previous research, the purpose of the implementation of HIE is to improve health care processes and support new action models for the development of health care processes (Ross et al. 2009; Frisse 2010; Hincapie et al. 2011; Korst et al. 2011). However, inefficient working practices also occurred when there were similar old as well as new working practices in use among the health care professionals as reported in Lammintakanen et al. (2010) and Saff et al. (2010). New inefficient practices occurred as physicians did not always view the reference information on the RHIS, but the nurses and department secretaries printed and collected patient medical records ready for the physicians, which took time from other health care. Also, after five years of HIE usage, inefficiency in work practices was shown as an increase and redundancy in the number of laboratory tests. On the other hand, the efficiency of work practices was shown as a decrease in the number of radiology examinations when the necessity for them was evaluated more carefully. Moreover, efficiency in work practices was demonstrated by the lack of need to order patient records, of missing patient information and re-appointments. Aaltonen et al. (2009) reported similar findings when studying factors affecting health centre efficiency and productivity.

The *usability* of HIE was concerned with user experience, data security, system assistance and system development after five years period. The RHIS was considered easy to use and the experiences were positive, but health care professionals and administrative representatives stressed technical problems, which made the system difficult to use. Previous studies have shown that the use of health care information technology is positively related to factors such as providing sufficient training and solving technical problems in time (Morton & Wiedenbeck 2009; Fontaine et al. 2010, Gadd et al. 2011; Lammi 2011; Patel et al. 2011). In terms of further development and feedback from professionals, it was seen as important to involve users in the development process. As stated previously, repeated usability evaluations are an integral part of system design, and receiving feedback from professionals is essential in developing health care information systems (Turunen 2001; Demski et al. 2010; Gadd et al. 2011; Lääveri et al. 2011).

The *cultural factors* of the organization have been found to be a challenge in changing work practices and routines by utilizing health care information technology (HIT) in health care delivery (Protti 2009; Melby & Helleso 2010). The attitudes of health care professionals and administrative representatives towards HIE usage had changed in a more positive direction during the five-year period. However, the organization was committed to the use of HIE through RHIS and it had been adopted as part of the work activities, even if usage was not entirely established. Adoption was associated with positive experiences of using the system, and it was expected to bring benefits and facilitate the work. According to previous research, organizational commitment and management support is considered especially important when implementing these types of health information systems (Goroll et al. 2009; Hessler et al. 2009; Protti 2009; Frisse 2010; Korst et al. 2011).

7.5. Conclusions of the findings

The study generated new knowledge about the benefits of implementing health information exchange (HIE) through regional health information systems (RHISs). Despite the fact that the RHISs were different types and in different phases of development, the findings of the main outcome areas were similar. The main outcomes were flow of information, collaboration, process redesign, usability and changes in organization culture. The RHIS is a key approach for changing organization-centred care into more patient-centred care. RHIS supported patient-centred care in shared health care services in health care delivery. It is expected that care will become more tailored for individual needs and highlight patient participation in the planning of their own health care services. As a result, RHISs are expected to have impacts on health care procedures, work practices and treatment outcomes.

It can be assumed that HIE through RHIS have an impact on health care delivery in overall patient health care, which is supported by a substantially decreased frequency of radiology examinations, appointments and emergency department visits in the five-year follow-up period. There was increasing interest in HIE usage through RHIS among health care professionals to improve health care delivery regionally. The more patient information available, and professionals feel that they benefit from such data, the more professionals in the patient health care chain will use HIE. However, so as to fully benefit from health care information technology, changes in working practices in health care delivery are also needed. Health care information technology has not yet at least been able to support a new action model with the aim of seamless patient care and service packages in overall patient health care delivery. However, there are indications that HIE usage leads to more efficient health care operation. This requires changes in working practices and clarification in the health care system.

The implementation of HIE through RHIS is a long-term process, since even after five years a several problems were identified in the use and substance of the flow of information, and collaboration had not necessarily been achieved. Health care working practices have not been clarified to the degree required, and there is a need for further clarification concerning efficiency in health care delivery if new and old work practices are in use at the same time among health care professionals. The study shows that the patient was felt to be now more responsible for their follow-up care and management of their own service package. Organizational commitment and management support of various stakeholders are needed for the necessary changes and new working practices in health care delivery. The feedback from professionals is important for further development of health information systems. Investment in the further development of health information systems will continue.

7.6. Implications for education, nursing practice and management and research

The results of the study have implications for different fields related to the HIE implementation through RHIS in health care delivery, including education, nursing practice and management and research.

Implications for education:

1. Attention should be paid to that health care professionals see their work as part of the whole management of patient service package. This requires training on recording of patient data consistent with other professionals' usage as soon as possible, taking into account national recording standards.
2. Sufficient attention should be paid to training by the organization and technical support when implementing new health information technology such as a regional health information system. In addition, the training of health care professionals to use regional health information as part of their everyday work is also an opportunity for future employees.
3. Utilization of regional health information in health care supports the strengthening of the role of customer care and choice, provided, however, that health care professionals learn to exploit knowledge created in another organization.

Implications for nursing practice and management:

1. The research reflected a growing need for health care professionals to learn to see their work as management part of the patient's service package and continuity of care and to learn to record data and make it available for other health care professionals as soon as possible.
2. The main results regarding process redesign show that there is a need for more efficiency in health care delivery, and regional health information systems allow for the harmonization of healthcare working practices. Utilization of the regional health information requires a new attitude towards the patient's overall treatment in patient health care delivery for health care professionals to desire to take advantage of patient information created by another organization.
3. The development of health care practices supported by information technology requires the commitment of all stakeholders in the region with a common goal and objectives, and in particular, administrative support which is considered particularly important.
4. Moreover, chronically ill patients' willingness to the management of their health service package and to take responsibility for their own care should be taken into account to improve regional planning and development of their health care services, and this must be taken into account when developing the future of health information systems.
5. Health care professionals should give feedback on the usability of health information systems, and also be actively involved in the further development and planning of health information systems.

Implications for research:

1. Future research on the effectiveness of regional health information systems (RHISs) and particularly health information exchange (HIE) should take a longer follow-up study period than five years.
2. Future research on the effectiveness of regional health information systems (RHISs) with health information exchange (HIE) should be approached through cost-effectiveness analysis.
3. The selected outcome variables i.e. indicators presented in the study can be used in cost-effectiveness analysis, particularly for more expensive individual laboratory tests or x-ray examinations, so trends can be followed.
4. In future studies, the main outcome areas could be examined in more detail and compared with various health care professional groups in order to find out how the experiences of HIE differs among primary and special health care practitioners, as this study consisted of one group.
5. The study design would need to be supported by statistical control or baseline analysis of the utilization of health information exchange (HIE).
6. Further investment in health information systems will continue. The theoretical framework can be used in an interdisciplinary approach.

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Appendices

Appendix 1 (1/2)

THE OUTCOMES FIGURES (TOTAL)

Table 1. Total laboratory and clinical chemistry tests and total radiology examinations and X-Ray imaging in follow-up period 2004–2008 in primary and special care in one hospital district.

		2004	**2005**	**2006**	**2007**	**2008**
		Laboratory tests				
	Municipalities					
	I	14520	19028	20406	16211	18731
	II	47209	46670	48814	47115	46249
	III	51889	55018	59986	55021	57221
	IV	84116	82703	95029	89574	76561
	V	79199	80507	82941	89194	88216
	VI	95782	101139	101448	92861	90474
	VII	111014	93366	91842	92543	94394
	VIII	*	*	106099	110744	122607
	IX	126320	134463	138298	135783	131462
	X	227975	236153	246869	234961	259400
	XI	271966	284478	294271	306281	308087
Primary care	**Total**	**1109990**	**1133525**	**1286003**	**1270288**	**1293402**
Special care	**Total**	**1064994**	**1098402**	**1224728**	**1236439**	**1239220**
Clinical chemistry	Total	963167	992265	1114235	1124543	1116740
		Radiology examinations				
	Municipalities					
	I	497	512	496	554	472
	II	3990	3418	3075	2301	1683
	III	3161	3820	3739	3254	2233
	IV	3271	3033	2992	2678	2451
	V	5154	4910	4204	4219	3699
	VI	4242	4169	4132	4034	3821
	VII	4743	4074	4114	3212	3985
	VIII	5119	4915	4586	4406	4386
	IX	8011	7328	6537	5930	5970
	X	9859	9638	8769	7821	9521
	XI	24205	22544	21506	19272	19077
Primary care	**Total**	**72252**	**68361**	**64150**	**57681**	**57298**
Special care	**Total**	**98995**	**98331**	**96378**	**96600**	**95807**
X-Ray Imaging	Total	80692	80313	77956	78484	78043

* *missing information*

Table 2. Total appointments and emergency department visits in follow-up period 2004–2008 in primary and special care in one hospital district.

		2004	2005	2006	2007	2008
	Appointments					
	Municipalities					
	I	7576	7659	7711	7634	7255
	II	15536	15849	15397	15330	12993
	III	11847	12779	13772	12307	13873
	IV	17050	17071	16773	16655	15548
	V	28169	27953	28437	28354	26005
	VI	30299	29690	29538	29419	26274
	VII	24972	25312	25548	26337	26433
	VIII	27847	29687	30063	32302	28275
	IX	54794	47903	47694	48222	41024
	X	70789	72007	79084	74958	73112
	XI	127184	126172	128677	120584	124015
Primary care	**Total**	**416063**	**412082**	**422694**	**412102**	**394807**
Special care	**Total**	**230039**	**234654**	**245439**	**246762**	**250125**
	Emergency department visits					
	Municipalities					
	I	382	360	251	375	459
	II	504	530	598	605	583
	III	733	789	879	883	881
	IV	2125	2180	2091	2124	1585
	V	4637	4565	4896	4503	4340
	VI	7405	7681	7446	6952	5861
	VII	6611	6765	5691	6021	6512
	VIII	7487	7580	8037	8061	8351
	IX	10167	10697	14162	15316	16493
	X	24168	24474	24294	19237	17224
	XI	11167	13933	23847	24111	18984
Primary care	**Total**	**75386**	**79554**	**92192**	**88188**	**81273**
Special care	**Total**	**38912**	**37851**	**37258**	**35107**	**32185**

THE PROPORTIONAL FIGURES OF OUTCOMES

Table 3. Changes in follow-up period 2004–2008 on total laboratory and clinical chemistry tests per total appointments in primary and special care in one hospital district.

		2004	2005	2006	2007	2008	
	Laboratory tests per total appointments*						
Municipalities	I	2,14	2,25	2,29	2,54	2,48	
	II	*	*	2,22	2,30	2,99	
	III	1,92	2,48	2,65	2,12	2,58	
	IV	2,77	2,73	2,91	2,83	2,97	
	V	3,22	3,28	3,12	3,13	3,55	
	VI	3,94	3,34	3,23	3,26	3,63	
	VII	3,17	3,18	3,25	3,39	3,34	
	VIII	3,44	3,41	3,37	2,87	3,20	
	IX	4,38	4,31	4,36	4,47	4,12	
	X	4,17	4,53	4,68	4,62	5,00	
	XI	5,41	5,22	6,17	5,84	5,89	
Primary care							
Total		3,07	3,11	3,43	3,49	3,66	
Annual Change			1,30 %	10,18 %	1,80 %	4,73 %	
Changes in 5 years							**19,00 %**
	Laboratory tests per total appointments						
Special care							
Total		4,63	4,68	4,99	5,01	4,95	
Annual Change			1,11 %	6,60 %	0,41 %	-1,12 %	
Changes in 5 years							**7,00 %**
	Clinical chemistry tests per total appointments						
Special care							
Total		4,19	4,23	4,54	4,56	4,46	
Annual Change			1,00 %	7,40 %	0,40 %	-2,00 %	
Changes in 5 years							**6,60 %**

** calculated without II federation municipality*

Table 4. Changes in follow-up period 2004–2008 in total laboratory tests per inhabitant of the municipality federations and total laboratory tests per inhabitant of the hospital district and special care clinical chemistry tests per inhabitant of the hospital district in primary and special care.

		2004	2005	2006	2007	2008	
Laboratory tests total per inhabitant of the municipality federations*							
Municipalities	I	3,57	3,74	3,86	4,02	4,03	
	II	4,06	4,30	4,70	4,34	4,55	
	III	4,56	4,72	4,95	4,78	5,31	
	IV	5,64	6,00	6,03	5,55	5,43	
	V	4,91	5,06	5,23	5,65	5,60	
	VI	4,39	5,72	6,12	4,88	5,65	
	VII	5,99	5,92	6,26	6,13	6,07	
	VIII	*	*	5,44	5,75	6,43	
	IX	7,14	6,76	6,67	6,75	6,89	
	X	9,99	9,89	11,48	10,9	9,4	
	XI	8,92	9,59	9,94	9,77	9,56	
Primary care							
Total		5,01	5,17	5,88	5,84	5,97	
Annual Change			3,20 %	13,70 %	– 0,7 %	2,10 %	
Changes in 5 years							**19,00 %**
Laboratory tests total per inhabitant of the hospital district							
Special care							
Total		4,62	4,78	5,34	5,41	5,44	
Annual Change			3,50 %	11,80 %	1,40 %	0,60 %	
Changes in 5 years							**17,92 %**
Clinical chemistry tests total per inhabitant of the hospital district							
Special care							
Total		4,17	4,31	4,86	4,92	4,91	
Annual Change			3,40 %	12,60 %	1,30 %	– 0,4 %	
Changes in 5 years							**17,50 %**

**calculated without VIII federation municipality*

Table 5. Changes in follow-up period 2004–2008 on total radiology and special care X-Ray imaging per total appointments in primary and special care in one hospital district.

		2004	2005	2006	2007	2008	
	Radiology examinations total per total appointments*						
Municipalities	I	0,07	0,07	0,06	0,07	0,07	
	II	0,26	0,22	0,20	0,15	0,13	
	III	0,14	0,13	0,11	0,10	0,13	
	IV	0,19	0,17	0,14	0,13	0,13	
	V	0,17	0,17	0,16	0,15	0,15	
	VI	0,15	0,15	0,14	0,12	0,15	
	VII	0,17	0,15	0,15	0,11	0,15	
	VIII	0,19	0,18	0,17	0,16	0,15	
	IX	0,19	0,18	0,18	0,16	0,16	
	X	0,27	0,30	0,27	0,26	0,16	
	XI	0,17	0,17	0,16	0,15	0,17	
Primary care							
Total		0,17	0,17	0,15	0,14	0,15	
Annual Change			– 4,5 %	– 8,5 %	– 7,8 %	3,70 %	
Changes in 5 years							**– 16,4 %**
	Radiology examinations total per total appointments						
Special care							
Total		0,43	0,42	0,39	0,39	0,38	
Annual Change			– 2,6 %	– 6,3 %	– 0,3 %	– 2,2 %	
Changes in 5 years							**– 11,0 %**
	X-ray imaging per total appointments						
Special care							
Total		0,35	0,34	0,32	0,32	0,31	
Annual Change			– 2,4 %	– 7,2 %	0,10 %	– 1,9 %	
Changes in 5 years							**– 11,0 %**

Table 6. Changes in follow-up period 2004–2008 on total radiology examinations per inhabitant of the municipality federations, total radiology examinations per inhabitant of the hospital district and special care X-ray imaging per inhabitant of the hospital district in primary and special care.

		2004	**2005**	**2006**	**2007**	**2008**	
Radiology examinations total per inhabitant of the municipality federations							
Municipalities	I	0,15	0,15	0,15	0,17	0,14	
	II	0,25	0,30	0,29	0,26	0,18	
	III	0,20	0,19	0,18	0,16	0,19	
	IV	0,47	0,41	0,37	0,28	0,21	
	V	0,30	0,29	0,25	0,25	0,22	
	VI	0,26	0,26	0,26	0,26	0,24	
	VII	0,32	0,30	0,28	0,25	0,25	
	VIII	0,31	0,30	0,30	0,23	0,29	
	IX	0,40	0,37	0,34	0,31	0,31	
	X	0,36	0,35	0,33	0,32	0,32	
	XI	0,41	0,38	0,38	0,35	0,32	
Primary care							
Total		0,3	0,29	0,27	0,24	0,24	
Annual Change			– 4,4 %	– 5,9 %	– 9,5 %	– 0,3 %	
Changes in 5 years							**– 18,9 %**
Radiology examinations total per inhabitant of the hospital district							
Special care							
Total		0,43	0,43	0,42	0,42	0,43	
Annual Change			– 0,4 %	– 1,7 %	0,60 %	– 0,5 %	
Changes in 5 years							**– 1,9 %**
X-ray imaging per inhabitant of the hospital district							
Special care							
Total		0,35	0,35	0,34	0,34	0,34	
Annual Change			– 0,2 %	– 2,7 %	1,10 %	– 0,2 %	
Changes in 5 years							**– 2,0 %**

Table 7. Changes in follow-up period 2004–2008 on total appointments per inhabitant of the municipality federations and total appointments per inhabitant of the hospital district in primary and special care.

		2004	**2005**	**2006**	**2007**	**2008**	
	Appointments per inhabitant of the municipality federations						
Municipalities	I	0,93	1,00	1,08	0,97	1,10	
	II	1,41	1,44	1,58	1,52	1,50	
	III	1,85	1,89	1,86	1,87	1,59	
	IV	1,67	1,66	1,69	1,58	1,62	
	V	1,55	1,59	1,61	1,67	1,68	
	VI	1,64	1,76	1,79	1,93	1,70	
	VII	1,81	2,03	2,07	2,07	1,90	
	VIII	2,14	2,12	2,12	2,12	1,91	
	IX	2,16	2,16	2,15	2,17	2,04	
	X	2,77	2,44	2,45	2,50	2,15	
	XI	2,29	2,30	2,31	2,30	2,19	
Primary care							
Total		1,73	1,73	1,78	1,74	1,67	
Annual Change			0,00 %	2,90 %	– 1,9 %	– 3,9 %	
Changes in 5 years							**– 3,0 %**
	Speciality care appointments per inhabitant of the hospital district						
Special care							
Total		1,00	1,02	1,07	1,08	1,10	
Annual Change			2,30 %	4,90 %	0,90 %	1,70 %	
Changes in 5 years							**10,20 %**

Table 8. T-test results, *statistical* change in selected outcomes in follow-up period 2004–2008 in primary and special care in one hospital district.

			95% Confidence Interval of the Difference			
Variable	Year	Period	Mean Difference	Lower	Upper	Sig(2-tailed)
PC total laboratory tests per total appointments	2004	2006–2008	0,4554	0,1644	0,7464	0,021
PC total laboratory tests per municipality inhabitants	2004	2006–2008	0,8866	0,7294	1,0437	0,002
SC total laboratory tests per total appointments	2004	2006–2008	0,3550	0,2843	0,426	0,002
SC total laboratory tests per districts inhabitants	2004	2006–2008	0,7787	0,6464	0,9110	0,002
SC clinical chemistry per total appointments	2004	2006–2008	0,3306	0,2085	0,4526	0,007
SC clinical chemistry per districts inhabitants	2004	2006–2008	0,7255	0,6420	0,8089	0,001
PC total radiology examinations per total appointments	2004	2006–2008	-0,0244	-0,0391	-0,0097	0,019
PC total radiology examinations per municipality inhabitants	2004	2006–2008	-0,0480	-0,0854	-0,0106	0,031
SC total radiology examinations per total appointments	2004	2006–2008	-0,0409	-0,0540	-0,0279	0,005
SC total radiology examinations per districts inhabitants	2004	2006–2008	-0,0869	-0,0122	-0,0052	0,009
SC X-Ray imaging per total appointments	2004	2006–2008	-0,0341	0,0425	-0,0257	0,003
SC X-Ray imaging per districts inhabitants	2004	2006–2008	-0,0079	-0,0128	-31,030	0,020
PC total appointments per municipality inhabitants	2004–2007	2008	-0,0718	-0,0346	-0,1089	0,009
SC total appointments per districts inhabitants	2004	2006–2008	0,0833	0,0454	0,1213	0,011
PC total emergency appointments per 100 municipality inhabitants	2004–2006	2008	1,341	-1,4682	4,1502	0,176
PC total emergency appointments per 100 district inhabitants	2004–2006	2008	2,3833	1,5972	3,1694	0,006
PC referrals to special care per 100 inhabitants	2004	2006–2008	2,1000	1,7045	2,4955	0,002
PC emergency referrals to special care per 100 inhabitants	2004	2006–2008	0,5340	0,2884	0,7796	0,011
PC emergency referrals to special care per 100 appointments	2004	2006–2008	1,7677	1,1241	2,4111	0,007
PC emergency referrals to special care per emergency appointment	2004	2006–2008	0,0226	-0,0274	0,0729	0,109
PC referrals to special care per 100 appointments	2004	2006–2008	2,5370	1,8607	3,2133	0,004

PC= Primary Care, SC= Special Care

HIE UTILIZATION RATES I.E. VIEWED REFERENCES

Table 9. Total viewed references per 100 appointments in follow-up period 2004–2008 in primary and special care in one hospital district.

		2004	2005	2006	2007	2008
	The viewed references per 100 total appointments					
Municipalities	I	1,4	4,8	5,0	10,4	21,9
	II	1,0	5,1	4,0	8,6	18,9
	III	0,0	3,9	3,2	5,9	18,3
	IV	1,8	4,7	6,2	5,9	15,4
	V	0,6	1,8	3,8	6,5	14,6
	VI	0,0	1,3	3,0	5,5	13,1
	VII	0,0	0,0	0,6	3,8	12,1
	VIII	0,4	5,4	4,1	4,8	10,5
	IX	0,0	2,4	3,4	5,0	9,6
	X	0,4	0,9	1,9	4,4	8,7
Primary care	**Total**	**0,43**	**3,48**	**3,3**	**5,52**	**13,32**
Special care	**Total**	*	**0,24**	**2,1**	**6,14**	**16,26**

* *missing information*

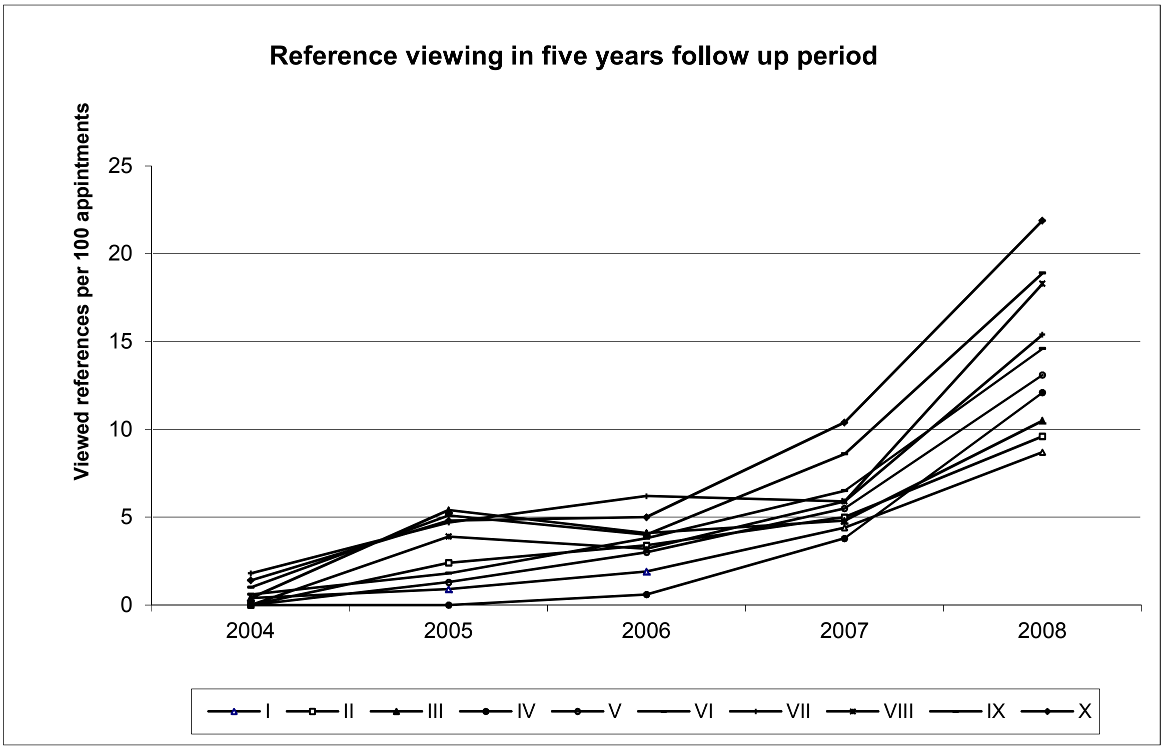

Figure 1. The reference viewing in primary care in all federation of municipalities per 100 appointments, in the follow-up period 2004–2008.

Table 10. Primary and special care percentage values (%) for viewed references by different health care professionals in follow-up period 2004–2008.

		2004	**2005**	**2006**	**2007**	**2008**
	Viewed references by different health care professionals					
Municipalities						
I	Physician	95,7	88,2	87,5	72,3	36,3
	Nurse	4,3	11,8	4,2	2,4	44,7
	Department secretary	*	*	8,3	25,3	19
II	Physician	92,7	62,4	49,5	51,8	48
	Nurse	7,3	37,6	38,1	31,4	44
	Department secretary	*	*	12,4	16,8	7,9
III	Physician	*	100	57,1	61,4	44,4
	Nurse	*	*	3,8	14,3	41,8
	Department secretary	*	*	39,1	24,3	13,8
IV	Physician	*	78,4	74,2	82	59,5
	Nurse	*	21,6	17,5	15,9	37,4
	Department secretary	*	*	8,2	2,1	3
V	Physician	72,3	87	86,5	79,9	65,4
	Nurse	27,7	13	13,5	19,9	27,6
	Department secretary	*	*	*	0,2	7
VI	Physician	*	65,1	53,3	58,4	22
	Nurse	*	34,9	46,7	35,7	52,9
	Department secretary	*	*	*	5,9	25,1
VII	Physician	*	100	87,7	44,4	50,6
	Nurse	*	*	12,3	49,7	38,6
	Department secretary	*	*	*	5,9	10,7
VIII	Physician	85,3	75,5	34,6	21,5	36,9
	Nurse	14,7	24,5	33,7	32,2	30,9
	Department secretary	*	*	31,7	46,3	32,2
IX	Physician	53,5	97,9	36,8	31,9	53
	Nurse	46,5	2,1	63,2	68,1	47
	Department secretary	*	*	*	*	*
X	Physician	98,5	89,8	56	57	61,1
	Nurse	1,5	10,2	32,3	43	38,9
	Department secretary	*	*	11,7	*	*
Primary care	Physician	84,0	79,1	67,9	61,0	**47,6**
	Nurse	16,0	20,9	23,8	26,7	**39,1**
	Department secretary	*	*	8,3	12,4	**13,3**
Special care	Physician	*	85,1	10,2	9,6	**8,8**
	Nurse	*	10,3	61,9	50,5	**57,9**
	Department secretary	*	4,6	27,9	39,9	**33,3**

**missing information*

EXAMPLE OF PATIENT INTERVIEW DATA ANALYSIS IN PREPARATION FOR ASSOSIATED CATEGORIES

Taulukko 11. Esimerkki **potilas aineiston** analyysin etenemisestä, kun muodostetaan yhdistävä kategoria ”**alueellinen tiedonkulku**”

Suora lainaus	**Pelkistys**	**Alakategoria**	**Yläkategoria**
"koneella ne tiedot kyllä on, et kyl ne tiedot hyvin löytyy sit sieltä"	tiedot ovat koneella	Potilastietojen löydettävyys aluetietojärjestelmästä	Tietojen saatavuus
	tiedot ovat hyvin löydettävissä koneelta		
"aika nopeesti ne tiedot kuitenki kulkee näit nettiyhteyksien kautta"	tiedot kulkevat nopeasti nettiyhteyksien kautta		
"käy sillai et saa ruudusta näytettyy ne tiedot paremmin ja nopeemmin"	potilaan tiedot nopeammin ja paremmin nähtävillä koneelta		
"jos täält lääkäri haluaa tietää et mitä keskussairaalas on tehty se saa suoraan sen lääkärin tiedot, mitä se lääkäri on pistäny koneelle"	lääkäri saa suoraan keskussairaalan lääkärin koneelle laittamat tiedot		
"on todelliset lausunnot sielt keskussairaalasra, must se on erittäin hyvä"	lausunnot saadaan keskussairaalasta		
"täällä terveyskeskuksessa on aina tiedot sekä toisaalta sitte keskussairaalalla"	potilaan tiedot saatavilla sekä terveyskeskuksesta että keskussairaalasta		
"aina sitte ku mää oon sieltäki (ks) tullu sitte tänne (tk), niin kyl ne täällä kaikki on tienny kaikki asiat jo valmiiksi"	potilaan erikoissairaanhoidon tiedot löytyvät koneelta terveyskeskuksessa		
"hän siinä naputteli, katso mun tutkimustuloksii, ja sitte hän sano et nyt täytyy lähteä keskussairaalaan"	tutkimustulosten katselumahdollisuus		

"jos oma lääkäri on lähteny pois, niin se tuleva näkee sieltä automaattisesti, kun pääsee koneelt kattoo täält käsin niin, mun mielest se on hyvä"	omalääkärin poissa ollessa uusi lääkäri näkee koneelta potilaan aikaisemmat tiedot		
"kyl ne sielt vaan helposti löytyy, mut se että jaksaaks lääkäri sit tutkii niit kaikkii sivui sieltä, mitä siel sit oikein on"	potilaasta on paljon tietoa aluetietojärjestelmässä, mutta lukeeko lääkäri kaikki hänen tietonsa		
"lääkäri on nähnyt suoraan koneelta sen tänhetkisen tilanteen, mikä on mun tilanne"	lääkäri näkee koneelta nykytilanteen	Tietojen ajantasaisuudessa vaihtelua	
"oli kaks viikkoo kulunu, niin sitä ei ollu saneltu edes"	tietoja ei ollut saneltu kahden viikon aikana		
"siel ei ollu sitä epikriisii vielä kun oli soittoaika, koska ei ollu epikriisiä saneltu"	tietoja ei ollut sanelu soittoaikaan mennessä		
	epikriisiä ei ollut saneltu		
"lääkäri sano sillon puhelimessa, et ”olis kontrolliaika sinne hematologialle”, ja et ”oiskohan se jääny tänne papereitten väliin se kutsu"	kutsu kontrolliajasta oli jäänyt papereiden väliin	Merkintöjen puuttuminen	
"yritettiin selvittää millon sitä lääkettä on annettu, onks sitä annettu keskussairaalassa vai terveyskeskuksessa, taas löytyny mistään merkintää, onko annettu"	puutteelliset lääkitystiedot		
"unohtaa sen lääkkeen merkitä sinne, niin sitte sitä ei oo annettu vaikka se ois annettu"	ellei lääkkeen antamista ole merkitty ylös, niin sitä ei ole silloin edes annettu		
"mun mielestäni se oikee tieto menee sinne paikkaan, mihin sitä tarvitaan"	oikea tieto on saatavilla oikeassa paikassa koneelta	Potilaan tietojen välittyminen organisaatioiden välillä	Tietojen vaihto
"kyllä se tiedonkulku varmaan se on ihan hyvää ja parantunut entisestään"	tiedonkulku on hyvää		
	tiedonkulku on parantunut entisestään		

"sehän, kulkee tietokoneen kautta, nopeesti, suuntaan ja toiseen"	tieto kulkee tietokoneen kautta suuntaan ja toiseen		
"keskussairaala määräs polil, et pidetään tauko siinä urologin piikkilääkkeessä, mut se tieto ei koskaan menny kotisairaanhoidon tietoon"	erikoissairaanhoidon käynnistä ei mennyt tietoa kotisairaanhoitoon		
"se keskussairaalan muutettu lääkitystieto ei välttämättä aina sinne kotisairaanhoitoonkaan mene"	keskussairaalassa tehty muutos potilaan lääkityksessä ei mene kotisairaanhoitoon		
"ku mä oon pyytäny kerran lähettävälle lääkärille lausunnon, niin sillonhan ne tulee tänne (tk)"	potilaan pyynnöstä epikriisi lähetetään postitse lähettävälle lääkärille		
"eikä mua haittaisi yhtään vaikka se epikiisi menis vielä yksityislääkäripuolellekin "	potilasta ei haittaisi, vaikka epikriisi menisi yksityislääkärille		
"koska, astmani takii mä käyn yleensä yksityislääkärillä ja siellä mun tietojani ei näy" *(vaikka potilas lähetetään yksityiseltä erikoissairaanhoitoon)*	potilaat käyvät hoidossa myös yksityisellä puolella, jossa potilaan tiedot eivät näy		
"eikö sinne hematologian osastolle mee tieto siitä, kuka sen kipulaastarin on alottanut, kun olin viikkoo aikasemmin ollu siellä päivystyksessä"	päivystysyksikössä tehdyt potilaan jatkohoidon muutokset eivät välittyneet potilaan omaan hoitavaan erikoisalan yksikköön	Puutteellinen potilaan tietojen välittyminen erikoisalayksiköiden välillä	
"olin sisätautien polilla vuorokauden ja lääkäri kysy multa, et missä se lääke on aloitettu, et eikö ne ollenkaan tiedä siellä keskussairaalassa toinen toisistaan"	muuttunut lääkitystieto ei välity päivystyspoliklinikan ja hoitavan poliklinikan välillä: lääkäri kysyi potilaalta, missä lääke on aloitettu		
"viimeks tietysti ku meni vuodeosastolle, niin se meni vuodeosastolle se tieto, se jäi sit sinne, et se ei tullu kotiin asti, eikä potilaalle itselle asti"	potilaan siirtyessä päivystyspoliklinikalta vuodeosastolle jatkohoitotiedot saattavat hukkua vuodeosaston potilaspapereihin		

"ne jää sinne, ne on siel koneella ja kukaan ei kato"	potilastiedot jäävät koneelle ja kukaan ei katso potilastietoja		
"keskussairaalasta lähetettiin epiksiisi kotiin ja sanottiin, että vien sen mennesäni sitten jatkohoitopaikkaan, mikä se sitten onkaan terveyskeskus tai joku muu"	potilaan epikriisitieto lähetetään postitse potilaalle kotiin	Potilaan vastuulla jatkohoitotietojen välittyminen	
	potilaat ovat vastuussa jatkohoitotietojensa välittämisestä jatkohoitopaikkaan		
"joo suullisesti, suullisesti sitten siinä puhuttiin siellä onkologian puolella, et lääkäri tietty sano, että jatkohoito tänne ja sitten hän lähettää tän epikriisin"	potilaalle annetaan suullisesti jatkohoito-ohjeet erikoissairaanhoidossa		
	epikriisi lähetetään kotiin		
"sillon ku mulla itselläki toimi muisti, niin sillon ne tiedot tuli mukana, enkä mä niist oikein…ja sit mä näytin niitä (omaiselle) sieltä keskussairaalasta"	potilaan oma ymmärrys epikriisitiedoista on huono, ja epikriisiä näytetään omaiselle tai läheiselle		
"potilaalle sanottu, että pidetään tauko urologin piikkilääkkeessä mutta tietoa, ei välitetty perusterveydenhoitoon"	potilas on vastuussa omien jatkohoitotietojen välittämisestä		
"jos en olis lähteny perään kysymään niitä röntgentuloksia keuhkokuvista niin en olis saanut tietää niistä koskaan"	potilaan on itse ymmärrettävä kysyä omien tutkimustensa perään, vaikka olisi löytynyt jotain poikkeavaa		
"viimisen puolen vuoden aikana tää ny menny tää kunto huonommaks, ettei enää itsenäisesti pysty hoitaa"	potilas ei aina itsenäisesti pysty hoitamaan omia asioitaan	Omaisten vastuulla jatkohoitotietojen välittyminen	
"mun muisti alkaa sitten mennä, et näit täs sit on anatnu (omaisten) hoitaa, et miten piti toimia"	potilaan voinnin ollessa heikko omaiset hoitavat potilaan jatkohoitoasioita		

"kiva olis, että kotiin tiedotettaisiin, että vois omaiset pysyis vähän kartalla kun meist ollu kummastakaan enää soittaan sinne"	omaiset ovat kiinnostuneita lähimmäisen voinnista ja toivovat, että heille tiedotettaisiin potilaan voinnista		
"tiedot terveyskeskukseen tai hoitaval lääkärille tai täl nii mä oon sit vetäny nimen siihen ja jotain ruksia siihen sitten että se hoitaval lääkärille ja terveyskeskukseen"	potilas on kirjoittanut nimensä, kun on pyydetty lupaa hänen tietojensa katseluun	Luvan pyytäminen	Tietosuoja
"jos lääkäri kysyy keskussairaalas ni täytyy olla lupa että hän saa katsoa mun tietoja näin minä olen ymmärtäny"	potilaat tietävät, että lääkärillä pitää olla hänen lupansa hänen tietojensa katseluun		
"tuuaan tajuttomana tai muuta vastaavaa, ni ei kysytä mitään, ja se on ihan hyvä"	potilaan ollessa tajuttomana ei kysytä lupaa tietojen katseluun	Luvan pyytämättä jättäminen	
"ei, semmost lupaa varmaankaan ei oo kyllä kysytty"	lupaa tietojen katseluun ei ole kysytty		
"on tehty sit semmonen jatkohoitosopimus varmaanki siel keskussairaalas sitteniin mä luulen, joo"	potilaalle on tehty jatkohoitosopimus tietojen katseluun jatkohoitopaikkaan		
"ihmettelen niinku sitä jatkuvaa luvan kyselemisestä, kun eikö ne kaikki tiedot mitä siihen kuuluu, niin hän näkee myös"	potilaat ihmettelevät usein pyydettävää lupaa tietojensa katseluun		

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Review

The outcomes of regional healthcare information systems in health care: A review of the research literature

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ABSTRACT

The resulting regional healthcare information systems were expected to have effects and impacts on health care procedures, work practices and treatment outcomes. The aim is to find out how health information systems have been investigated, what has been investigated and what are the outcomes. A systematic review was carried out of the research on the regional health information systems or organizations. The literature search was conducted on four electronic Cinahl Medline, Medline/PubMed and Cochrane. The common type of study design was the survey research and case study, and the data collection was carried out via different methodologies. They found out different types of regional health information systems (RHIS). The systems were heterogeneous and were in different phases of these developments. The RHIS outcomes focused on the five main areas: flow of information, collaboration, process redesign, system usability and organization culture. The RHIS improved the clinical data access, timely information, and clinical data exchange and improvement in communication and coordination within a region between professionals but also there was inadequate access to patient relevant clinical data. There were differences in organization culture, vision and expectations of leadership and consistency of strategic plan. Nevertheless, there were widespread participation by both healthcare providers and patients.

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1. Introduction

Powerful societal and economic forces are moving us towards an integrated, patient-centered health care information system that will allow providers to exchange up-to-date patient health information quickly and easily. These forces include patient safety, potential health care cost savings, and empowerment of consumers, new policies and growing regional health care initiatives [1–4]. The proper functioning of a healthcare information system requires an advanced health information network that supports clinical care, personal health management, the reduction of avoidable mistakes in population health and research, and evidence-based medicine [5,6]. These cause new challenges such as acceptable standards, choice of technologies, jurisdictional boundaries, up-front investment, and an element of risk to the privacy, confidentiality, and integrity of information [1,2,7,8]. The creation and management of mechanisms to support the exchange of data between organizations has been used in other industries, in manufacturing, retail and government [9].

The development of regional information exchange among health care organizations is viewed as an important step in the development of health information technology [1,2,10]. Operational health information exchange promises substantial financial and societal benefits and suggests that health care delivery costs can be reduced by making clinical data available at the time of care in all departments [11–13]. Information exchange is the key to the many initiatives underway including the development of regional health information systems or organizations [14]. According to the eHealth Initiative (2006), there is an increasing level of maturity in the functionality of these health information exchange efforts—the most common related to care delivery providing disease or chronic care management services, quality performance reporting for clinicians, purchasers or payers [15].

Many communities are now building a local or regional health information infrastructure or strategy to provide secure, ubiquitous access to complete healthcare information and to improve health care through the quality, completeness, and timeliness of public health data reporting from clinical care settings. These will improve the ability to monitor better-quality information through timely disease reporting, improve case management and care coordination, communicable disease patient management. These strategies have improved the analysis of patterns of care, and gaps in delivery of preventive services, and have improved the ability to plan, and resource allocation for preventive services. These regional health information infrastructure or strategies provide the capability to move from a traditional paper-based retrospective data collection and review mode of operation, to real-time, interactive electronic data exchange and action response practice. They also reduce health care cost, prevent medical errors, improve administrative efficiency, reduce paperwork, and increase access to affordable health care [11,13,17,18].

Nevertheless there is little experience or data about the factors that contribute to the successful formation and sustainability of these exchanges, including the development of a framework for a health information network and funding for implementation. The most difficult challenge is that related to assessing the value of services that emerge from the health information exchange to various stakeholder groups such as providers, players, and employers. Communities have not yet achieved the specific technical approaches to ensure privacy and confidentiality, or the sustainable business model that will be required. Also, leadership commitment and strong support from stakeholders are needed to translate that interest into an operational reality [2,5,9,15,19,20].

Regional collaborations, termed Regional Health Information Organizations (RHIOs), which others have called Local or Regional Health Infrastructures (LHIIs) are multi-stakeholder organizations working together to connect health care communities with the goal of improving quality of care, the health and safety of individuals, and the efficiency of public health systems, and nations [20–22]. These stakeholders may include hospitals, nursing facilities, clinics, private physicians' offices, pharmacies, laboratories, radiology facilities, health departments, and possibly the patients themselves [15,23]. The inherent purpose of an RHIO is to facilitate the electronic exchange of health information in the community and requires collaboration among care delivery organizations. Assembling information from disparate sources and simplifying the flow and presentation of the information have a major impact on care delivery [2]. The RHIO can offer better patient-centered care, with possibilities ranging from regional, national and even to global care. It is to be expected that, in addition, care will become more specific and tailored for the individual, and that better personalized care will be achieved. In the near future, the citizen will have an active role participating in his own care and taking steps for pro-active prevention [24,25].

Most of the international literature on regional or national health information systems focuses on, discusses or describes the financial, technical and organizational factors, and political and privacy aspects [26,27]. Financial, technical and organizational factors have been discussed in the following works: the challenge encountered in developing and deploying an RHIO and its relevant benefits for citizens and health professionals [6,11,12] and clinicians, consumers, and government agencies creating a nationwide or regional health delivery system that increases access to clinical care, prevention, and research, thereby improving health outcomes [21] and coordinate information sharing among regional and other networks thought universal adherence to basic framework of policies and standard [28]. The political aspects described include initiatives that were key in developing a strategic framework and building an electronic health information infrastructure [5], an implementation plan [29], and the history, roles, and evolution of organizations and their plans for and success with pilot projects [28]. The privacy aspects discussed were why health data standards are required, the process of creating those standards, the groups creating those standards, and some of the problems and issues that affect the progress and acceptance of standards [30].

There has been very little research about National or Regional Health Information Systems or Organizations (RHIO), and no systematic review of the topic was found. There is, however, a systematic review of regional diabetes surveillance systems [31], regional telemedicine systems [16], the distribution of international, regional and national scientific output in health information and communication systems [32], and a review of the design and standard process for an RHIO [33].

The purpose of this study is to find out how health information systems have been investigated, and what has been investigated. What are the effects that have been achieved, in other words what are the outcomes?

The following research questions were addressed:

- What is the scope of studies for the topic?
- What types of regional health information systems have been investigated?
- What are the outcomes of regional health information systems?

2. Methods

2.1. Search methods

This systematic review concerns healthcare information technology and the implementation of health information exchanges, focusing on empirical research on regional health information systems or organizations.

2.2. Database searches

An extensive literature search was conducted on four electronic databases with assistance from librarians. These databases were Medline (from 1966 to May 2008), CINAHL (1982 to May 2008), the Cochrane Library, and PubMed/Medline (from 2000 to December 2008). The search strategies were specific to the database with key words that reflected regional health information systems and integrated electronic health information systems. The search was performed using the following keywords: 'health informatics', 'health information', 'health information systems', 'health information exchange', 'medical records systems', 'electronic health records', 'health technology', 'integrated electronic health records', 'health information systems', and 'nursing information systems'. These keywords were combined using the Boolean operator AND or OR with the keyword 'regional' or 'integrated'. Additional keywords were: 'regional health information systems', 'integrated electronic health records', 'integrated health information', and 'information exchange'. A complementary search was conducted using the keywords: 'medical records systems', 'computerized', 'nursing records', 'public health informatics', 'information systems', 'medical informatics', combined using the Boolean operator AND or OR with the keyword 'regional health planning' or 'integra*'.

A search using the main keywords yielded a large number of articles on regional healthcare information systems or integrated networks from local, regional, or state level from many countries, but when the search was limited to empirical studies, the number was significantly reduced. A total of 1447 studies were identified through the initial search. After checking 521 abstracts and a further review of 51 full-text articles, a total of 24 studies that met the inclusion criteria were identified. A summary of the main study characteristics is shown in Fig. 1.

2.3. Inclusion and exclusion criteria

Our systematic review comprises empirical research articles concerning all kinds of regional health information systems or networks. The following inclusion criteria were used: firstly, the search was limited to articles published in English. Secondly, only empirical research articles concerning all kinds of regional health information systems or networks were included. Studies made with a technological and architectural approach were excluded.

2.4. Retrieval of references and handling

Firstly, the article titles were read and the titles that matched the research questions and the keywords were retrieved. Only English text papers published in peer-reviewed journals were selected for further review. Editorials, letters, conceptual papers, and duplicate texts were excluded. Secondly, the abstracts were checked against the inclusion criteria concerning regional health information systems and outcomes. Therefore, all abstracts that addressed the research question were retrieved, regardless of their study design. Abstracts of all papers identified from the search strategy were read and assessed by one of the authors. Abstracts that were considered relevant to the research question were kept and the full-text papers were retrieved for further review. Thirdly, after proper examination of the full texts, a list of the studies included and excluded was compiled. The articles were analyzed using content analysis to categorize the data. Content analysis is designed to classify data by the characteristics deemed of theoretical importance [34]. The data were classified using the research question criteria: the scope of studies for the regional health information systems, the type of regional health infor-

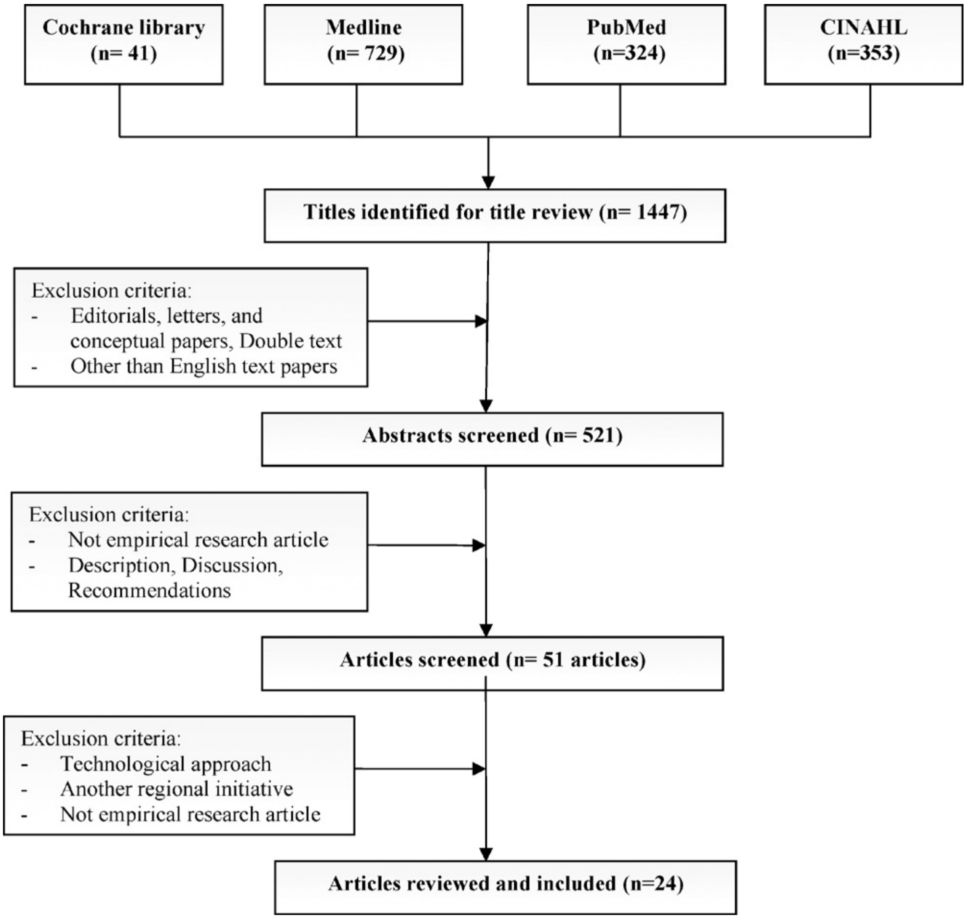

Fig. 1 – Search flow for regional health information systems.

mation systems, and regional health information systems outcomes.

3. Results

3.1. *Scope of the studies*

Analysis of the scope of the studies included their state, study design, and methodologies. The included studies were published between 1996 and 2008, with the studies' data collected from 1966 to May 2008, and an additional search was carried out on the period 2000 to 2008 in December 2008. Most of the 11 studies of regional health information systems have been done in the United States. A total of 13 studies were from European countries and most of the studies have been done in the United Kingdom ($n = 3$) and in Finland ($n = 3$). Furthermore, one was done in each of the following countries: Austria, Canada, Greece, Denmark, France, Germany, and South Africa (Table 1).

Healthcare information technology and the implementation of health information exchanges and regional or national health information systems or organizations have been investigated in many different ways, and with many different study designs. The most common type of study design was survey research and the second was case study. There were also examples of evaluation research with two constructive evaluation studies and one study was multi-methodical triangulation. Thus the types of study design were survey research ($n = 11$), case study ($n = 9$), evaluation or constructive evaluation studies ($n = 3$), and multi-methodical triangulation ($n = 1$) (Table 1).

In these 24 studies, the data collection of regional health information systems was carried out by means of different methodologies; interviews, questionnaires, observatories, comparisons or other collections. There were no studies using only one data collection method. The studies used interviews or semistructured interviews ($n = 11$), group interviews ($n = 3$) and workshops ($n = 1$). The studies included structured or semistructured questionnaires ($n = 5$), an open-ended group teleconference questionnaire ($n = 1$), and open-ended questions ($n = 1$). Observations ($n = 4$), patient scenarios ($n = 1$), comparisons ($n = 2$), and document analysis ($n = 4$) were used. Cost–benefit analysis ($n = 1$), usability studies ($n = 1$), before–after activity analysis ($n = 1$), and literature-based surveys with complementary methodical process analyses ($n = 1$) and review ($n = 1$) were also utilized. In one study "A paradigm shift over time ©timeline of computerization from 1950 through 2000" was used, and in one study, an expert review panel created a Request for Capability (RFC) instrument (Table 1).

Table 1 – Studies included in the systematic review of research literature.

Author, date and country	Study design	Methodology	Participants	Type of regional health information system investigated	Outcomes
Korst et al., 2008, USA	Case study	Review, semistructured interviews	NI, projects participants and documents	Regional perinatal data system that involved four hospitals in the city of Los Angeles	Disagreements regarding governance Different vision and expectations of leadership No common rules and policies to share clinical data Complexity of clinical data-sharing, both within and across organization
Maass et al., 2008, Finland	Case study	Semistructured interview, before–after activity analysis, cost–benefit analysis	N = 20 patients' clinical appointments	Regional Health Care Information System	Improvement of effectiveness Real-time clinical data access Real-time clinical data exchange Decreased duplication of services Improved quality of patient care Improved coordination and communication Improved decision making Increased professional performance Support of patient health care plan process Coordinated and supported workflow Increased patient safety Net cost savings
Adler-Milstein et al., 2007, USA	Survey	Semistructured interview	N = 145 contact persons or the director of RHIOs	Regional Health Information Organizations (RHIOs)	Real-time clinical data exchange Real-time data receiving and viewing being exchanged Improved clinical data access Real-time consultation/referrals Improved clinical documentation
Bergman et al., 2007, Germany	Survey	Literature-based survey, complemented with methodical process analyses	N = 2 regional healthcare networks	The scenario of thyroid disease care in an integrated care setting in a regional healthcare network, The Braunschweig Medical Centre as a regional provider for external medical services, two hospitals in the region, and several cooperating practices	Improved clinical data exchange Improved clinical data access Improvement of effectiveness Subsequent electronic data processing Improved coordination and communication Improved cooperation

Table 1 (*Continued*)

Author, date and country	Study design	Methodology	Participants	Type of regional health information system investigated	Outcomes
Chronaki et al., 2007, Crete	Survey	Structured, two-part questionnaire	N = 30 health professionals, N = 324 patients	Primary healthcare center information system in several facilities across Greece	Real-time clinical data exchange Discussion of patient case online Improvement of effectiveness Digital ECG recording Online ordering of laboratory examinations Saved time Concerns over security and confidentiality Consultation with colleagues Patients reluctant to accept a medical visit via computer, or mobile phone Patient not alienated from doctor
Follen et al., 2007, USA	Case study	Questionnaire, patient scenario	N = 46 care providers	The integration of Marshfield's electronic medical records and chronic disease management systems	Real-time clinical data access Timely monitoring of disease-specific measures Improvement of effectiveness Saved time Support of patient health care plan process Support of workflow Improved quality of patient care Improved the self-care behavior of patients and their families Improved patients' clinical outcomes Increased patient satisfaction Increased patient safety Improved coordination and communication Coordinated workflow Improved case management Satisfaction with use
Hanmer et al., 2007, South Africa	Case study	Semistructured Interview, Observation	NI, hospital management, end users (4–8 interviews at each of 4 hospitals studied)	Computerized hospital information systems in four secondary level public sector hospitals in South Africa	Improvement of effectiveness Usefulness Wide management commitment Concern over limited understanding of the system

Noblin, 2007, USA	Survey	Comparison	NI, several RHIOs	CalRHIO in California, HealthBridge in Cincinnatti in Ohio, the PeaceHealth Community Health Record in rural Alaska, Washington and Oregon, the Indiana Network for Patient Care, the Nebraska Statewide Telehealth Network, the Florida Health Information Network, Exchange Network in Hawaii, the New York Telemedicine Demonstration Program, the North Carolina Healthcare Information and Communications Alliance, the Rhode Island Quality Institute Health Information Exchange, the MidSouth eHealth Alliance in Memphis Tennessee, the Utah Health Information Network	Improved clinical data exchange Improvement of effectiveness Decreased duplication of services Improved quality of patient care Concern over security and confidentiality Widespread participation by both providers and patients
Solomon, 2007, USA	Case study	Cross-case comparative analysis	N = 3 emerging RHIOs	Indiana Health Information Exchange, Massachusetts Health Data Consortium, Santa Barbara County Care Data Exchange	Improved clinical data access Improved clinical data exchange Improvement of clinical effectiveness Efficiency of reporting medical events Improved quality of patient care Improved decision making Concern over security and confidentiality Acceptable community standards Resistance to change
Cuggia et al., 2006, France	Survey	Interview	NI, all healthcare professionals involved in the project	Regional Health Information Network for neurological diseases	Improved clinical data exchange Improvement of effectiveness
Halamka et al., 2006, USA	Case study	Interview	NI, clinicians and office staff in 3 pilot hospitals emergency departments	The e-Prescribing systems integration of the Regional Health Organization for Massachusetts	Poor usability Reduced productivity Not interoperable with practice management systems No appropriate equipment Concern over security and confidentiality Previous negative experiences New technology a high priority Resistance to change
Sackett et al., 2006, USA	Survey	A paradigm shift over time ©timeline of computerization from 1950 through 2000, (SWOT)	N = 41 Registered Nurses (RNs)	The Western New York Regional Electronic Health Record	Improved clinical data access Saved time Computer skills advancement Fear of change

Table 1 (*Continued*)

Author, date and country	Study design	Methodology	Participants	Type of regional health information system investigated	Outcomes
Machan et al., 2006, Austria	Multi-methodical study, triangulation	Semistructured interviews, questionnaire based on the hypotheses derived from the results of the interviews	*N* = 242 practitioners, 4 interviews with 3 general practitioners and one specialist	The regional health care network between hospitals and general practitioners in Tyrol	Improved clinical data access Improved clinical data exchange Improvement of effectiveness Reduced filing and archiving work Reduced reviewing and reading work Saved time Saved time benefited the patient Improved quality of patient care High acceptance
Nykänen and Karimaa, 2006, Finland	Constructive evaluation	Interviews, observation, usability study, document analysis	NI, pilot users	Regional health information systems	Improved clinical data access Support of patient health care plan process Better understanding of the patient situation Improvement of empowerment and collaboration Changed work practice
Overhage et al., 2005, USA	Survey	Request for Capability instrument (RFC instrument)	*N* = 839, (National associations, *N* = 110, Government Agencies, *N* = 57, Individuals, *N* = 117, National Organizations, *N* = 354 State Focused, *N* = 201)	The regional health information organization or exchange projects/efforts	No observations
Triska et al., 2005, Canada	Survey	Questionnaire, open-ended questions	*N* = 1390 physicians, random sample from physicians in VIHA, *N* = 485, CHR, *N* = 505, all in DTHR *N* = 400	Integration of the health delivery system (IHDS), integration in three regions of two Western Canada provinces – the Vancouver Island Health Authority (VIHA) in British Columbia, and the Calgary Health Region (CHR) and David Thompson Health Region (DTHR) in Alberta	Inadequate access to clinical data Improved coordination and communication Enabled multidisciplinary team Perceptions varied (organizational culture) No consistent strategic plan Part of regionwide staff
Fehrenbach et al., 2004, USA	Survey	Group interview, open-ended group teleconference, questionnaire	NI, contact person from two or more stakeholders of the integration project from 23 health departments (20 states, 2 cities, 1 country)	Integration of child health information systems,	Improved clinical data access Timely and appropriate provision of patient information Organizational commitments Concern over security and confidentiality
Hoyle and Swanson, 2004, USA	Survey	Semistructured in-depth interview, group interviews	*N* = 23 personnel (8 administrators, 10 program managers, 2 from managed care organization, 1 representative of federally qualified health clinic, 2 local public health officials)	The Michigan Department of Community Health	Improved clinical data access

Maglaveras et al., 2002, USA	Case study	Observation	NI, medical personnel (physicians, nurses citizens,patients, healthy individuals)	The ECG/Angio System, a WAP Based System for data integration in a regional telemedicine environment	No observations
Nykänen and Karimaa, 2002, Finland	Constructive evaluation study	Interview, document analysis	NI, designer, developers, users, decision-makers	The regional seamless network of social and health care services	No observations
Nohr et al., 2001, Denmark	Survey	Observation, structured and semistructured questionnaires, semistructured follow-up group interviews	N = 91, 7 persons in each project, representative of the doctors, the nursing staff, the medical secretary, the managers of the department, the hospital manager, the project manager	The 13 regional electronic patient record development projects in very different size, patient category and state of development	Improved clinical data access Improved clinical documentation Support of workflow Concern over security and confidentiality Improved quality of patient care Improved decision making Improved coordination and communication Enabled multidisciplinary team
Beynon-Davies and Lloyd-Williams, 1999, UK	Case study	Document analysis	N = 2 information systems projects	The regional information systems plan of Wessex London ambulance service's computer aided dispatch system	Failure Poor usability Conflict with allocation Complexity of system Poor project management Cancellation
Herbst et al., 1999, UK	Formative, and summative evaluation	Interview, workshop	N = 250 potential users	The Northern province is implementing a comprehensive integrated hospital information system in all of its 42 hospitals.	No observations
Bourn and Davies, 1996, UK	Case study	Document analysis	Regional information system project	The regional information system project	Failure Poor project management Overestimated savings Over-reliance on consultants

NI: Not information.

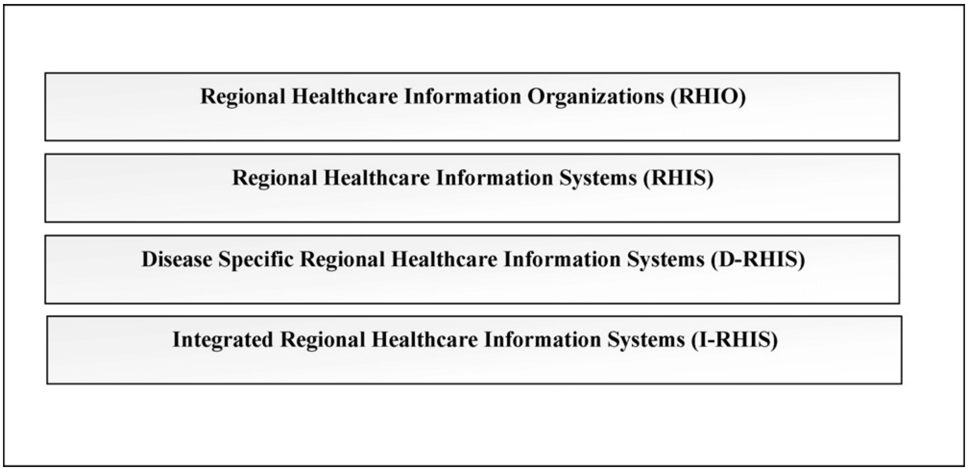

Fig. 2 – The types of integrated health information systems.

3.2. *Types of regional healthcare information systems*

There are four different types of regional health information systems: the Regional Healthcare Information System (RHIS) [10,13,29,35–44], the Regional Healthcare Information Organization (RHIO) [2,12,20,27], Disease Specific Regional Healthcare Information Systems (D-RHIS) [17,45,46] and Integrated Regional Healthcare Information Systems (I-RHIS) [19,28,47,48] (Fig. 2).

The Regional Healthcare Information Systems (RHISs) were very different in size and in the stage of development, and there was no standardized name for the system. One of the first regional health information networks worldwide was a system with integrated eHealth services for remote healthcare facilities in three primary care healthcare centers and their community office and pre-hospital emergency coordination center [44]. There was one Comprehensive Integrated Hospital system (CHIS) in all eight regional hospitals and 32 district hospitals [36], a regional network between regional hospitals and general practitioners [41], computerized hospital information systems in four hospitals [43], a service to enable all health centers of a region to have access to secondary care diagnostic information regarding all patients [13], and a regional prenatal data system that involved a total of four hospitals [10].

On state level, there are examples of regional Integration of Electronic Patient Record (I-EPR) development projects with different sizes, patient categories and state of development [38] and a Regional Information System Plan (RISP) with integration across the health region, linking all hospital wards, GP surgeries, and district nurses [37] and adoption of a regional healthcare information systems [42] and of two regional social and healthcare information systems to improve information delivery and accessibility in the social and health care organizational context in the design phase [39] or in the pilot phase of the system [40]. There was also a reform to enhance Integration of the Health Delivery Systems (IHDS) in three regions with differing periods of regionalization, variation in population size and willingness to participate [29]. Failures of regional information projects have also been reported [35,37].

The Regional Healthcare Information Organizations (RHIOs) researched were collaborations or an alliance involving community health centers, health departments and hospitals [2,20]. The lead organizations were hospitals, provider organizations, academic health centers, and community health information exchange organizations [2,12,20,27]. Organizations included inpatient, outpatient, primary care and tertiary. Data sources included laboratories, health departments, school-based clinics, ambulatory visit data, inpatient discharge data, emergency department visit data, and laboratory data [2,20,27]. The RHIO typically pass through three stages of development identified as follows: convening stakeholders to pursue clinical data exchange; creating the infrastructure to support clinical data exchange; and finally enabling clinical data exchange across independent entities [12].

There were three different types of Disease Specific Regional Healthcare Information Systems (D-RHIS). They comprised a network for patients suffering from chronic and handicapping neurological diseases [45]; the integration of chronic disease management systems focused on providing care for hypertension and diabetes for example [17]; and one was the exemplary scenario of thyroid disease care in an integrated setting [46].

Four different types of Integrated Regional Healthcare Information Systems (I-RHIS) were found. One RHIO implemented the MedsInfo-ED project to automate the transmission and communication of medication history from six different health plan data sources to five emergency departments. MedsInfo-ED focused on two components of e-prescribing: identifying patients with health plan drug coverage, and returning prescription medication history [28]. The Childhood Immunization Registry (CIR) is linked to the Women, Infants, Children (WIC) system and the Medicaid Management Information System (MMIS) and these are integrated in a regional Department of Community Health Application, which interoperates with a number of other systems internal and external to the infrastructure [48]. The Integration of Child Health Information Systems (I-CHIS) with immunization registries, Women, Infants, Children (WIC), newborn dried blood-spot and hearing screening systems, and vital registration systems [19] and two different new technologies in a regional telemedicine environment, an ECG/angio

Table 2 – The main outcomes of the RHIS.

Flow of information	Data access Timely data Data exchange	Improvement in clinical data access Improvement in clinical data exchange Complexity of clinical data exchange Inadequate access to clinical data Real time data
Collaboration	Communication Coordination	Improvement in communication Improvement in coordination Enable multidisciplinary team
Process redesign	Effectiveness	Improvement in effectiveness Time saved Supported workflow Supported patient health care plan process Improve decision making Quality of life
Usability	Usefulness Reliability	Poor usability Concerned security and confidentiality Financial benefit
Organization culture	Commitment Attitudes	Commitment Organization structure Resistance to change Attitudes

processing and management system and a WAP-based system for data transmission from the patient's and from the clinician's side were found [47].

3.3. *The outcomes of regional healthcare information systems*

The RHIS outcomes focused on four main areas: flow of information, collaboration, process redesign, and system usability. Studies have also examined organizational behavior in more broad terms but there is a sense of a mixture of outcomes and the organizational social contexts of RHIS here (Table 2).

The information flow of the RHIS focused on three main categories: access to clinical data, timely information, and clinical data exchange. The RHIS improved access to clinical data and provided real-time patient information and the timely and appropriate provision of patient information as well as the timely monitoring of disease-specific measures, and the opportunity to discuss patient care online. The RHIS improved the timeliness of patient information exchange between professionals and entities. However, the RHIS also exhibited complexity in clinical data exchange and inadequate access to clinical data relevant to the patient (Table 2).

Collaboration in the RHIS focused on two categories: communication and coordination. The RHIS improved communication and coordination within a region in an appropriate time and situation-specific format, improved case management and consultation with colleagues, and enabled empowerment and multidisciplinary teamwork for the better understanding of the patient situation. The RHIS increased patient safety, and satisfaction, and also the self-care behaviors of patient and their families, leading to better health outcomes but patients were reluctant to accept a medical visit via computer, or mobile phone (Table 2).

The RHIS redesigned the process and improved clinical effectiveness. Effectiveness focused on six categories: improved effectiveness, time saved, supported workflow, supported patient health care plan process, improved decision making, and quality of life. The RHIS decreased the duplication of services, enabled online ordering of laboratory or radiology examinations, digital ECG recording, improved patient documentation, and enabled subsequent electronic data processing. The RHIS saved time, coordinated and supported the clinical workflow and patient health care plan processing, and the time saved benefits the patients. The RHIS and electronic data transmission improved the quality of care with better decision making (Table 2).

System usability focused on two categories: usefulness and reliability. There was found to be poor usability of the RHIS, no single region-wide management system or interoperability, and no appropriate equipment. There was also the issue of the complexity of the RHIS and it was not user-friendly. The RHIS also raised concerns over security and confidentiality. Nevertheless, it is possible to achieve net cost savings with an RHIS (Table 2).

Work morale including commitment and attitudes was the most important issues of organizational behavior concerning RHIS. There was a sense of commitment to the RHIS, with the acceptance and wide management, and a feeling of participation by regional staff, and the avoidance of depersonalization of patients by doctors. However, differences in organizational culture, vision and expectations of leadership, the non-existence of common rules and policies to share clinical data and the non-existence of a consistent strategic plan, and limited understanding of the system was found concerning the RHIS. Nevertheless, there was widespread participation by both providers and patients. In addition, previous negative experiences with an RHIS and resistance to change were pointed out: new technology is not always a high priority. Nevertheless, the RHIS was connected to the advancement of computer skills (Table 2).

4. Limitations

This systematic review has some limitations. The first is related to the quality and scope of the analyzed literature. This has to do with the numerous different sites, and the different phases of development of Regional Healthcare Information Systems (RHIS). The investigated phenomenon was unwieldy and complicated to approach. The reported methodologies in the systematic review appear to be heterogeneous, which limits their comparability. The regional health information systems or organizations have thus been investigated in many different forms, and with many different study designs. As noted earlier, the quality of the studies included could not be determined. However, in this study we have identified different types of integrated health information systems although the boundaries between the types are not exact. Secondly, the papers were reviewed by just one researcher. Finding the right key words for the database search was challenging, and therefore an information specialist was consulted. In this study one exclusion criteria was the technological approach, using only medicine and nursing science databases and approaching RHIS from the functional point of view.

Only 24 papers met the selection criteria despite the fact that all the papers were published between 1996 and 2008, while the data was collected between 1966 and 2008. Furthermore, the classification of the studies according to their purpose was also extremely difficult, not least because they rarely provided explicit accounts of the purpose of the systematic review and therefore the inference had to be made by the author (TM). In fact only a few studies directly examined the effectiveness or outcomes of the systems. Studies with a technological and architectural approach were excluded. However, regardless of the study design the systematic review results were parallel. One additional limitation of this systematic review is that it only covered studies in the English language.

5. Discussion

To our knowledge, this is the first systematic review to document regional healthcare information systems. Several systematic reviews related to health information technology have been done previously. However, they have been limited to specific systems, such as for diabetes surveillance [31]; chronic disease management [54] or scientific output in health information technology [32]. In addition they have been limited to Electronic Health Records (EHRs), so as to examine the benefits [49], the impact [50,51], or the effect of health information technology on quality, efficiency and cost [52], and the definition, structure and content of the EHR to use in health care [51].

No study to date has reviewed a broad range of Regional Healthcare Information Systems (RHIS). According to the analyses of this study, the systems were heterogeneous and in different phases of development, and also sometimes incompetently described. The approach of the studies to the systems was either functional or technological. Studies with only a technological and architectural approach were excluded from this systematic review. Parts of the RHIS were fully used while some were in the pilot phase, and some systems were already out of use. As e.g. Solomon [2] describes, three emerging RHISs in the case study were chosen because each represents a different geographical region, different origins of their evolution. According to the studies analyzed, there were also differences in the systems' functionalities. There were very large coalitions of many regional providers and small ones, a few district hospitals integrated with some external actors such as laboratories or radiology entities. However, the adoption of a shared care paradigm in regional healthcare networks demands shared, patient-centered documentation, and leads to new architectural approaches supporting cross-institutional cooperation [46].

Most of the studies analyzed here were made in the US and the rest in various European countries. A number of states are moving forward to develop and improve healthcare through health information technology and electronic health information exchange among healthcare organizations [2,15]. According to the studies analyzed here there has been very little empirical research about Regional Health Information Systems (RHIS) or Organizations (RHIO). Most of the international literature focuses on developed and deployed projects or discusses or describes their financial, technical, organizational or privacy aspects. Mostly different combinations of methodologies were used and the sample sizes were usually small, or the sample size was not mentioned. The most common type of study design was the survey research and case study. Machan et al. [41] have reported that triangulation in particular and qualitative methods in general can make a valuable contribution to the further improvement of evaluation research in medical informatics.

Nevertheless, four different types of regional health information systems were found: the Regional Healthcare Information System (RHIS), the Regional Healthcare Information Organization (RHIO), the Disease Specific Regional Healthcare Information System (D-RHIS), and the Integrated Regional Healthcare Information System (I-RHIS). According to previous reviews, different types of technology systems were found such as: decision support aimed at providers, electronic health records, and computerized provider order entry, and only a few had capabilities that allowed systems from different facilities to connect with each other and share data interoperably [52].

Despite the fact that Regional Health Information Systems (RHIS) or Organizations (RHIO) were very different types and that the research approaches were different in the studies, the main outcomes were fairly similar. According to this analysis, the main outcomes of RHIS were better flow of information, better collaboration, process redesign, usability, and changes in organization culture. These regional health information infrastructures or strategies promise to provide real-time, interactive electronic data exchange and action response practice [17,53]. According to this analysis, the RHIS improved clinical data exchange, data access and provided real-time patient information (e.g. [17]). The RHIS enable electronic data interchange among stakeholders in a certain geographic area [23]. The RHIS improve communication and coordination within a region, and improve case management, and empowerment, collaboration and multidisciplinary teamwork (e.g.

Summary points

What was already known before this study:

- There has been very little research about National or Regional Health Information Systems (RHIS) or Organizations (RHIO), and no systematic review of the topic was found.
- Regional Health Information Systems are multi-stakeholder organizations working together to connect health care communities with the goal of improving quality of care, the health and safety of individuals, and the efficiency of public health systems and nations.
- RHIS provide secure, ubiquitous access to complete healthcare information and to improve health care through the quality, completeness, and timeliness of public health data reporting from clinical care settings.

What this study has added:

- There has been very little empirical research about RHIS and no study to date has reviewed a broad range of RHIS.
- RHIS are heterogeneous and in different phases of development, and there is no standardized name for the system.
- RHIS have been investigated in many different forms, and with many different study designs. However, in this study we have identified different types of integrated health information systems although the boundaries between the types are not exact.
- Despite the differences in RHIS types and research approaches in the studies, the main outcomes were fairly similar. RHIS improve clinical data exchange, data access, and effectiveness; provide real-time patient information; improve communication and coordination within a region; and support process redesign.

[38]). The main goal of RHIS is improving quality of care, the health and safety of individuals, and the efficiency of public health systems, and nations [21,22]. According to this analysis, RHIO support process redesign and improve effectiveness (e.g. [2]). The RHIS promise to offer better patient-centered care and it is expected that care will become more specific and tailored for the individual, and that it can achieve better personalized care [24,25]. The RHIS make it possible to improve decision making, increase patient safety, satisfaction and the self-care behaviors of patients and their families, leading to better health outcomes and improving the quality of life (e.g. [41]).

The organizational social context of RHIS was a focus of some studies, mainly in terms of employee commitment, leadership and formal organizational rules, but it is not evident how to separate organizational factors in the context of RHIS from organizational phenomena as outcomes. Differences in organizational culture, vision and expectations of leadership and the non-existence of a consistent strategic plan, as well as limited understanding of the system concerning RHIS were also found (e.g. [10]). Leadership commitment and strong support from stakeholders are needed to translate that interest into an operational reality [19,20]. According to the studies analyzed, the system usability of the RHISs was quite poor also due to a lack of region-wide management systems or interoperability or user-friendliness (e.g. [28]), and there were also concerns over security and confidentiality (e.g. [27]). Communities do not yet have the specific technical approaches to assure privacy and confidentiality and the sustainable business model that will be required [5,15]. However, the RHIS was connected to the advancement of computer skills (e.g. [42]).

6. Conclusion

During the late nineties the concept of the Integrated Electronic Health Record (I-EHR) and patient-centered shared healthcare, supported by Regional Healthcare Information Systems (RHIS), has been recommended for more than 30 years (e.g. [41]). Integration is a way of developing health information systems and new organizational models of collaboration that meet the needs of the population (e.g. [36,40]). The RHIS is a key approach to organizational change in health providers, clinical services, information technology, and horizontal integration. The centerpiece of a nation's ICT vision is the implementation of health information exchanges. As a result, regional healthcare information systems are expected to have effects and impacts on health care procedures, work practices and treatment outcomes.

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Outcomes Assessment of the Regional Health Information Exchange

A Five-year Follow-up Study

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Regional health information system (RHIS), regional health information exchange, health outcome, assessment

Summary

Background: The implementation of a technology such as health information exchange (HIE) through a Regional Health Information System (RHIS) may improve the mobilization of health care information electronically across organizations. There is a need to coordinate care and bring together regional and local stakeholders.
Objectives: To describe how HIE had influenced health care delivery in one hospital district area in Finland.
Method: Trend analysis was used to evaluate the influence of a regional HIE. We conducted a retrospective, longitudinal study for the period 2004–2008 for the eleven federations of municipalities in the study area. We reviewed statistical health data from the time of implementation of an RHIS. The t-test was used to determine statistical significance. The selected outcomes were the data obtained from the regional database on total appointments, emergency department visits, laboratory tests and radiology examinations, and selected laboratory tests and radiology examinations carried out in both primary care and special health care.
Results: Access to HIE may have influenced health care delivery in the study area. There are indications that there is a connection between access to regional HIE and the number of laboratory tests and radiology examinations performed in both primary care and specialized health care, as observed in the decreased frequency in outcomes such as radiology examinations, number of appointments, and emergency department visits in the study environment. The decreased frequencies of the latter suggest an increased efficiency of outpatient care, but we were not able to estimate to what extent the readily available comprehensive clinical information contributed to these trends.
Conclusion: Outcome assessment of HIE through an RHIS is essential for the success of health information technology (HIT) and as evidence to use in the decision-making process. As health care information becomes more digital, it increases the potential for a strong HIE effect on health care delivery.

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1. Introduction

The needs to increase efficiency and quality in the health care sector have led, for example, to the development of regional health information systems (RHISs). These enable accessibility to information and services in the region without visible organizational boundaries, and provide health care through integrated services for seamless care and personalized, individual patient-centered care and information delivery [1–5]. The implementation of a technology such as health information exchange (HIE) through an RHIS should improve the mobilization of health care information electronically across organizations within a region, by coordinating care and bringing together local stakeholders. This would allow service providers to exchange clinically appropriate, patient-specific information between hospitals, health departments, health centers, physician's offices, other ambulatory care providers, independent laboratories, radiology facilities, and possibly the patients themselves [2–11]. The most commonly exchanged coded information among stakeholders comprise laboratory test results and radiology examination reports, medication histories, discharge summaries, demographic and episode data on hospital patients, and administrative and financial data [3, 4, 7, 10, 12–14, 16, 21].

Increasingly, health care leaders and policy makers are realizing the importance of collaboration at regional level in driving improvements in health care quality, safety and efficiency, and they are particularly interested in the role of HIE [9, 10, 13, 14, 17, 18]. However, decision makers require credible knowledge-based evidence on the ability of specific health interventions to influence health care that policymakers can use in the decision-making process within RHIS and HIE initiatives [17, 19, 20, 22–24]. Through selected outcomes, such as the frequencies of laboratory tests and referrals, the benefits from HIE through RHISs can be analyzed more carefully to assess, how information systems can support the positive impact of health care delivery [9, 14, 25, 26] for patients.

2. Background

HIE provides physicians and other health professionals with immediate and effective access to more complete and timely information for treatment at the point of care, which is where clinicians and their patients need it most. It also supports quality improvement and reporting, public health activities, and clinical research [1, 3–6, 9]. HIE promotes the collection of previously unavailable clinical data from patients' disparate health records, which may be spread over multiple provider and payer networks, across all community health care facilities [11, 13–15, 21, 27–29]. The fragmentation of the health care system and the legal and organizational barriers between primary and secondary care and discontinuity of care is one of the challenges to overcome before an interoperable HIE can be achieved [4, 6, 8, 9, 30–32].

According to the previous literature, HIE improves the processing of laboratory and radiology information. Access to data enables more efficient delivery of hospital test results to physicians, which could decrease the number of laboratory tests and radiographic examinations, reducing redundant and duplicate examinations [7, 8, 13, 16, 21, 27, 28, 30, 33–35, 37, 41]. Duplicate laboratory tests have been reported to range from 13–20% [30], and approximately 25% [27] of similar radiology procedures have been performed by another institution in the region. HIE should improve communication among providers and public health service information processing and reduce emergency department visits, and re-appointments and result in fewer admissions for observation [8, 13, 28–30, 33, 36, 37]. Additionally, primary and secondary care visits should decrease [27, 31, 35, 37] and referral processes be improved. [7, 27, 37] Overhage et al. [38] reported a significant reduction in emergency department visits. Between 14% and 25% of emergency department visits were due to missing information that was stored in another hospital system in the region [39, 40]. One quarter of the patients according to Shapiro et al. [32] could benefit from external health information and one fifth would benefit according to Maass et al. [36]. An updated and well-functioning HIE can also improve patient safety, improve medication information processing, and prevent medical errors [1, 7, 28, 34, 42].

HIE projects concerning clinical data compiled by various health care providers and public health organizations in particular geographical regions to improve the quality of care and public health are becoming common in several countries and local communities. However, as yet, the literature provides little evidence to prove these effects. To date, there is a lack of substantial and consistent empirical demonstration of the effectiveness of HIE, the systematic assessment of the benefits of HIE is incomplete, and there is little real-world experience [7, 10, 18, 19, 24–27, 29, 43–44]. There is a significant need for evaluation and research to understand the effects and the value of HIE initiatives [8, 19, 22, 23, 25–27, 32, 43, 44]. Furthermore, measurements of the impact of HIE on health outcomes [2, 15, 24, 43, 45] should be part of the implementation process [45].

2.1 Objectives of the Study

The purpose of this five-year follow-up study was to describe how HIE had influenced health care delivery in one hospital district area in Finland. The objective was to investigate the collected data on laboratory tests, radiography examinations, appointments, emergency department visits and referrals to find out the changes in the studied region. The specific research questions addressed in this study were a) How does regional health information exchange influence the selected outcomes: laboratory tests, radiology examinations, referrals, appointments, and emergency department visits in the five-year follow-up period?, b) What is the relationship between the availability of regional health information exchange and the number of laboratory tests and radiology examinations performed in both primary care and special health care?

3. Study Context

3.1 Organizational Setting

In Finland, public health services are divided into primary health care and specialized medical and hospital care. Primary health care is provided by municipal health centers. Municipalities may have their own health centers, or one health center may serve several municipalities. Each municipality has to join a hospital district. Each hospital district contains a central hospital and other specialized units. Municipal health center services include physical examinations and other basic services. Physicians may refer patients to specialized health care units in the hospital, when necessary [46].

3.2 System Details and System in Use

A Regional Health Information System (RHIS) for health information exchange (HIE) between primary, secondary and tertiary care had implemented in this hospital district prior to 2004–2008 (the period for which this study was conducted). The purpose of the RHIS was to enable primary care professional's access to specialised health care information and vice versa across organizational boundaries. Through the RHIS, documents of medical reports, laboratory and radiology tests, treatments and courses of treatment can be viewed regardless of time and place. [47]

The implementation of an RHIS is based on a registry of references or pointers to the patient's data that resides in the different electronic health record (EHR) systems of the health care service providers. The approach to use registries and repositories is further developed and standardised in the Integrating the Healthcare Enterprise (IHE) Cross-Enterprise Document Sharing (XDS) Profile. There are two main regional flows of data. The first flow of data is reflected in the continuous creation and update of references from the EHR systems to the regional reference repository. This is a background flow with no human intervention. For the second flow of data access and retrieval of the client data from the EHR systems to an RHIS for viewing. The updating process occurs automatically in a regular manner. This flow is always initiated by a human user. The data from the source systems is presented using Health Level Seven Inc. (HL7) Clinical Document Architecture (CDA) documents. Using the references and referenced data the clinician or nurse can compose an overall picture of the client´s history and situation. [47]

The privacy of the patient is a key requirement in this exchange of information. Two use cases are used: the professional asks for consent from the patient to view data of that patient, the patient gives informed consent to the professional to view patient’s data. The patient can decide which data is disclosed to the professional by giving consent for accessing the references and referenced data. The consent and list of the references accessed by each user are stored in a log file in the regional system. Emergency situations may override the need for consent but that is also recorded in the log file. The patient can check who has accessed his or her references, based on what consent and for what reason. The composition of an RHIS is based on grouping data and functions into modules which have clear interfaces: the content about regional service providers and their services, retrieving and accessing the references and referenced data, patient’s consent management, identification and authentication of users, adapters to source systems, which send references to registry and which reply to queries by sending the actual referenced document. [47]

4. Methods

4.1 Study Design

To evaluate the influence of the regional health information exchange, we conducted a retrospective, longitudinal five-year follow-up study for the years 2004 to 2008 for all the eleven federations of municipalities in one hospital district in Finland. There are a total of twenty hospital districts in Finland and the one in this study had a medium-size population of about 234 000 inhabitants. A federation of municipalities may include one or more municipalities. The health information exchange (HIE) occurs at federation level within the RHIS. The RHIS is meant for the use of social and health care professionals when there is a need to utilize patient care data from other organizations to ensure the continuity and coordination of care and to achieve efficient and effective care.

4.2 Data Collection

We reviewed the data from the time of implementation of the Regional Health Information System (RHIS) in all municipalities of the hospital district. The RHIS was implemented in 2004–2008 and had therefore been in use in the region for five years by the start of the study. The use of HIE increased steadily during the follow-up period [48]. We collected statistical information data using routinely collected information from the electronic patient health care records (EHRs) in primary and special health care concerning selected outcomes in the follow-up period 2004–2008. The selected outcomes were the data obtained from the regional database on total appointments, emergency department visits, laboratory tests and radiology examinations, and selected laboratory tests and radiology examinations carried out in both primary care and special health care. The selected laboratory tests were limited to the clinical chemistry department and the selected radiology examinations to the imaging department performed in special care, since these tests and examinations are performed in both primary care and special health care. The outcomes were based on availability and on the theoretical knowledge that they are expected to have an impact through the HIE. [e.g. 7, 8, 27, 37]

The statistical data was gathered at municipal level by a contact person in each municipality who forwarded the data to the researchers. The researchers collected statistical data manually, and transferred it to a separate table. There was no statistical program that could be used to obtain all municipal statistics in hospital region at once. Therefore, the data was collected manually because each EHR produced its own data and a variety of statistical reports. The statistical recording method did not change in the municipalities during data collection and the statistics were comparable both in the five-year follow-up study and the various municipalities.

All the municipality federations and hospital district managers were asked permission to research and view their statistics for 2004–2008. None of the individual municipality or the municipal federations' data is revealed in the study, not any individual patient data.

4.3 Data Analysis

Trend analysis was used in the retrospective, longitudinal five-year follow-up study. Firstly, the primary care outcomes of laboratory tests, radiology examinations, appointments and emergency department visits and referrals relating to the inhabitants of the all eleven federations of municipalities were collected annually for a five-year period. The primary care outcomes were compared to the total number of appointments and to the number of inhabitants of the municipality federation for each year. Secondly, the special care data on the same outcomes related to the inhabitants of hospital district was collected annually for the five-year study period. The special care outcomes were proportioned to the total appointments and inhabitants of the hospital district. Thirdly, proportional annual change figures were calculated for the outcomes per total appointments, the number of municipality inhabitants in primary care, total appointments and the hospital district inhabitants per year in special care.

Finally, the total change on outcomes in the five-year period was calculated in both primary and special care.

The figures for selected laboratory tests and radiology examinations were collected from the five-year follow-up period in all the eleven municipality federations in primary and special care. The figures were compiled by the municipality federations and adjusted in proportion to the total number of appointments and the number of municipality inhabitants per year; the specialty care figures were adjusted for the total number of appointments and the hospital district inhabitants per year. In addition, the figures were calculated for the proportional annual change in the selected tests and examinations per total appointments, number of municipality inhabitants, and hospital district inhabitants per year. Also, the total changes for the five-year study period were calculated for all the selected laboratory tests and radiology examinations. These rates were further plotted over time, enabling the visualization of the trend data, and both the annual and total changes of these rates were calculated. The t-test was used to determine the statistical significance and confidence intervals of the changes in rates over the five-year follow-up period.

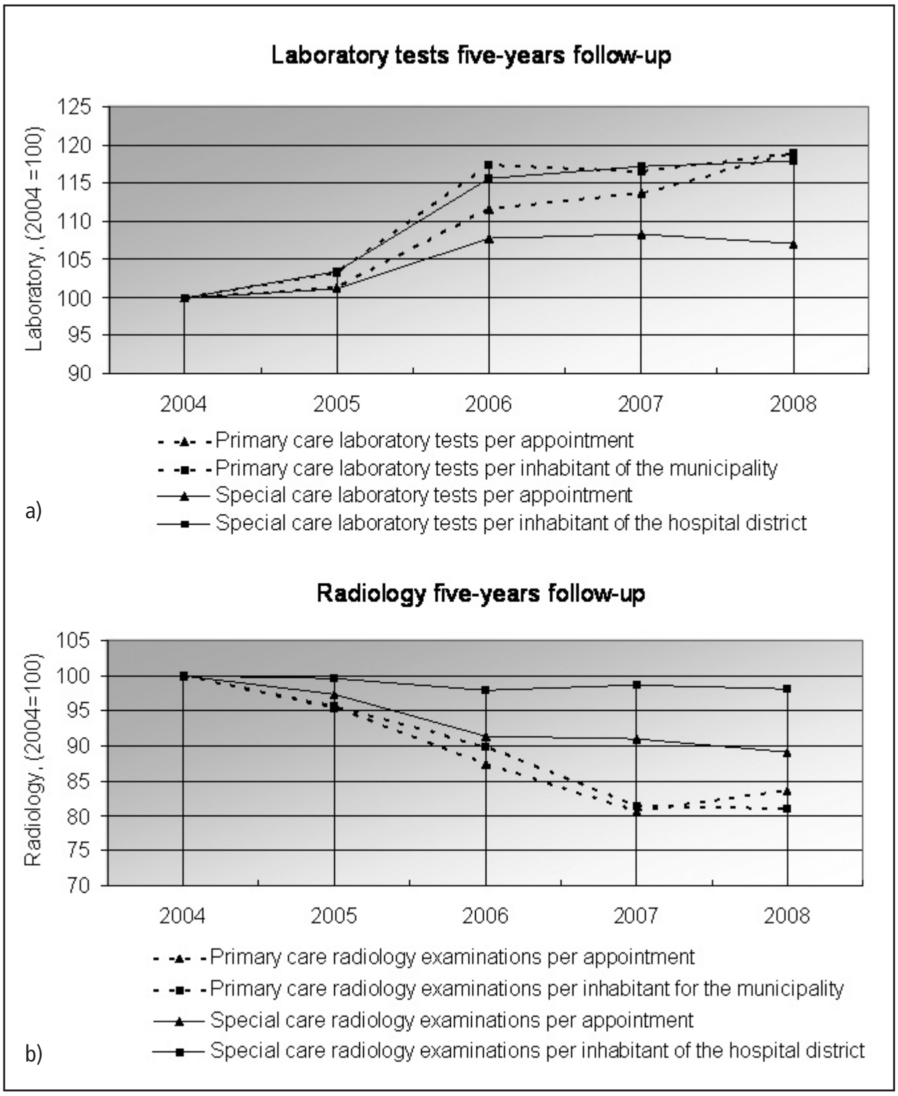

Fig. 1 The five-year follow-up trends of the primary and special care laboratory tests and radiology examinations

5. Results

5.1 Influence of Regional Health Information Exchange on Selected Outcomes

5.1.1 Laboratory Services

The number of primary care laboratory tests per appointment increased in each year of the five-year review period, 19.0% altogether. There was an increase in the number of laboratory tests in seven out of the ten municipality federations reviewed (Table I). Compared to the starting point, the number of tests increased by 0.46 tests per appointment ($p < 0.05$, CI: 0.16, 0.75) (▶Fig. 1). The increase in laboratory tests per inhabitant for the municipality federations was also 19.0% (▶Table 1). Compared to the starting point the number of tests increased by 0.89 per inhabitant ($p < 0.05$, CI: 0.72, 1.05) (▶Fig. 1).

The total amount of special care laboratory tests per appointment increased by 7.0% in the five-year period, and the number of clinical chemistry tests by 6.6% (Table I). Compared to the starting point the increase in the number of tests was 0.36 laboratory tests per appointment ($p < 0.05$, CI: 0.28, 0.43) and 0.33 clinical chemistry tests per appointment ($p < 0.05$, CI: 0.20, 0.46)(▶Fig. 1). The number of laboratory tests per inhabitant increased by 17.9% and the number of clinical chemistry tests by 17.5% (▶Table 1). Compared to the starting point the number of tests increased by 0.78 laboratory tests ($p < 0.05$, CI: 0.65, 0.90) and by 0.73 clinical chemistry tests per inhabitant of the hospital district ($p < 0.05$, CI: 0.65, 0.81) during the study period (▶Fig. 1).

5.1.2 Radiology Examinations

The number of radiology examinations decreased in each of the review years. The number of radiology examinations in primary care per appointment decreased in each year of the five-year review period, by 16.4% altogether in all the municipality federations reviewed (▶Table 1). Compared to the starting point, the number of examinations decreased by 0.02 examinations per appointment ($p < 0.05$, CI: –0.04, –0.01])(▶Fig. 1). The decrease in radiology examinations per inhabitant for the

Table 1 Primary and special health care laboratory tests and radiology examinations specialized medical imaging and clinical chemistry tests in the five-year follow-up.

	2004	2005	2006	2007	2008	2004	2005	2006	2007	2008
Primary care	**Laboratory tests total per total appointments ***					**Laboratory tests total per inhabitant of the municipality federations**				
Total	3.07	3.11	3.43	3.49	3.66	5.01	5.17	5.88	5.84	5.97
Annual Change		1.3 %	10.2 %	1.8 %	4.7 %		3.2 %	13.7 %	–0.7 %	2.1 %
Change in 5 years			19.0 %					19.0 %		
Special care	**Laboratory tests total per total appointments**					**Laboratory tests total per inhabitant of the hospital district**				
Total	4.63	4.68	4.99	5.01	4.95	4.62	4.78	5.34	5.41	5.44
Annual Change		1.1 %	6.6 %	0.4 %	–1.1 %		3.5 %	11.8 %	1.4 %	0.6 %
Change in 5 years			7.0 %					17.9 %		
Special care	**Clinical chemistry tests per total appointments**					**Clinical chemistry tests per inhabitant of the hospital district**				
Total	4.19	4.23	4.54	4.56	4.46	4.17	4.31	4.86	4.92	4.91
Annual Change		1.0 %	7.4 %	0.4 %	–2.0 %		3.4 %	12.6 %	1.3 %	–0.4 %
Change in 5 years			6.6 %					17.5 %		
Primary care	**Radiology examinations total per total appointments**					**Radiology examinations total per inhabitant of the municipality federations**				
Total	0.17	0.17	0.15	0.14	0.15	0.30	0.29	0.27	0.24	0.24
Annual Change		–4.5 %	–8.5 %	–7.8 %	3.7 %		–4.4 %	–5.9 %	–9.5 %	–0.3 %
Change in 5 years			–16.4 %					–18.9 %		
Special care	**Radiology examinations total per total appointments**					**Radiology examinations total per inhabitant of the hospital district**				
Total	0.43	0.42	0.39	0.39	0.38	0.43	0.43	0.42	0.42	0.43
Annual Change		–2.6 %	–6.3 %	–0.3 %	–2.2 %		–0.4 %	–1.7 %	0.6 %	–0.5 %
Change in 5 years			–11.0 %					–1.9 %		
Special care	**Imaging examinations per total appointments**					**Imaging examinations per inhabitant of the hospital district**				
Total	0.35	0.34	0.32	0.32	0.31	0.35	0.35	0.34	0.34	0.34
Annual Change		–2.4 %	–7.2 %	0.1 %	–1.9 %		–0.2 %	–2.7 %	1.1 %	–0.2 %
Change in 5 years			–11.0 %					–2.0 %		

* calculated without VII municipality federation

municipality federations was 18.9% in the eleven federations (▶Table 1). Compared to the starting point, the decrease in the number of examinations per inhabitant of the region was 0.05 examinations ($p < 0.05$, CI: –0.09, –0.01])(▶Fig. 1).

The total number of special care radiology examinations per appointment decreased by 11.0% in the five-year period, as did the number of imaging examinations (▶Table 1). Compared to the starting point, the decrease in the number of examinations was 0.04 imaging examinations per appointment ($p < 0.05$, CI: –0,05, –0.03) and 0.03 radiology examinations ($p < 0.05$, CI: –0.04, –0.03])(▶Fig. 1). The number of radiology examinations per inhabitant decreased by 1.9%, and that of imaging examinations by 2.0% (▶Table 1). Compared to the starting point, the number of examinations decreased by 0.9 radiology examinations ($p < 0.05$, CI: –1.2, –0.5) and 0.8 imaging examinations per 100 inhabitants of the hospital district ($p < 0.05$, CI: –1.3, –0.3]) during the study period (▶Fig. 1).

5.1.3 Appointments and Emergency Department Visits

The mean amount of primary care appointments per inhabitant for the municipality federations decreased in the five-year review period, by 3.0% altogether. There was a decrease in the number of appointments in six out of the eleven municipality

Table 2 Five-year follow-up of the primary and special care appointments and emergency department visits, and primary care referrals to special care.

	2004	2005	2006	2007	2008	2004	2005	2006	2007	2008
Primary care	**Appointmentsper inhabitant of the municipality federations**					**Emergency department visits per 100 inhabitants of the municipality ***				
Total	1.73	1.73	1.78	1.74	1.67	29.01	29.94	31.26	29.47	28.73
Annual Change		0.0 %	2.9 %	–1.9 %	–3.9 %		3.2 %	4.4 %	–5.7 %	–2.5 %
Change in 5 years			–3.0 %					–1,0 %		
Special care	**Specialty care appointments per inhabitant of the hospital district**					**Emergency department visits per 100 inhabitants of the hospital district**				
Total	1.00	1.02	1.07	1.08	1.10	16.9	16.5	16.2	15.4	14.1
Annual Change		2.3 %	4.9 %	0.9 %	1.7 %		–2.4 %	–1.3 %	–5.4 %	–8.0 %
Change in 5 years			10.2 %					–16.2 %		
Primary care	**Primary care referrals to special care per 100 appointments ****					**Primary care referrals to special care per 100 inhabitants of the municipality**				
Total	4.70	5.39	6.24	6.41	6.75	6.45	7.29	8.41	8.52	8.72
Annual Change		14.7 %	15.7 %	2.8 %	5.3 %		13.1 %	15.2 %	1.4 %	2.3 %
Change in 5 years			43.6 %					35.2 %		
Special care	**Primary care emergency referrals to special care per emergency department ***					**Primary care emergency referrals to special care per 100 inhabitants of the hospital district**				
Total	0.19	0.20	0.19	0.21	0.22	5.10	5.54	5.53	5.65	5.72
Annual Change		5.2 %	–4.5 %	8.9 %	3.5 %		8.6 %	–0.2 %	2.3 %	1.2 %
Change in 5 years			12.8 %					12,2 %		

*calculated without XII federation municipality, ** calculated without X** federation municipality

federations reviewed (▶Table 2). Comparing the final situation in 2008 to the starting point, the number of appointments decreased by 0.07 appointments per inhabitant ($p < 0.05$, CI: –0.04, –0.11])(▶Fig. 2).

The number of primary care emergency department visits per 100 inhabitants for the municipality federations decreased in the five-year review period, by 1.0% altogether. The numbers have decreased in the two last review periods. There was a decrease in the number of emergency department visits in three out of the ten municipality federations reviewed (▶Table 2). Compared to the starting point, the number of emergency department visits per 100 inhabitants decreased by 1.34 visits, but the change was not statistically significant (▶Fig. 2).

The number of specialty care appointments per hospital district inhabitant increased in each year of the five-year review period, by a total of 10.2% (▶Table 2). Compared to the starting point, the number of appointments per inhabitant showed a statistically significant increase. There was an increase of 0.08 appointments per hospital district inhabitant ($p < 0.05$, CI: 0.05, 0.12)(Fig. 2).

The number of specialty care emergency department visits per 100 inhabitants of the hospital district decreased in each year of the five-year review period, by 16.2% altogether (▶Table 2). Compared to the starting point, the number of emergency department visits decreased by 2.38 visits per 100 inhabitants of the hospital district ($p < 0.05$, CI: –1.60, –3.17])(▶Fig. 2).

5.1.4 Referrals

The number of primary care referrals to special care per 100 appointments increased in each year of the five-year review period, by 43.6% altogether. There was an increase in the amount of referrals in seven out of the eleven municipality federations reviewed (▶Table 2). Compared to the starting point, the number of referrals increased by 1.77 referrals per 100 appointments ($p < 0.05$, CI: 1.12, 2.41)(▶Fig. 2). The number of primary care referrals to special care per 100 inhabitants increased in each year of the five-year review period, by 35.2% altogether. There was an increase in the amount of referrals in nine out of the eleven municipality federations reviewed (▶Table 2). Compared to the starting point, the increase in the number of referrals per 100 inhabitants of the region was 2.10 referrals ($p < 0.05$, CI: 1.71, 2.49]) (▶Fig. 2).

The number of primary care emergency referrals to special care per emergency department visit increased by 12.8% altogether. There was also an increase in the amount of emergency referrals in five out of the eleven municipal federations reviewed (▶Table 2). Compared to the starting point, the number of emergency referrals increased, but not significantly. The increase was 0.023 emergency referrals per emergency department visit (▶Fig. 2). The number of primary care emergency referrals to special care per 100 inhabitants for the municipality federations increased in the five-year review period, by 12.2% alto-

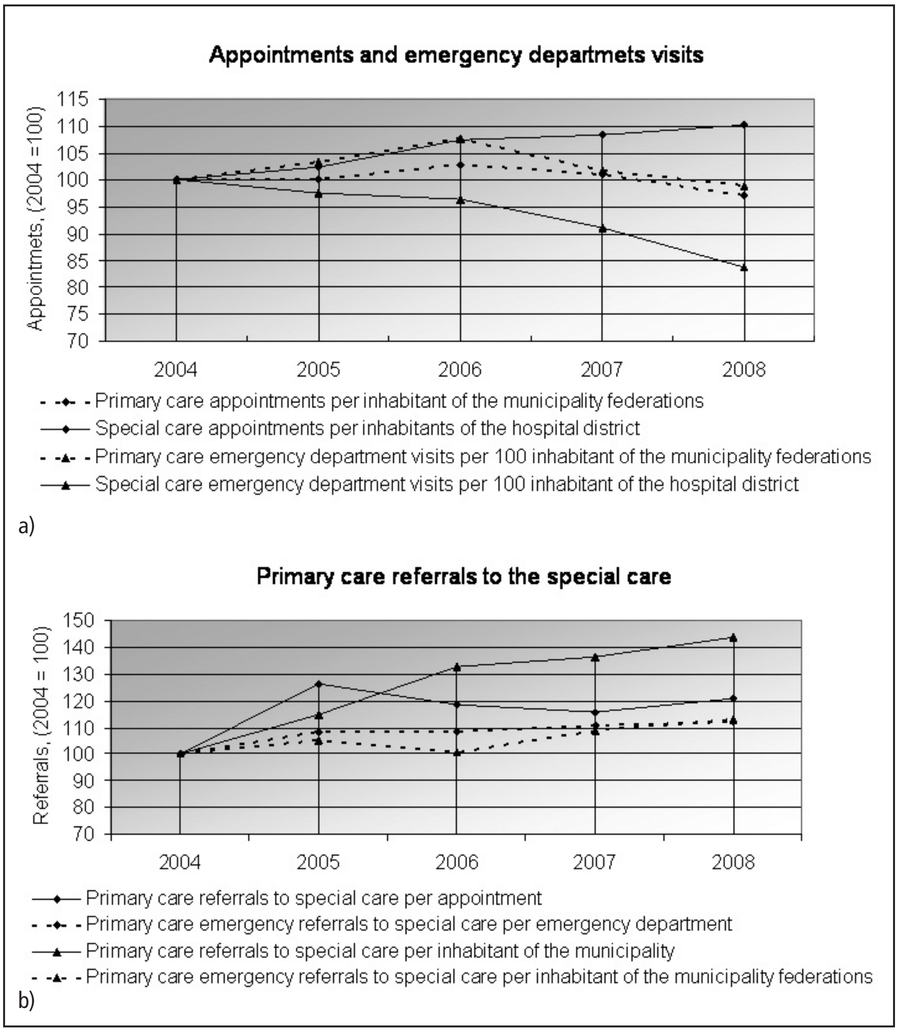

Fig. 2 The five-year follow-up trends of primary and special care appointments and emergency and primary care referrals to special care

gether. There was an increase in the number of emergency referrals in nine out of the eleven municipality federations reviewed (▶Table 2). Compared to the starting point, the number of emergency referrals increased by 0.54 per 100 inhabitants for the municipality federations ($p < 0.05$, CI: 0.29, 0.78)(▶Fig. 2).

5.2 Relationship between Regional Health Information Exchange and the Number of Individual Tests

5.2.1 Laboratory Tests

We continued the review on the level of individual laboratory tests and noticed that the largest change that occurred in the review period was in special care Plasma Low Blood Counts (P-LBC).The number of the most commonly carried out laboratory tests (P-LBC) increased by 11.9% per 100 appointments in primary care but decreased in special care by 6.9%. In comparison with the starting point in primary care, the number of tests increased by 1.7 tests per 100 appointments. Correspondingly in special care, compared to the starting point, the number of tests fell substantially. The decrease was 2.4 tests per 100 appointments. ($p < 0.05$, CI: –3.85, –0.91])(▶Fig. 3a).

As regards the number of P-LBC tests per 100 municipality inhabitants, it increased during the review period by 11.9%, and by 2.6% when reviewed per 100 inhabitants of the hospital district. Compared to the starting point, the increase was 3.7 tests in primary care per 100 inhabitants ($p < 0.05$, CI: 2.36, 5.04) and 1.2 tests per 100 inhabitants of the hospital district in special care ($p < 0.05$, CI: 0.10, 2.29)(▶Fig. 3a).

Regarding laboratory tests, plasma C-reactive protein (P-CRP) tests decreased by 3.9% both per appointment and per inhabitant during the review period in primary care. In special care, P-CRP tests decreased by 2.7% per appointment but increased by 7.3% per inhabitant of the hospital district. In the case of fasting plasma glucose (fP-Gluc) sampling, there was an increase of 10.0% both per appointment and per inhabitant in primary care, but a decrease of 29.0% and 21.7% in special care tests per appointment and inhabitant of the hospital district, respectively (▶Fig. 3a).

5.2.2 Radiology Examinations

We reviewed the level of individual radiology examinations and noticed that the largest change that occurred during the review period in primary and special care was in chest X-rays. In primary care and special care, the number of the most commonly carried out radiology examinations, chest X-ray, per 100 appointments decreased during the five-year review period in primary care by 17.6% and in special care by 20.7%. In comparison with the starting point in primary care, the number of examinations decreased by 1.0 examination per 100 appointments ($p < 0.05$, CI: –1.38, –0.61) and in special care by 1.4 examinations per 100 appointments ($p < 0.05$, CI: –2.33, –0.55])(▶Fig. 3b).

The number of chest X-ray examinations per 100 municipality inhabitants decreased during the review period by 20.1%, and by 12.7%, when reviewed per 100 inhabitants of the hospital district. Compared to the starting point, the decrease was 1.7 examinations in primary care per 100 inhabitants ($p < 0.05$, CI: –2.19, –1.17) and in special care 0.80 examinations per 100 inhabitants of the hospital district ($p < 0.05$, CI: –1.51, –0.10])(▶Fig. 3b).

Regarding radiology examinations, wrist X-ray examinations also decreased by 20.6% per appointment and by 23.0% per inhabitant during the review period in primary care (▶Fig. 3b). In special care, wrist X-ray examinations decreased by 19.7% per appointment and 11.5% per inhabitant of the hospital district. Lumbar spine X-ray examinations decreased by 3.7% per appointment and by 6.6% per inhabitant during the review period in primary care. Furthermore, the number of lumbar spine X-ray examinations decreased in special care by 38.2% per appointment and by 31.8% per inhabitant of the hospital district, respectively (▶Fig. 3b).

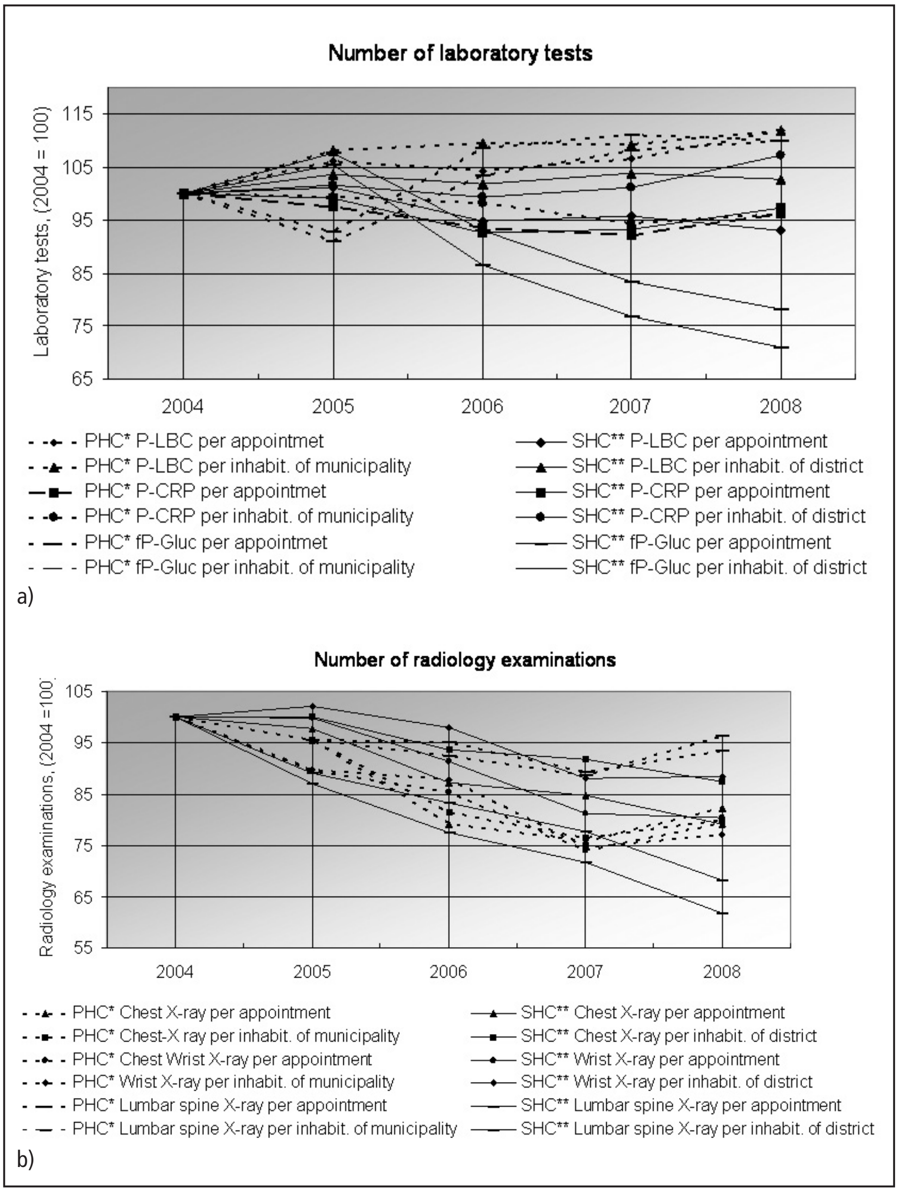

Fig. 3 The five-year follow-up trends of the number of primary and special care laboratory tests and radiology examinations. Legend: PHC*, primary health care, SHP**, special health care

6. Discussion

6.1 Discussion Related to the Results

There has not been much research on the impact of the use of electronic clinical information from HIE initiatives to date [9, 15]. Several follow-up studies, however, have previously been carried out in relation to evaluating the effects of HIE, such as a one-year period to evaluate the benefits of HIE [40], a follow-up survey of RHISs to assess the state of HIE [10], and a retrospective, cross-sectional study to evaluate the effects of integrated electronic health records [35]. According to the previous studies, HIE provides the additional clinical value of multiple independent institutional EHRs. Further opportunities exist for HIE to directly influence medical care [40], such as decreased primary care visits, radiology and laboratory services [35]. Although the amount of operational HIE is growing, its scope remains limited and its viability uncertain [10].

The aim of this paper was to assess the effect of the implementation of one instance of regional health information exchange (HIE). For this purpose, the influence of the HIE on health care delivery and changes in investigated outcomes were assessed. According to the analysis in this retrospective, longitudinal five-year follow-up study, we found substantial changes in the outcomes investigated in both primary and special care. The HIE may have influenced health care delivery in the hospital district in question. There might also have been a connection between the regional HIE and the number of laboratory tests and radiology examinations performed in both primary care and special health care. The changes observed in the use of regional HIE services have many possible explanations. The efficiency of outpatient care may have been increased by the readily available comprehensive clinical information. This conclusion is supported by the decreased frequency of radiology examinations, appointments and emergency department visits. Also Maass et al. [36] estimated a 20% reduction in redundant examinations and repeat appointments. It is vital to investigate whether the population are receiving the health care services that they need, and if this has been affected by the progress in HIE. Outcome assessment is essential for the success of health information technology. Decision makers also require evidence to use in the decision-making process, so we must be able to measure the outcomes within RHIS and HIE initiatives [2, 45]

We investigated the effect of one regional HIE and found that the numbers of primary care laboratory tests seem to have increased in each year of the five-year review period in seven out of the ten municipality federations reviewed. Furthermore, the numbers of special care laboratory tests also seems to have increased over the five-year period. Compared to the starting point, the number of laboratory tests increased significantly. No study to date has found clear evidence that the presentation of prior laboratory tests decreases the ordering of laboratory tests [38]. Neither is there conclusive evidence that the improved availability of complete laboratory data eliminates redundant testing [35]. However, according to a previous study, there are indications that HIE may have decreased laboratory tests and reduced the number of redundant tests [8, 13, 36]. Also, professionals have expressed the opinion that the numbers of tests ordered would decrease with HIE [33].

HIE could improve radiology information processing and decrease radiology examinations [28, 37]. One reviewed outcome that may have influenced health care delivery was radiology examinations. The number of radiology examinations decreased both in special and primary care. Radiology examinations even decreased in primary care in all the municipality federations reviewed here. Likewise, the number of special care radiology examinations decreased during the five-year period, and so did the number of imaging examinations. Compared to the starting year, the number of imaging examinations decreased substantially. In other studies, the use of radiology services decreased by 14% in the two years after implementation of HIE [35]. This led to a decreased number of radiology examinations [27].

Health information exchange among providers makes previously inaccessible data available to clinicians, resulting in more complete information and improved public health information processing [29]. In this study, one reviewed outcome that may have influenced health care delivery was primary and special care appointments. The trend in primary care appointments showed a decrease during the study period. Correspondingly, the number of specialty care appointments increased, but only by 3%. Frisse and Holmes [27] also estimated that reductions are related to fewer admissions for observation, and that HIE may decrease unnecessary admissions [8]. Reduced utilization in the form of encounters has been shown in the literature as an expected outcome of HIE implementation [28].

The immediate availability of patient information at the point of care should increase effective coordination of care in disease management and continuity of care, and also support clinicians in decision-making and benefit their patients [14]. The trend for primary care emergency department visits that may have influenced health care delivery was analyzed, and found to have decreased during the five-year review period. There was an increasing trend for specialty care appointments. Similarly, Overhage et al. [38] reported reduced emergency department visits in a randomized controlled HIE pilot and found that professionals felt that the emergency department would benefit from an HIE system [33]. Also, according to Vest [29], HIE information access was associated with the number of emergency department room visits.

Regional HIE is expected to reduce referrals between providers [39] and improve referral processes [7]. When reviewing the outcomes of primary care referrals and emergency referrals to special care, we observed an increasing trend in most of the municipality federations reviewed. We did not find any impact on health care delivery regarding the investigated outcomes.

We investigated the influence of a regional HIE on the level of the individual number of laboratory tests and radiology examinations in both primary care and special health care. HIE should reduce duplicate tests and thus reduce the use of health care services [13, 27]. We found that the number of individual laboratory tests e.g. P-LBC, mainly increased during the five-year review period. However, we also found a decrease in the number of other laboratory tests e.g. P-CRP. The examination of ordering patterns for specific tests may better reflect the effect of laboratory systems than overall trends [35]. Redundant tests lead to a counter-intuitive trend to repeat tests rather than relying on information recently obtained [33]. Also, difficulties in trying to change work habits and the time required to search for information were significant barriers to accessing clinical information online [18].

The number of individual radiology examinations e.g. chest X-rays, seems to have decreased during the five-year review period in both primary and special care. Also, wrist X-ray examinations decreased during the five-year review period in primary and special care. In the review, it was assumed that radiology examinations are connected to regional HIE systems. Walker et al. [7] have similarly proposed that HIE would reduce redundant radiology examinations and thus also reduce delays and save the costs associated with paper- and film-based processes.

6.2 Limitations

There are some limitations to this study. It is difficult to set up a control group for the phenomenon under research and this lack of control group was a major limitation. Comparative design was not appropriate in this situation because of different sizes and function of hospital district, and they may have different information system in use. In future studies the study design with a control group would be challenged in the case if same RHIS is going to be used in various hospital districts in future in Finland. A second limitation was that the electronic patient health records (EHRs) were different in the various municipality federations, and it was time-consuming to find the correct follow-up outcome results in the different statistical report formats. All the outcome results were collected manually by searching through statistical reports. All this data was collected using similar criteria and instructions, and no changes in compiling the statistics were notified during the study period. Additionally, the special health care laboratory tests were limited to the clinical chemistry department and the radiology examinations to the imaging department because only these were performed in both special and primary health care and were thus comparable. Furthermore, there were usually only a few contact persons in the municipalities who knew how to use the differing statistical systems connected to electronic health records. The other limitations are that these results are limited in scope geographically to one hospital district in Finland, and while the data covers total numbers of inhabitants, appointments and tests in the district, the numbers of tests per appointment or per inhabitant were unavailable. Therefore the access to variability in test rates is limited.

There were no regional structural changes in the hospital district area in the follow-up period 2004–2008. However, there was some organizational pressure to reduce the use of ambulatory care, which might have caused similar effects than HIE. For example, better emergency department triage may have led to fewer admissions. It should be noted that the picture archives and communication system (PACS), which uses digital data in distributed databases and is accessible through a network offering interfaces to health care facilities, could also have caused a decrease in the number of radiology examinations. There may be other factors and developments changes that may have affected the results in the same way like HIE e.g. general trends towards more effective health care and political changes in area. Also other developments in science, technology, treatments and services may also have contributed on the results.

7. Conclusion

The objective was to describe how HIE had influenced health care delivery in one hospital district area in Finland. It is assumed that HIE has an impact on the results, which are supported by decreased frequency of radiology examinations, appointments, and emergency department visits.

There are only a limited number of studies regarding the effect of HIE initiatives. Generally this study was designed as a follow-up study. Outcome assessment of HIE through an RHIS is essential for the success of health information technology (HIT) and as evidence to use in the decision-making process. The contribution to literature on this topic would be strengthened by future studies that could be structured to provide clear evidence of the effects of RHIS implementation. In an ideal situation, the evaluation should be done by using a carefully chosen control area.

As health care information becomes more digital, the potential for HIE to have a strong impact on health care delivery is increasing. HIE allows a tighter integration of public health information flows within clinical information, increasing the feasibility of creating a truly nationwide health information network.

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The Utilization Rate of the Regional Health Information Exchange: How it Impacts on Health Care Delivery Outcomes

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Interest in improving quality and effectiveness is the primary driver for health information exchange efforts across a health care system to improve the provision of public health care services. **Objective:** The aim here was to describe and identify the impact of a regional health information exchange (HIE) using quantitative statistics for 2004-2008 in one hospital district in Finland. **Design:** We conducted a comparative, longitudinal 5-year follow-up study to evaluate the utilization rates of HIE, and the impact on health care delivery outcomes. The selected outcomes were total laboratory tests, radiology examinations, appointments, emergency visits, and referrals. **Results:** The HIE utilization rates increased annually in all 10 federations of municipalities, and the viewing of reference information increased steadily in each professional group over the 5-year study period. In these federations, a significant connection was found to the number of laboratory tests and radiology examinations, with a statistically significant increase in the number of viewed references and use of HIE. The higher the numbers of emergency visits and appointments, the higher the numbers of emergency referrals to specialized care, viewed references, and HIE usage among the groups of different health care professionals. **Conclusions:** There is increasing interest in HIE usage through regional health information system among health professionals to improve health care delivery regionally and bring information on the patient directly to care delivery. It will be important to study which changes in working methods in the service system are explained by RHIS. Also, the experiences of the change that has taken place should be studied among the different stakeholders, administrative representatives, and patients.

KEY WORDS: assessment, health outcomes, regional health information system (RHIS), regional health information exchange (HIE)

Over recent years, health information exchange (HIE)—the mobilization of health information electronically across the health care delivery setting within a given area—has had the potential to improve public health, health status and health care.[1–7] Hundreds of community projects are under way to develop HIE capabilities.[3,6,8] These local projects involved a network of stakeholders within a defined region bringing together relevant stakeholders, such as hospitals, laboratories, radiology centers, public health departments, pharmacies, and other providers to set up the infrastructure for HIE.[2,4-5,7–11]

Interoperable health information exchange networks are a cornerstone of the strategy for developing

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regional health information system (RHIS) in the region. Achieving the vision of patient-centered access to clinical data across institutional boundaries depends upon linkages across the different electronic patient records that store health information.[12–15] Too often, however, these linkages do not take place, and health care professionals lack comprehensive information when it is needed most: at the point of care. For example, laboratory and radiology results, and medications are the most commonly missing information,[16] which have also frequently been reported to be located outside the health information system. Information about the patient is stored in a variety of locations in paper-based forms and therefore, cannot be accessed easily, unless they are computerized and a functioning interface between the electronic patient record systems exists. This may inflict inefficiencies in care, care delays, decision making without relevant information, and redundant testing.[6,12,14,16–20] The quality and safety of health care services, inefficiencies experienced by providers, and increasing health care costs are causes for concern. Furthermore, the issue of an aging population and the support provided by interoperable health information technology (HIT) are the primary drivers in efforts to improve health information exchange in the interests of enhancing public health.[5,6,21–24]

Background

Health information exchange consists of several local networks that are capable of communicating and exchanging information with each other and bringing information on the patient to the care delivery process. Efficient delivery of clinical information can improve the management of health care procedures,[5,10,12,25–28] allow clinicians to focus more on patient concerns, and integrate critical information to support clinical decision making[9,10,29,30] at the point of care.[6,7,9–12,17,21,22,25,26,29–31]

According to previous literature research, HIE reduces overall community spending on services. These reductions are the result of a decreased number of laboratory and radiographic tests, admissions for observation, and emergency appointments[12,14,15–18,20,21,26,27,32–34] as well as a reduced number of referrals between providers. Furthermore, HIE has improved solutions for electronic e-referrals to support enhanced work processes.[31,14,15,33,35] There are also numerous examples of the HIE benefits of timely access to patient information,[36] such as resolving patient issues during the first contact without need for separate appointments,[15,18,26,37] and shortening patient waiting time when further diagnostic or treatment decisions are required.[6,31] The general health care system would thus benefit from HIE.[12,15]

Health information exchange efforts should appeal to the strategic interest of the whole health care community with mutual agreement among providers, purchasers, and payers and also meet stakeholders' expectations to benefit health care delivery. All this requires strong administrative and policy support.[11,13,22,24,38] The most significant challenges today are related to the systematic assessment of the value of services and benefits that emerge from HIE. Data on this remains incomplete, since little real-world experience and research has been undertaken in this area.[6,39] There is also a need for measurement indicators (outcomes) when examining the improvements in health care that can be derived from HIE investment and through providing information that supports health decision makers at consumer, service provider, regional, and national levels.[2,5,39–41]

The aim of this study is to describe and identify the impact of a regional HIE using quantitative statistics for 2004-2008 in one of the 20 hospital districts in Finland. The purpose is to study, with outcome measurements, how HIE influenced health care delivery by investigating selected health care delivery outcomes, and whether HIE with different utilization rates had an impact on these outcomes in the 5-year period. The selected outcomes were laboratory tests, radiography examinations, appointments, emergency department visits and referrals. The following particular study questions are addressed:

- How did the HIE utilization rates differ by municipality and municipal health professional groups?
- How are the HIE utilization rates in viewed references by municipality and municipal health professional groups connected with the outcomes?

Methods

Study context

Public health services in Finland are divided into primary health care and special medical and hospital care. Primary care services are provided at municipal health centers. The municipality may have its own health center(s), or one health center may provide services for several municipalities. Each municipality must belong to one of the 20 hospital districts, which are in charge of specialized health care services.[42] A primary care physician, if necessary, refers patients to operating units in specialized hospitals.

An RHIS with integrated services between primary, secondary, and tertiary care was implemented in one hospital district in 2004-2008. The general aim was to provide all health care professionals with access to patient information across organizational boundaries. The health care professionals could access real-time specialized health care information viewed referrals using a reference repository system (RRS). Through the RRS, referrals of medical reports, laboratory and radiology tests, treatments, and courses of treatment can be viewed regardless of time and place.[43]

Study design

To evaluate the utilization rates of HIE, and its impact on health care delivery outcomes, we conducted a comparative, longitudinal 5-year follow-up study for the years 2004-2008 for all 10 federations of municipalities in 1 Finnish hospital district area with 234 000 inhabitants. We compared the federations of municipalities by usage of HIE in total and by different groups of health care professionals, and linked this information to the outcome data.

Data collection

We reviewed the statistical data of viewed references (1 viewed reference means one instance of using the HIE) and selected outcomes from the time of implementation of the RHIS in the study area. We ordered the amount of viewed references for all 10 federations of municipalities in the hospital district by groups of health care professionals (physicians, nurses, departmental secretaries) in the whole hospital district from the supplier of the RHIS. The viewed references included specialist information on patients, for example, surgery or internal medicine information, laboratory and radiology results, and a nursing summary. We also collected statistical data using routinely collected information from the electronic patient health care records (EHRs) in primary and special health care concerning the selected outcomes for the follow-up period 2004-2008. The selected outcomes, which were obtained from the regional databases, included total laboratory tests and radiology examinations, appointments, emergency department visits, and referrals. The selection of outcomes was based on the theoretical knowledge that they are expected to have an impact through HIE.[12,14,26]

The statistical data were gathered at municipal level by a contact person who forwarded the data to the researchers. The data were collected manually because each municipal EHR produced its own data with a variety of statistical reporting systems. The statistics were, however, comparable both across the years and across various municipalities. The statistical data of references by provider was sorted by year and by professional groups (physicians, nurses, and department secretaries). All the municipality federations and hospital district managers were asked permission to research and view their statistics for 2004-2008. None of the individual municipality or federation data are revealed in the study, nor is any individual patient data. All municipalities were represented by random numbering and not identified by name.

Data analysis

First, the number of viewed references was adjusted in proportion to the number of appointments for each municipality federation and per year. In each municipality federation, the viewed references increased in the 5-year follow-up period (Table 1). In addition, the percentage shares of the amount of viewed references were calculated by health care professional group in different municipality federations for the 5-year follow-up period. Also, the differences in averages between groups were tested using analysis of variance.[44] The statistical difference was tested to see whether there was a statistically significant difference for HIE utilization between professional groups in the different federations and whether there was a difference between the professional groups. Second, the municipality federations were divided by the level of their use of HIE. The federations of municipalities were divided into lower and upper quartiles in terms of the number of viewings per number of inhabitants. Three municipalities were chosen both in the lowest and in the highest quartile. The number of references included the total amount of viewings from the 5 years 2004-2008. Even though the implementation was slower in some federations, there was no substantial change in the lower and upper quartiles when investigating the number of references viewed in 2008.

Third, the response variables, that is, the viewed references, were modeled as predictors of the result variables. Negative binomial distribution with a log link function was used, and the values were proportioned to the population. The explanatory result

TABLE 1 ● The Reference Viewings in Primary and Specialized Care Per 100 Appointments, 5-Year Follow-Up Period 2004-2008.

		2004	2005	2006	2007	2008
Primary care[a]	I	1.4	4.8	5.0	10.4	21.9
	II	1.0	5.1	4.0	8.6	18.9
	III	0.0	3.9	3.2	5.9	18.3
	IV	1.8	4.7	6.2	5.9	15.4
	V	0.6	1.8	3.8	6.5	14.6
	VI	0.0	1.3	3.0	5.5	13.1
	VII	0.0	0.0	0.6	3.8	12.1
	VIII	0.4	5.4	4.1	4.8	10.5
	IX	0.0	2.4	3.4	5.0	9.6
	X	0.4	0.9	1.9	4.4	8.7
	Total	0.4	3.5	3.3	5.5	13.3
Specialized care	Total	-	0.2	2.1	6.1	16.3

[a]Federation of municipalities I–X.

variables in the model were the number of laboratory tests, radiology examinations, appointments, emergency visits, and referrals during the 5-year follow-up period from 2004 to 2008. Three federations of municipalities were included in the lowest and highest quartiles, and two in the middle quartiles. The default distributions of the lower and upper quartiles were also investigated for modeling purposes. For both lower and upper quartiles, the negative binomial default distributions were valid ($P > .05$, Pearson $\chi^2 = 0.377$ and 1.407, degrees of freedom [df] = 6 and 6).

Finally, the response variables, that is, the viewed references by professional group, were modeled as the explanatory result variables, which were done for all viewed references. The default distribution is a negative binomial distribution and the link function log-link, and the values are proportioned to the population for all professional groups ($P > .05$, $\chi^2 = 18.754$ with df = 38 for physicians, 37.482 with df = 36 for nurses, and 15.470 with df = 15 for ward secretaries).[44] The explanatory result variables in the model were numbers of laboratory tests, radiology examinations, physician visits, and referrals in the 5-year follow-up period from 2004 to 2008.

Results

Utilization of HIE in the federations of municipalities

The speed of implementation varied within the study area, and the federations of municipalities implemented the RHIS on a different time scale in primary care. The system usage clearly increased annually in all federations, and it was in use throughout the whole hospital district area by 2008. By that time, HIE was being used substantially more (8.7-21.9 viewed references per 100 appointments) in all the federations of municipalities compared with usage 2 years earlier (0.6-6.2 viewed references per 100 appointments) or at the starting point in 2004 (0.0-1.8 viewed references per 100 appointments) (Table 1).

Activity, measured as HIE usage, differed greatly between the federations of municipalities. For example, the federation of municipalities that used HIE the most had almost 3 times more appointments per capita than the federation of municipalities with the lowest use of HIE during the study period. The data for 2008 describe the HIE utilization rate best. The 5 most active municipalities used HIE almost twice as much (14.6-21.9 viewed references per 100 appointments) than the 5 least active municipalities (8.7-13.1 viewed references per 100 appointments) in 2008 (Table 1).

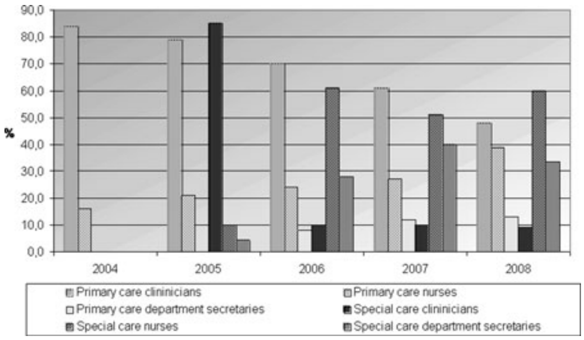
The RHIS was implemented in specialized care 1 year after primary care in 2005, and HIE usage remained relatively low (0.2 viewed references per 100 appointments). The HIE utilization rate increased substantially after that, standing at 2.1 in 2006 and 16.3 in 2008. The total utilization rate of HIE in specialized care (16.3 per 100 appointments) exceeded the average usage in primary care (13.3 viewed references per 100 appointments) at the end of the follow-up period (Table 1). There was no statistically meaningful difference in the number of physician visits proportioned to the number of viewed references ($P = .890$) between different federations of municipalities when examining the difference using analysis of variance.[44]

Viewed references by municipality health professionals

As HIE usage grew, its user base expanded simultaneously. At the beginning of the follow-up period, clinicians viewed reference information more (84%) than nurses (16%) in primary care. In specialized care, reference data were viewed (85%) by clinicians, (10%) nurses, and (5%) department secretaries. At the end of the follow-up, nurses and department secretaries viewed the system more often in both primary and specialized health care, and more than physicians in specialized care by the end of the follow-up period (Figure 1).

The viewings of references increased steadily for each professional group in the 5-year period. However, the final year of the follow-up period, 2008, describes the HIE utilization rate best. At the end of the follow-up period, 48% of the viewers were clinicians, 39% were

FIGURE 1 ● **The 5-year follow-up trends of the primary and specialized care health care professionals' viewing referrals in percentages (%).**



References viewed in primary health care in 2004–2008 by physicians from N = 486 to N = 3581, by nurses from N = 59 to N = 23535, and by department secretaries from N = 26 to N = 13542. References viewed in special care in 2004–2008 by physicians from N = 1496 to N = 25051, by nurses from N = 284 to N = 20587, and by department secretaries from N = 1156 to N = 6958.

nurses, and 13% were ,department secretaries in primary care. In specialized health care the shares were 9% for clinicians, 57% for nurses, and 33% for department secretaries (Figure 1). There was no statistically meaningful difference in the number of viewed references between the municipality federations when examining the differences in averages among the different professional groups ($P = .916$, .583, and .103, respectively) using analysis of variance, when proportioned to the number of appointments. Thus, the utilization of the system has been adopted very evenly by each professional group.[44]

Connection of viewed references to the outcomes by municipality federation

Health information exchange utilization rates in terms of viewed references in all the municipality federations by selected health care delivery outcomes did not reveal any statistically significant explanations. For the 3 upper-quartile federations with high HIE utilization rates, no single outcomes were interpreted in the model. For the lower quartile of federations, statistically significant connections were observed for the number of laboratory tests ($P = .016$) and radiology examinations ($P = .02$) per inhabitant. The more laboratory and radiology tests were made, the more they were viewed in reference information. In the upper-quartile municipality federations, the number of laboratory tests increased and correspondingly the number of radiology examinations reduced considerably the usage of HIE and number of viewed references per inhabitant (Table 2).

The HIE utilization rates of the lower quartile federations of municipalities in viewed references varied from 36 to 8819 times a year (after removing missing values). Comparably, for the upper-quartile federations the variation was slightly smaller, with a minimum of 441 and maximum of 7819 viewed references a year. Both groups have an average number of laboratory tests between 12 000 and 15 000 tests per year. The number of appointments was almost the same in both quartile groups, with an average of 37 000 to 38 000 visits per year. Upper-quartile federations made on average nearly twice as many referrals to specialized care as the lower-quartile federations with 1200 to 2300 referrals per year (Table 3).

Connection of viewed references to the outcomes by health professional group

The HIE utilization rates in terms of viewed references differed by health care professional group. The more referrals physicians made, the more they utilized HIE. For physicians, the viewed reference information was statistically significantly connected to primary care emergency referrals to specialized care ($P = .045$). Similarly, nurses used HIE significantly more when the number of emergency visits and emergency referrals increased. In turn, the fewer radiology examinations were connected to a significantly lower use of HIE. For nurses, viewed reference information was connected with statistical significance to radiology examinations ($P = .001$), emergency visits ($P = .044$), and emergency referrals to specialized care ($P = .001$) per inhabitant. Significant correlations were found between the viewed references by department secretaries and the number of appointments with physicians: the increased number of appointments, emergency visits, and laboratory tests was linked to the increased use of HIE among department secretaries. For department secretaries, viewed references were statistically significantly connected to appointments ($P = .028$), and were close to statistical significance regarding emergency visits ($P = .073$) and laboratory tests ($P = .073$) (Table 2).

Physicians used HIE to view references the most, at an average of 1333 per year. The nurses viewed reference information nearly half as often as physicians, at an average of 758 times per year. The department secretaries had the lowest average, with 497 times per year. In the cases of physicians, the number of observed cases was 45, compared with 43 for nurses. In the case of department secretaries, the number of observed cases was only 22, because of missing values. In one federation of municipalities, for example, department secretaries did not view reference information or use HIE at all during the 5-year follow-up period (Table 3).

Discussion

Discussion related to the results

In our study, a growing interest was found in clinical data exchange for improving health care quality, efficiency, and public health. The RHIS was implemented in different time schedules and at different speeds, especially in primary care. The system usage clearly increased during the study period in primary and specialized care. At the end of the follow-up period, the utilization rate of HIE in viewing references in specialized care exceeded the average HIE usage in primary care. The prerequisites for successfully implemented HIE are building community support, developing key stakeholders' interest in clinical data exchange, and demonstrating its benefits.[7,38]

The most descriptive HIE utilization rate in viewed references in the study district was the last year of the follow-up period, when HIE had become a part of the normal workflow. The trend of HIE regarding health

TABLE 2 ● **Viewed References in all Municipality Federations in the Whole Hospital District and in Different Professional Groups**

	Response Variables[a]					
Variables	Total Viewed References	Viewed References in Lower-Quartile Municipalities	Viewed References in Upper-Quartile Municipalities	Physicians' Viewed References	Nurses' Viewed References	Department Secretaries' Viewed References
Laboratory tests	.104	**.016**	.596	.335	.085	.073
Radiology examinations	.084	**.020**	.127	.234	**.001**	.518
Appointments	.175	.303	.788	.287	.580	**.028**
Emergency visits	.087	.945	.233	.288	**.044**	.073
Referrals	.325	.657	.469	.549	.097	.952
Emergency referrals	**.019**	.945	.753	**.045**	**.010**	.830

[a] $P < .05$, significant results are bolded.

care professionals' usage was clearly rising during the follow-up, both in primary and specialized care. Our data confirmed that there is a need for efficient delivery of clinical information and professional access to it (eg, patient's laboratory or radiology results) and to improve the clinical decision making and management of the health care process. Shapiro et al[12] also thought that clinicians having access to data from external institutions benefits the continuity of patient care and the efficiency of health care delivery.[4,12]

We also investigated HIE utilization rates in viewed references in federations of municipalities by the outcomes of health care delivery. In the 3 federations of municipalities with the highest HIE utilization rates, usage increased most during the follow-up period, and the figures observed were the highest in 2008. The best explanatory factor was the length of time after RHIS was implemented. Health information exchange efforts might be driven by perceived local needs for clinical data exchange, cultural readiness to engage in exchange, and sufficient participation from regional stakeholders.[7]

The 3 federations of municipalities with the lowest utilization rates also showed increasing use, even though the growth was not as clear and fast as in the upper quartile. For these federations of municipalities, the number of laboratory tests and radiology examinations were connected to HIE utilization rates in terms of viewed references. For example, the more laboratory tests made, the more HIE was used. Hripcsak et al[30] also reported that laboratory and radiology data were used most frequently and that they were also the most commonly used HIE functionality.

There is an obvious need for an easier information flow among service providers and practices, and for improved access to patient information.[12] In this study, the HIE utilization rate in different professional groups was connected to the outcomes of health care delivery. In this model, explanatory variables for the health care delivery outcomes meaningfully explained the response variable, i.e. the number of viewed references per population.

Health information exchange was used most by physicians: use among nurses was on average half of that among physicians. Department secretaries had the lowest use. The making of referrals by physicians was connected to using HIE in viewed references. When making emergency referrals, they also viewed significantly more reference information. As mentioned earlier, according to Shapiro et al,[12] emergency physicians believed that having access to current data from outside the institution at the point and time of care benefits patient care.[29] Similarly, nurses used HIE significantly most in viewing reference information in emergency visits and emergency referrals. The more emergency visits there were, the more they viewed reference information. Ambulatory care practices viewed patient information most frequently. Moreover, HIE should reduce fragmentation of care and improve the referral processes.[4,12]

There was a significant connection between radiology examinations and HIE usage and submission of reference information among nurses. The fewer radiology examinations made, the less nurses used HIE. A functioning regional HIE network may well reduce diagnostic testing.[15,17] There was a significant correlation between the number of appointments and use of HIE for viewing reference information by department secretaries. The more appointments made, the more the department secretaries also viewed reference information. Giving professionals access to data on their patients' care from providers outside their organization is likely to result in an improved flow of information with better communication and coordination to support continuity of care.[4,12,15]

TABLE 3 ● **Variable Parameters of Lower- and Upper-Quartile Municipality Federations and in Different Professionals Groups in a Year**[a]

Variable Parameters of the Lower-Quartile Federations, When Response Variables Are all References

Variables	N	Minimum	Maximum	Average	SD
Viewed references	13	**36**	**8819**	1601	2417
Laboratory tests	13	46249	259400	**119561**	88327
Radiology examinations	13	2451	9638	5102	2747
Appointments	13	15548	79084	**37376**	26317
Emergency visits	13	1585	16493	7059	5411
Referrals	13	198	3871	**1191**	1419
Emergency referrals	13	112	1991	708	762

Variable Parameters of the Upper-Quartile Federations, When Response Variables Are all References

Variables	N	Minimum	Maximum	Average	SD
Viewed references	13	**441**	**7819**	2917	2377
Laboratory tests	13	106099	196477	**147343**	30487
Radiology examinations	13	4386	9144	6039	1499
Appointments	13	26274	47632	**37975**	7630
Emergency visits	13	4340	18964	7915	3939
Referrals	13	629	4563	**2327**	1580
Emergency referrals	13	329	2028	1187	701

Variable Parameters of all Federations of Municipalities, When Response Variables are Physicians' Viewed References.

Variables	N	Minimum	Maximum	Average	SD
Viewed references	45	23	8500	**1333**	1736
Laboratory tests	45	14520	308087	126112	87803
Radiology examinations	45	472	24205	6346	5887
Appointments	45	7255	128677	40430	35396
Emergency visits	45	504	24474	7533	6889
Referrals	45	152	5309	1943	1643
Emergency referrals	45	112	6185	1340	1698

Variable Parameters of all Federations of Municipalities, When Response Variables Are Nurses' Viewed References

Variables	N	Minimum	Maximum	Average	SD
Viewed references	43	1	3960	**758**	1033
Laboratory tests	43	14520	308087	124613	87957
Radiology examinations	43	472	24205	6320	5995
Appointments	43	7255	128677	40047	35822
Emergency visits	43	504	24474	7477	7033
Referrals	43	152	5309	1976	1664
Emergency referrals	43	112	6185	1352	1728

Variable Parameters of all Federations of Municipalities, When Response Variables Are Department Secretary's Viewed References

Variables	N	Minimum	Maximum	Average	SD
Viewed references	22	9	1883	**496**	496
Laboratory tests	22	48814	308087	146258	80892
Radiology examinations	22	2233	19272	6377	4560
Appointments	22	12307	124015	43956	31678
Emergency visits	22	879	19237	8541	5883
Referrals	22	295	5309	2377	1601
Emergency referrals	22	163	6185	1450	1596

[a] N is the number of observations in the group. Values given in bold are the upper and lower quartile of municipalities viewed references minimum and maximum. Average of the upper and lower quartile of municipality laboratory tests, appointments, referrals.

Limitations

The EHRs were different in the various municipality federations, and all the outcome results were collected manually by searching through statistical reports. There were usually only a few contact persons in the municipalities who knew how to use the different statistical systems connected to EHR. All these data were collected using similar criteria and instructions. The validity of conclusions from the study would need to be supported by statistical control or baseline analysis of the utilization of HIE. However, the numbers of duplicate laboratory tests or radiology exams or repeat admissions, and so forth, were not available, even though it would have been important to have them for comprehensive analysis of the development.

Another limitation was that our results are limited in scope geographically to one hospital district in Finland. There were no regional structural changes in the hospital district area in the follow-up period 2004-2008. However, there was some organizational pressure to reduce the use of ambulatory care to reduce health care costs, which might have caused similar effects as those observed in the use of HIE.

Furthermore, there were only 2 or 3 federations of municipalities in the quartiles. Thus, the small number of observations may partially explain why significant explanatory factors were not found. The observations made by physicians and nurses numbered close to 50, but those of department secretaries were fewer, since there were a lot of missing values. It can always be attempted to improve a single model by removing poorly explanatory variables or by adding terms of efficacy. However, this study deals with more than 1 model, different responses and different quartiles, and the similar models can be compared. Research material was gathered and sorted by years in the federations of municipalities. Since human behavior affect the use of HIE in the early stages, it is challenging to find a clear explanation.

Conclusion

There are only a limited number of studies regarding the effects of HIE and no studies on HIE utilization rates within a particular regional health care delivery area.[6,39] It is essential to assess outcomes providing the evidence of specific measurement indicators through HIE efforts. There was an increasing interest in HIE usage through RHIS among health professionals to improve health care delivery and public health in the region. Health information exchange improves efficient delivery of clinical information and brings information on the patient directly to care delivery, thus enhancing the management of health care procedures. The more patient data are available and professionals feel they benefit from the data, the more professionals in the patient health care chain will use RHIS. In the future, it would be important to study which changes in working methods in the service system are explained by RHIS. It would also be vital to study in more detail, how different stakeholders, government representatives, and patients experience the change that has taken place when the system has been in use for 5 years.

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Potilaan kokemukset alueellisesta yhteiskäyttöisestä tiedosta

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TIIVISTELMÄ

Tutkimuksen tarkoituksena on kuvata kroonista sairautta sairastavien kokemuksia alueellisesta yhteiskäyttöisestä tiedosta. Kokemuksia tarkasteltiin tiedonkulun, yhteistyön ja toimintatapojen muutoksen näkökulmista. Tutkimusaineisto kerättiin potilailta (n = 10) teemahaastattelulla. Aineisto analysoitiin deduktiivis-induktiivisella sisällönanalyysillä.

Potilaiden mielestä aluetietojärjestelmän käyttö oli parantanut potilastietoihin pääsyä palvelutilanteessa. Heillä kuitenkin oli huoli hoitokokonaisuutensa hallinnasta, vaikka alueellinen yhteiskäyttöinen tieto oli parantanut organisaatioiden yhteistyötä heidän hoitonsa koordinoinnissa. Toimintatavoissa oli tapahtunut muutoksia, mikä ilmeni potilaan palvelutilanteen tehostumisena kuten esimerkiksi potilastietojen saatavuuden paranemisena. Palveluiden tehostumattomuudesta potilaat toivat esille sen, että tutkimuksia tehtiin edelleen päällekkäisesti.

Alueellisen yhteiskäyttöisen tiedon ei koettu tukevan potilaan palvelukokonaisuutta. Potilaat kokivat olevansa enemmän vastuussa jatkohoidostaan ja olivat tulevaisuudessa halukkaita itse katsomaan potilastietojaan.

ASIASANAT

potilas, alueellinen yhteiskäyttöinen tieto, tiedonkulku, yhteistyö, toimintatavat

Terveydenhuoltopalvelut kohtaavat nykyisin monia haasteita kuten väestön ikääntymisen ja kroonisten tautien lisääntymisen. Kroonista sairautta tai useampia sairauksia sairastavat ovat usein eri organisaatioissa hoidossa, ja heitä hoitaa usea terveydenhuollon ammattilainen. (Marchibroda 2008, Demski ym. 2010). Terveydenhuoltopalvelujen toimivuus edellyttää terveydenhuollon ammattilaisten alueellista yhteistyötä ja tietojen vaihtoa yli organisaatiorajojen kaikkien potilaan hoitoon osallistuvien kesken (Hansagi ym. 2008, O'Donnell ym. 2011).

Alueellisen yhteistyön edellytyksenä on, että eri ammattilaiset tekevät yhteistyötä ja että tarpeelliset ja oikea-aikaiset potilastiedot eri organisaatioiden potilastietojärjestelmistä ovat saatavilla päätöksenteon tueksi (Marchibroda 2008, Vest 2009, Patel ym. 2010). Erikoisaloittain pirstoutunut terveydenhuoltojärjestelmä sekä hoidon koordinoinnin puute ja terveydenhuollon tietojärjestelmien yhteensopimattomuus asettavat haasteita erityisesti kroonisten sairauksien ja monisairaiden potilaiden hoidolle (Marchibroda 2008). Krooniset sairaudet vaativat usein erilaisia hoitoja ja tutkimuksia, kuten laboratorio- ja seurantakokeita, ja potilailla saattaa olla useita lääkityksiä samanaikaisesti käytössään. Potilasta hoitavilla ammattilaisilla ei ole useinkaan tietoa potilaan hoidon kokonaistilanteesta, ja kaikkia tarvittavia tietoja ei ole saatavilla potilaan palvelutilanteessa. (Vest 2009, Demski ym. 2010, Vänskä ym. 2010.)

TUTKIMUKSEN LÄHTÖKOHDAT

Aikaisemmissa tutkimuksissa on todettu, että alueellisesti yhteiskäyttöinen tieto mahdollistaa ajantasaisten tietojen saannin palvelutilanteessa, kun tietoja vaihdetaan eri organisaatioiden sähköisten potilastietojärjestelmien välillä (Vest 2009, Demski ym. 2010, Fontaine ym. 2010). Alueellisen yhteiskäyttöisen tiedon on todettu myös parantavan alueellista yhteistyötä, hoidon koordinointia ja potilaan hoitokokonaisuuden hallintaa. Samalla hoidon jatkuvuus paranee ja päällekkäisesti tehtävät tutkimukset vähenevät, mikä nopeuttaa potilaan hoitoprosessia. (Marchibroda 2008, Demski ym. 2010, Fontaine ym. 2010, Hincapie ym. 2011.) Alueellisen tietojen vaihdon on todettu olevan erityisen hyödyllistä kroonista sairautta sairastaville potilaille, joilla on useita palvelutapahtumia (O'Donnell ym. 2011).

Siitä, miten potilaat kokevat alueellisen yhteiskäyttöisen tiedon tai sähköisen tietojen vaihdon yli organisaatiorajojen, on aikaisempaa kansallista tai kansainvälistä empiiristä tutkimustietoa vain niukasti. Aikaisempien tutkimusten mukaan potilaat kuitenkin kannattivat alueellisen yhteiskäyttöisen tiedon käyttöä ja sitä, että potilastietoja on mahdollista välittää sähköisesti heitä hoitavien eri ammattilaisten ja organisaatioiden välillä (Simon ym. 2009, O'Donnell ym. 2011). Potilaat uskovat alueellisen tietojen vaihdon parantavan ammattilaisten välistä viestintää (Bjerkan ym. 2010, O'Donnell ym. 2011) ja parantavan hoidon laatua ja turvallisuutta, vaikka ovatkin olleet huolissaan yksityisyyden suojasta ja tietoturvasta (Simon ym. 2009, Wen ym. 2010). Potilaat ovat myös olleet kiinnostuneita pääsemään katsomaan omia tietojaan aluetietojärjestelmästä (Patel ym. 2010, O'Donnell ym. 2011). Omaishoitajat ovat kokeneet potilastiedot hyödylliseksi (Wen ym. 2010, Patel ym. 2011).

TUTKIMUKSEN TARKOITUS JA TUTKIMUSTEHTÄVÄT

Tutkimuksen tarkoituksena oli kuvata potilaiden kokemuksia alueellisesta yhteiskäyttöisestä tiedosta. Potilaan kokemuksia tarkasteltiin tiedonkulun, yhteistyön ja toimintatapojen muutosten osalta yhden sairaanhoitopiirin alueella, jossa aluetietojärjestelmä oli ollut käytössä viisi vuotta. Tarkasteltavana ollut aluetietojärjestelmä on tarkoitettu sosiaali- ja terveydenhuollon ammattilaisten käyttöön potilaan palvelutilanteessa, jossa on tarve saada potilaan hoitotietoja muiden organisaatioiden potilastietojärjestelmistä (Asikainen ym. 2006).

Tutkimustehtävät olivat seuraavat:

1. Miten alueellinen yhteiskäyttöinen tieto on muuttanut tiedonkulkua?
2. Minkälainen yhteys alueellisella yhteiskäyttöisellä tiedolla on yhteistyöhön?
3. Miten alueellinen yhteiskäyttöinen tieto on muuttanut toimintatapoja (toimintatapojen muutos suhteessa potilaan laboratoriotutkimusten, röntgentutkimusten, vastaanottokäyntien ja lähetteiden määriin)?

TUTKIMUSMENETELMÄT

Tutkimukseen osallistujat ja aineistonkeruu

Tutkimukseen valittiin harkinnanvaraisesti 10 potilasta, jotka olivat antaneet suostumuksensa aluetietojärjestelmäpalvelun käyttämiseen lääkärin vastaanottotilanteessa. Potilaat olivat aikuisia, ja heillä oli jokin krooninen sairaus, joka oli diagnosoitu vähintään viisi vuotta sitten. Tutkimukseen osallistui 10 potilasta yhden sairaanhoitopiirin alueelta neljältä eniten aluetietojärjestelmää käyttäneeltä perusterveydenhuollon ja erikoissairaanhoidon lääkärinvastaanotolta.

Aineisto kerättiin teemahaastatteluilla heinä-syyskuussa 2010. Teemahaastattelu valittiin tutkimusmenetelmäksi, koska tavoitteena oli syventää ymmärrystä alueellisen yhteiskäyttöisen tiedon hyödyistä. Haastateltavilla kroonista sairautta potevilla oletettiin olevan kokemuksia ja mielipiteitä järjestelmän käytöstä (Polit ja Beck 2010). Haastattelutilanteet olivat välittömiä, ja niiden aikana voitiin tarvittaessa toistaa kysymyksiä ja esittää tarkennuksia (Burns ja Grove 2005). Tavoitteena oli saada monipuolista tietoa tutkittavasta ilmiöstä, joten haastattelujen teemat olivat laajoja. Ne muodostuivat aikaisemmin saatujen tulosten perusteella (Mäenpää ym. 2009). Haastattelujen teemat olivat tiedonkulku, yhteistyö ja toimintatapojen muutos.

Taustamuuttujina potilailta kysyttiin ikää, sukupuolta, koulutusta, vastaanoton laatua (perusterveydenhuolto/erikoissairaanhoito), potilaan tietojen katsomista potilaan suostumuksella (harvoin/usein), diagnoosia (yksi/useampi) sekä sitä, milloin kyseinen diagnoosi on todettu ensimmäisen kerran ja syytä, jonka vuoksi potilas nyt oli lääkärissä.

Tutkimusluvat myönsivät organisaatioiden ylilääkärit. Tutkimukseen osallistuvista organisaatioista sovittiin lääkäriyhdyshenkilö, joka toimi haastateltavien potilaiden rekrytoijana. Yhdyshenkilön pyytäessä potilaalta suostumusta aluetietojärjestelmän käyttöön hän kertoi tehtävästä haastattelututkimuksesta ja kysyi potilaan halukkuutta osallistua tutkimukseen. Tutkija otti yhteyttä tutkimukseen suostuneisiin potilaisiin ja sopi haastatteluajan ja -paikan, joka oli vastaanotolla oleva rauhallinen kansliatila. Tutkijan tapaa haastatella täsmennettiin kokeilemalla haastattelurunkoa yhdellä potilaalla. Kokeilun perusteella päädyttiin korostamaan sitä, että aiheeseen tulee palata mahdollisimman nopeasti, jos haastateltava poikkeaa siitä. Haastattelut kestivät keskimäärin 44 minuuttia (vaihteluväli 35–52). Ne nauhoitettiin haastateltavien luvalla ja litteroitiin.

Aineiston analyysi

Tutkimusaineiston analyysissa käytettiin sekä deduktiivista että induktiivista sisällönanalyysia. Deduktiivista analyysia ohjasi luokitusrunko, joka perustui aikaisempaan tutkimukseen, jossa ammattilaisia ja hallinnon edustajia oli haastateltu samoilla kysymyksillä (Mäenpää ym. 2012). Aineisto järjestettiin ensin aikaisemman tutkimuksen yläkategorioiden mukaan. Niitä olivat tietojen saatavuus, tietojen vaihto, tietosuoja, yhteistoiminta, hoidon koordinointi ja viestintä sekä potilaan palvelun tehostuminen tai tehostumattomuus. Näistä muodostettiin yhdistävät kategoriat, joita olivat alueellinen tiedonkulku, yhteistyö ja toimintatapojen muutos. Sitten aineisto analysoitiin alakategoriatasoilla induktiivisen sisällönanalyysin keinoin. Analyysiyksikkönä oli sanayhdistelmä tai lausekokonaisuus, joka vastasi tutkimuksen tarkoitukseen. Aineistossa esiintyneille ilmauksille annettiin sama arvo riippumatta niiden esiintymisen useudesta. Aineistosta pelkistetyt ilmaukset taulukoitiin ja koodattiin numerolyhentein. (Polit ja Beck 2010.) Ilmaukset ryhmiteltiin asiasisällön erojen ja yhtäläisyyksien mukaan alakategorioiksi, joille annettiin sisältöä kuvaava nimi. Taustamuuttujista laskettiin frekvenssit, keskiarvot ja vaihteluväli sekä prosentuaaliset osuudet. (Burns ja Grove 2005.)

TULOKSET

Vastaajien taustatiedot

Haastatelluista potilaista suurin osa (60 %) oli 60–69-vuotiaita (vaihteluväli 61–83, keskiarvo 69), miehiä haastatelluista oli 60 %. Kaikilla potilailla oli useita kroonisia sairauksia. Eniten oli sydän- ja verisuonisairauksia, diabetesta ja syöpäsairauksia. Krooninen sairaus oli diagnosoitu yli puolella potilaista (60 %) vähintään 10 vuotta aiemmin. Haastattelutilanteessa suurin osa (80 %) potilaista oli perusterveydenhuollon lääkärin vastaanotolla käyneitä. He olivat tulleet lääkärin vastaanotolle krooniseen sairauteensa liittyvien vaivojensa takia kuten huimauksen, ahdistuksen, rytmihäiriön tai lääkkeen uusimisen vuoksi. Erikoissairaanhoidossa potilaat kävivät eri erikoisalojen poliklinikoilla. Kaikilta oli usein kysytty lupaa tietojen katseluun aluetietojärjestelmästä.

Alueellinen tiedonkulku

Alueelliseen tiedonkulkuun sisältyivät tietojen saatavuus, tietojen vaihto ja tietosuoja (taulukko 1).

Tietojen saatavuudessa potilaat toivat esille potilastietojen löydettävyyden aluetietojärjestelmästä, tietojen ajantasaisuuden vaihtelun sekä potilastietojen merkintöjen puuttumisen. Potilaiden mukaan heidän potilastietonsa löytyivät aluetietojärjestelmästä paremmin ja olivat nopeasti nähtävillä palvelutilanteessa. Potilaat olivat tyytyväisiä siihen, että terveyskeskuslääkäri pystyi katsomaan heidän erikokoisalatietojaan suoraan aluetietojärjestelmästä, ja myös tutkimustulokset saatiin paremmin käyttöön. Omalääkärin poissa ollessa uuden lääkärin oli mahdollista nähdä potilaan aikaisempi sairaushistoria järjestelmästä. Tietojen ajantasaisuus vaihteli, koska aina tietoja ei ollut saneltu potilaan soittoaikaan mennessä. Kuitenkin lääkärin oli mahdollista saada potilasta koskevaa ajankohtaista tietoa palvelutilanteessa. Potilastietojen merkinnöissä oli puutteita, sillä kaikkia potilaan tietoja ei löytynyt aluetietojärjestelmästä.

Tietojen vaihdossa potilaiden kokemukset liittyivät tietojen välittymiseen organisaatioiden välillä, puutteelliseen tietojen välittymiseen erikoisalayksiköiden välillä sekä siihen, että jatkohoitotietojen välittyminen on potilaan tai omaisen vastuulla. Aluetietojärjestelmän käyttö oli parantanut potilaan tietojen välittymistä eri organisaatioiden välillä. Tiedonkulku erikoissairaanhoidosta perusterveydenhoitoon toimi hyvin. Potilaat olivat havainneet, että suhteessa potilaspapereiden lähettämiseen alueellinen yhteiskäyttöinen tieto oli parantanut ja helpottanut tiedonkulkua.

Toisaalta potilaat kokivat tietojen välittymisen eri organisaatioiden välillä huonontuneen, kun tieto erikoissairaanhoitokäynnistä ei välittynyt terveyskeskukseen. Epikriisitieto lähetettiin terveyskeskuslääkärille, kun potilas sitä pyysi. Erikoissairaanhoidosta välittyi huonosti tietoa kotisairaanhoitoon. Potilaat olivat ihmeissään, kun kotisairaanhoito haki apteekista vielä sellaisia lääkkeitä, joiden käyttö oli lopetettu erikoissairaanhoidossa. He toivoivat, että yksityisen puolen tiedot välittyisivät aluetietojärjestelmään, koska he kävivät erikoissairaanhoidon lisäksi myös yksityisellä lääkärillä ja jatkohoidossa perusterveydenhuollossa.

Potilaan tietojen välittyminen erikoisalayksiköiden välillä oli puutteellista keskussairaalassa. Muuttuneet hoito- tai lääkitystiedot eivät välittyneet sairaalapäivystyksestä hoitavaan erikoisalayksikköön, jossa potilas oli kroonisen sairautensa vuoksi hoidossa. Potilaan siirtyessä terveyskeskuksen vuodeosastolle erikoissairaanhoidossa saadut jatkohoito-ohjeet eivät aina kulkeneet hänen mukanaan, vaan saattoivat hukkua potilaspapereihin tai jäädä koneelle, josta ei kukaan niitä katsonut.

Potilaat kokivat, että jatkohoitotietojen välittyminen oli heidän vastuullaan. Erikoissairaanhoidon käynnistä epikriisitieto lähetettiin kotiin, ja potilaita ohjattiin viemään se omaan jatkohoitopaikkaan. Potilaiden jatkohoitotietojen välittyminen oli siirtynyt myös omaisten vastuulle. Omaiset selvittelivät potilaan hoito- ja tutkimustuloksia, kun potilaat eivät kyenneet enää hoitamaan omaan hoitoonsa liittyviä asioita. Potilaiden mukaan omaiset olivat kiinnostuneita lähimmäistensä voinnista ja toivoivat, että myös heille jaettaisiin siitä tietoa.

Potilaan palvelutilanteessa tietosuoja oli yhteydessä luvan pyytämiseen tai luvan pyytämättä jättämiseen. Potilaalta pyydettiin suullinen tai kirjallinen lupa hänen tietojensa katseluun. He tiesivät oikeutensa ja olivat tietoisia annettavasta luvasta, vaikka aina ei ollut selvää, oliko heiltä kysytty lupaa. He myös ymmärsivät, että tajuttomana ollessaan heidän tietojansa

Taulukko 1. Esimerkki analyysin etenemisestä, yhdistävä kategoria "*alueellinen tiedonkulku*".

Yläkategoria	Alakategoria	*Suora lainaus*
Tietojen saatavuus	Potilastietojen löydettävyys aluetietojärjestelmästä	*"koneella ne tiedot kyllä on, et kyl ne tiedot hyvin löytyy sit sieltä"*
	Tietojen ajantasaisuudessa vaihtelua	*"lääkäri on nähnyt suoraan koneelta sen tänhetkisen tilanteen, mikä on mun tilanne"* *"siel ei ollu sitä epikriisii vielä kun oli soittoaika, koska ei ollu epikriisiä saneltu"*
	Merkintöjen puuttuminen	*"yritettiin selvittää millon sitä lääkettä on annettu, onks sitä annettu keskussairaalassa vai terveyskeskuksessa, taas löytyny mistään merkintää, onko annettu"*
Tietojen vaihto	Potilaan tietojen välittyminen organisaatioiden välillä	*"sehän, kulkee tietokoneen kautta, nopeesti, suuntaan ja toiseen"*
	Puutteellinen tietojen välittyminen erikoisalayksiköiden välillä	*"olin sisätautien polilla vuorokauden ja lääkäri kysy multa, et missä se lääke on aloitettu, et eikö ne ollenkaan tiedä siellä keskussairaalassa toinen toisistaan"*
	Potilaan vastuulla jatkohoitotietojen välittyminen	*"keskussairaalasta lähetettiin epiksiisi kotiin ja sanottiin, että vien sen mennesäni sitten jatkohoitopaikkaan"*
	Omaisten vastuulla jatkohoitotietojen välittyminen	*"mun muisti alkaa sitten mennä, et näit täs sit on antanu (omaisten) hoitaa, et miten piti toimia"*
Tietosuoja	Luvan pyytäminen	*"jos lääkäri kysyy keskussairaalas ni täytyy olla lupa että hän saa katsoa mun tietoja, näin minä olen ymmärtäny"*
	Luvan pyytämättä jättäminen	*"ei, semmost lupaa varmaankaan ei oo kyllä kysytty"*

voitaisiin tarvittaessa katsoa ilman lupaa. Potilaille oli tehty myös pitkäaikainen jatkohoitosopimus, jonka voimassa ollessa lupaa ei tarvinnut usein kysyä. Muutoin he ihmettelivät usein pyydettävää lupaa tietojensa katseluun.

Alueellinen yhteistyö

Alueellinen yhteistyö muodostui yhteistoiminnasta, hoidon koordinoinnista ja viestinnästä (taulukko 2).

Yhteistoiminnassa oli potilaiden mukaan kyse terveyskeskuksen ja keskussairaalan tai poliklinikoiden yhteistyöstä sekä toisen ammattilaisen tietojen näkemisestä tietokoneelta. Terveyskeskuksen ja keskussairaalan yhteistyö oli helpottanut potilaan hoitoa, kun toisen organisaation tietoja pystyttiin hyödyntämään potilaan palvelutilanteessa. Potilaiden mukaan organisaatioiden yhteistyö sekä alueellinen yhteistyö toimivat riittävän hyvin. Terveyskeskuksessa tiedettiin nyt paremmin, mitä potilaalle oli tehty keskussairaalassa. Toisaalta potilaat kokivat, ettei poliklinikoiden yhteistyö toiminut potilasta hoidettaessa. Monisairaat kävivät eri erikoisalojen poliklinikoilla viikon välein. Toivottavaa oli, että yhdellä käynnillä voisi käydä samassa organisaatiossa useassa eri hoitopaikassa. Potilaat havaitsivat, että toisten ammattilaisten tietojen näkeminen tietokoneelta mahdollisti yhteistyön, kun ammattilaiset näkivät koneelta toistensa lausunnot, ja sen, mitä keskussairaalassa oli tehty ja suunniteltu potilaan hoidoksi.

Hoidon koordinointi kohdistui hoitokokonaisuuden hallinnan mahdollistumiseen, hoidon jakautumiseen eri erikoisaloille, omalääkärin puuttumiseen sekä jatkohoitoon siirtymiseen potilaan tai omaisen vastuulle. Aluetietojärjestelmän käyttö oli parantanut potilaan hoitokokonaisuuden hallintaa, kun terveyskeskuksessa tiedettiin enemmän hänen hoidostaan ja jatkohoidostaan sekä saatiin selkeämpi kokonaiskuva voinnista. Toisaalta potilailla oli käsitys, ettei heidän hoitokokonaisuutensa ollut kenenkään hallinnassa. Monisairaalla potilaalla oli paljon käyntejä eri erikoisalalla, ja hoito oli jakautunut eri erikoisaloille. Hänellä oli huoli siitä, luetaanko kaikkia hänen sairaustietojansa, koska yhdellä erikoisalalla hoidettiin

Taulukko 2. Esimerkki analyysin etenemisestä, yhdistävä kategoria "*alueellinen yhteistyö*".

Yläkategoria	**Alakategoria**	***Suora lainaus***
Yhteis-toiminta	Terveyskeskuksen ja keskussairaalan välinen yhteistyö	*"tuolt tietokoneesta nähdään se mitä keskussairaalassa on tehty, niin se tiedetään tääl terveyskeskukses näin"*
	Ei poliklinikoiden välistä yhteistyötä	*"minkäännäköstä yhteistyötä ei ainakaan oo, et yhdellä kerralla vois käydä mones paikas, ku mulla on viikon välein tässä nyt sitte kontrolleja eri poliklinikoille keskussairaalassa"*
	Toisten ammattilaisten tietojen näkeminen tietokoneelta mahdollistaa yhteistyön	*"kyl se nyt mun nähdäkseni parempi on se että tosiaan suoraan tuolt tietokoneelta nähdään se mitä keskussairaalassa on sanottu tääl (tk) hoidettavan"*
Hoidon koordinointi	Hoitokokonaisuuden hallinnan mahdollistuminen	*"tarvittaessa sielt järjestelmäst saa niit lisätietoja mitä haluaa katsoa mun hoidoista"*
	Hoidon jakautuminen eri erikoisaloille	*"on monen alan hoidossa ja kukaan ei katso toisensa tietoja, eli jokainen keskittyy siihen omaansa hoitamiseen"*
	Omalääkärin puute	*"siis se suhde katoaa kokonaan, ei semmosta hoitosuhdetta ole, ko se tuttu lääkäri lähtee pois"*
	Jatkohoito potilaan vastuulla	*"sanottiin, että menen sitten kontrolleille sinne terveyskeskukseen, enkä mää nyt oikeen muista mihin kokkeisiin"*
	Jatkohoito omaisten vastuulla	*"hän soitti omaisena mun puolest soittoajalla"*
Viestintä	Ammattilaiset pystyvät näkemään toistensa lausuntoja	*"he (ammattilaiset) näkee siellä toistensa lausunnot, niin kyllähän se sillain toimii"*
	Ammattilaiset katsovat potilaille tietoja koneelta	*"he selvittelee ko asia on rempalla tai epäselväksi jäänyttä tilannet he vastaa koneelta, he vastaa paperille, he tulostaa sen tiedon"*
	Toive omiin potilastietoihin pääsystä kotona	*"vielä erinomaisempi, kun pääsis itse kattomaan niitä tietojansa kans kotona"*
	Potilaalla kotona omat tiedot paperisessa muodossa	*"kyllä lausunnoissa, kyllä mä niistä oon kopiot saanu, tapahtuneista asioista"*

vain yhtä sairautta. Hoitokokonaisuuden hallintaa heikensi lisäksi se, ettei terveyskeskuksessa ollut enää omalääkäriä, joka olisi ollut tietoinen potilaan kaikista sairauksista.

Potilaat kokivat, että aluetietojärjestelmän vuoksi he ovat enemmän vastuussa omasta jatkohoidostaan ja että heidän on itse hakeuduttava jatkotutkimuksiin ja -hoitoon. Potilaan oli ymmärrettävä tiedustella tehdyistä tutkimuksista, koska niistä ei erikseen ilmoitettu hänelle ja ne saattoivat jäädä pitkäksikin ajaksi terveyskeskukseen odottamaan joko hänen tai omaisen yhteydenottoa, mikä heikensi hoidon jatkuvuutta. Omaisille oli siirretty vastuuta potilaan jatkohoidosta, kun potilaat eivät enää itse pystyneet hoitamaan asioitaan.

Viestinnän yhteydessä potilaat toivat esille, että ammattilaiset pystyvät näkemään toistensa lausunnot ja että ammattilaiset katsovat potilaalle tietoja koneelta. Lisäksi he toivat esille toiveet omiin potilastietoihinsa pääsystä ja siitä, että potilaan tiedot olisivat paperisessa muodossa kotona. Potilaan hoitoa paransi se, että ammattilaiset pystyivät näkemään toistensa lausunnot ja näkemään enemmän tietoa potilaasta toisista organisaatioista. Ammattilaiset katsoivat potilaalle tietoja aluetietojärjestelmästä, kun he selvittivät epäselväksi jääneitä tietoja epikriiseistä. Potilailla oli toive päästä kirjautumaan omiin tietoihinsa, jotta he voisivat tulevaisuudessa itse katsoa omia potilastietojaan.

Taulukko 3. Esimerkki analyysin etenemisestä, yhdistävä kategoria *"toimintatapojen muutos"*.

Yläkategoria	**Alakategoria**	***Suora lainaus***
Potilaan palvelutilanteen tehostuminen	Potilaspapereiden tilaaminen loppunut	*"aika tavalla muuttunu, ei tartte paperil tilata tietoja"*
	Potilastietoja paljon käytettävissä	*"meikäläiselläkin kun on sivukaupal sitä tietoo, ni voi sielt koneelt sit niit kattella"*
	Lääkäri näkee, mitä potilaalle on muualla tehty ja mitä potilaan hoidosta on sanottu	*"lääkäri näkee heti tost tietokoneelt ne tulokset ku on käyny ja mitä on tehty"*
	Ei tarvitse itse kuljettaa potilaspapereitaan	*"ennne täyty hommata kaikki omat epikriisit kun tulit tän terveyskeskukseen"*
Potilaan palvelutilanteen tehostumattomuus	Ei muutoksia toimintatavoissa	*"emmä oo huomannu et mittään toimintatapoihin olis muutettu"*
	Päällekkäiset tutkimukset	*"siin semmost päällekkäisyyttäki on ollu, ne samat asiat otetaan uudelleen sit siel keskussairaalassa"*
	Potilas viikon välein eri poliklinikoilla	*"nyt oltiin hematologian polilla ja ensviikolla mennään kokeisiin geriatrille vai oliko se urologille ja sitte seuraavaksi urologille*

Toimintatapojen muutos

Toimintatapojen muutokseen sisältyivät potilaan palvelutilanteen tehostuminen ja sen tehostumattomuus (taulukko 3).

Potilaan palvelutilanteen tehostuminen näkyi siinä, että potilaspapereiden tilaaminen oli loppunut, potilastietoja oli paljon käytettävissä ja lääkäri näki, mitä potilaalle oli aikaisemmin muualla tehty tai sanottu, eikä potilaan tarvinnut kuljettaa potilaspapereita mukanaan. Potilaat havaitsivat, että potilaspapereiden määrä oli vähentynyt eikä niiden tuloa tarvinnut enää odottaa kuten ennen. Aluetietojärjestelmässä oli käytettävissä paljon tietoa potilaan aikaisemmista sairauksista. Lääkäri näki aluetietojärjestelmästä potilaan aikaisemmat tutkimustulokset ja sen, mitä potilaalle oli keskussairaalassa jo tehty. Potilaan ei tarvinnut enää kuljettaa potilaspapereitaan jatkohoitopaikkaan. Aikaisemmin potilaat kuljettivat itse potilaspaperinsa keskussairaalasta terveyskeskukseen.

Palvelutilanteen tehostumattomuuden potilaat kokivat johtuvan siitä, ettei toimintatavoissa ollut tapahtunut muutoksia. Potilaiden mukaan tietojärjestelmiä ei hyödynnetty, vaan heiltä edelleen kysyttiin tietoja. Potilaat kertoivat, että heille tehtiin päällekkäisiä tutkimuksia, kun he kävivät viikon välein eri poliklinikoilla keskussairaalassa.

Toimintatapojen muutosta tarkennettiin kysymällä potilailta, miten toimintatapojen muutos oli yhteydessä laboratoriotutkimusten ja lähetteiden määrän lisääntymiseen sekä röntgentutkimusten ja vastaanottokäyntien määrien vähentymiseen viiden vuoden aikana.

Laboratoriotutkimusten määrän lisääntyminen potilaiden hoidon yhteydessä viiden vuoden aikana oli haastateltavien mukaan yhteydessä päällekkäisesti tehtäviin tutkimuksiin, vanhoihin toimintatapoihin ja laboratoriokokeiden tarpeellisuuteen. Potilaat toivat esille sen, ettei toisen organisaation ottamia kokeita otettu huomioon, vaan tehtiin päällekkäisiä tutkimuksia. Monisairaat kävivät usein keskussairaalassa eri poliklinikoilla, jotka noudattivat omia toimintatapojaan ja ottivat omat rutiini- ja kontrollikokeensa riippumatta toisessa yksikössä tehdyistä tutkimuksista. Laboratoriotutkimusten merkitys oli kasvanut, kun potilaita haluttiin tutkia tarkemmin. Myös potilaat itse vaativat tehtäväksi enemmän tutkimuksia.

Röntgentutkimusten määrän vähentyminen oli potilaiden mukaan yhteydessä tutkimuksen tarpeellisuuden määrittelyyn, kustannusvaikutukseen ja röntgentutkimusten saatavuuteen. Potilaiden mielestä röntgentutkimuksen tarpeellisuutta arvioitiin tarkemmin ja kontrollikokeita otettiin tarpeen mukaan. Röntgentutkimukset olivat kalliita, ja potilaat ymmärsivät niiden kustannusvaikutusten merkityksen. Päällekkäisten röntgenkuvien ottaminen oli vähentynyt, ja jo olemassa olevia kuvia hyödynnettiin. Röntgentutkimusten saatavuutta oli rajoitettu, koska röntgenaikoja ei ollut saatavilla, mikä johtui röntgenlääkäreiden pulasta ja röntgenosastojen sulkemisesta alueella. Potilaat tiesivät, että alueella oli käytössä myös yhteinen kuva-arkisto.

Lääkärin vastaanottokäyntien määrän väheneminen oli haastateltavien mukaan yhteydessä uusintakäyntien määrään, vastaanottoaikojen riittämättömyyteen, lääkäreiden kokeneisuuteen, sairaanhoitajien vastaanottoihin, puhelinaikoihin sekä yksityiseen sektoriin. Potilaiden mukaan uusintakäynniltä voitiin välttyä, kun lääkäri pystyi katsomaan potilaan jatkohoitotiedot sekä aikaisemmat hoitotiedot aluetietojärjestelmästä, ja myös vastaanottokäynti eteni terveyskeskuksessa helpommin. Puuttuvien tietojen tai potilaspapereiden tilaamisen vuoksi ei tarvinnut varata uutta vastaanottokäyntiä. Turhalta kontrollikäynniltä voitiin välttyä, kun potilaan ongelma oli mahdollista hoitaa yhdellä vastaanottokäynnillä. Lääkärin vastaanotolle oli pitkiäkin jonoja, eikä terveyskeskuksissa ollut riittävästi vastaanottoaikoja eikä lääkäreitä, mikä vähensi vastaanottokäyntien määrää. Tosin potilaat osasivat vaatia päästä hoitoon tietyssä ajassa. Kokemattomat lääkärit ottivat vähemmän potilaita vastaan kuin kokeneemmat lääkärit, ja lääkäreiden vaihtuvuus oli suurta. Terveyden- ja sairaanhoitajan vastaanotot siirsivät potilaita lääkärin vastaanotolta esimerkiksi diabeteshoitajan tai avannehoitajan vastaanotoille. Potilasta ohjattiin enemmän puhelimitse jatkohoidossa ja myös reseptit uusittiin puhelimitse. Potilaat kertoivat menevänsä myös enemmän yksityiselle lääkärinvastaanotolle.

Lähetteiden määrän lisääntyminen oli yhteydessä lähetteiden tekemiseen, lääkäreiden kokeneisuuteen, vastuun siirtämiseen, potilaan miellyttämiseen, yksityiseen sektoriin ja tilaongelmiin. Lähete erikoissairaanhoitoon tehtiin, kun oli selkeä tarve tehdä lähete. Hätätilanteissa tehtiin päivystyslähete. Samasta vaivasta tehtiin usea lähete erikoissairaanhoitoon pääsyn nopeuttamiseksi. Kokemattomammat lääkärit tekivät helpommin lähetteen erikoissairaanhoitoon. Vastuu potilaan hoidosta siirrettiin herkemmin perusterveydenhuollon vastaanotolta erikoissairaanhoitoon. Myös sairauksien lisääntyminen lisäsi lähetteiden tekemistä. Toisaalta lähetettä erikoissairaanhoitoon oli joskus vaikea saada, ja lääkärit kirjoittivat lähetteen potilaan vaatimuksesta. Potilaat saivat yksityiseltä puolelta helpommin lähetteen erikoissairaanhoitoon. Potilaita oli lähetetty erikoissairaanhoitoon terveyskeskuksen tilaongelmien ja vuodepaikkojen pulan vuoksi.

POHDINTA

Luotettavuus ja eettiset näkökohdat

Laadullisen tutkimuksen luotettavuuden arviointi kohdistuu koko tutkimusprosessiin. Tutkimuksen keskeisiä luotettavuuden kriteereitä ovat uskottavuus, riippuvuus, siirrettävyys ja vahvistuvuus. (Burns ja Grove 2005.) Tässä tutkimuksessa tutkittavien kokemus tutkittavasta ilmiöstä lisäsi tutkimustulosten uskottavuutta. Tutkimukseen valitut potilaat olivat monisairaita, joilla oli kokemusta alueellisesta yhteiskäyttöisestä tiedosta ja tutkimuksen kannalta muuta oleellista tietoa.

Tutkimuksen riippuvuutta voidaan tarkastella aineiston pysyvyyden näkökulmasta, ja sovellettavuus luotettavuuden kriteerinä ilmenee tutkimustulosten siirrettävyytenä (Burns ja Grove 2005). Aineiston analyysiin saattoi vaikuttaa tutkijan oma esiymmärrys tutkittavasta ilmiöstä. Tätä pyrittiin välttämään siten, että toinen tutkija arvioi analyysin etenemistä. Aineistoksi kerättiin yhden sairaanhoitopiirin alueelta 10 potilaan mielipide, joten tutkimuksessa ei ole pyritty yleistettävyyteen. Tutkimuksesta saatuja tuloksia voidaan kuitenkin hyödyntää terveydenhuollon tietojärjestelmien kehittämistyössä. Vahvistettavuudessa on tärkeää, että lukija pystyy riittävästi arvioimaan tutkimusprosessia (Polit ja Beck 2010). Yhteys aineiston ja tulosten välillä varmistettiin palaamalla tarvittaessa alkuperäisaineistoon. Lisäksi tässä tutkimuksessa on esitetty analyysin tueksi aineistosta alkuperäisilmauksia, ja analyysin eteneminen on kuvattu taulukoiden avulla.

Tutkimusluvan myönsi organisaation ylilääkäri. Haastateltavilta saatiin kirjallinen suostumus tutkimukseen ja haastattelun nauhoittamiseen. Tutkimukseen osallistuvat saivat informaation tutkimuksen tarkoituksesta, luottamuksellisuudesta sekä sen säilymisestä tutkimuksen kaikissa vaiheissa. Tutkimuksen teolle oli eettisen toimikunnan puoltava lausunto.

Tulosten tarkastelu

Kun aluetietojärjestelmä oli ollut sairaanhoitopiirissä käytössä viisi vuotta, sen käyttö oli potilaiden mukaan parantanut alueellista tiedonkulkua. Myös aikaisempien tutkimusten mukaan hoito- ja tutkimustiedot olivat paremmin saatavilla potilaiden palvelutilanteessa (Hansagi ym. 2008, Asikainen ym. 2009). Terveyskeskuksessa lääkäri pystyi katsomaan potilaan erikoisalatietoja aluetietojärjestelmästä. Potilaiden mielestä tietoja heidän kokonaistilanteestaan ei ollut järjestelmästä helposti saatavilla, kun he olivat hoidossa usealla erikoisalalla. Potilaiden mukaan aluetietojärjestelmän käyttö oli kuitenkin parantanut heidän tietojensa välittymistä sairaanhoitopiirin alueella. Myös aikaisempien tutkimusten mukaan potilaat kannattivat sitä, että heidän tietonsa olivat kaikkien heidän hoitoonsa osallistuvien ammattilaisten käytössä (Tripathi ym. 2009, Patel ym. 2010, Wen ym. 2010, O'Donnell ym. 2011).

Erikoissairaanhoidon käyntitiedot ja jatkohoitotiedot eivät välittyneet potilaan terveyskeskukseen tai kotisairaanhoitoon, mikä potilaiden mukaan heikensi tietojen vaihtoa organisaatioiden välillä. Myös tietojen välittyminen eri erikoisalayksiköiden välillä toimi huonosti. Huonon potilastietojen vaihdon on todettu huonontavan hoidon laatua (Vest 2009, Vänskä ym. 2010, O'Donnell ym. 2011). Potilaat kokivat, että jatkohoitotietojen välittyminen oli siirtynyt heidän vastuulleen. Kuitenkin sähköisen potilastietojen vaihdon organisaatiorajojen yli on todettu tuottavan hyötyjä, ja potilaat halusivat sitä käytettävän (Hincapie ym. 2011, O'Donnell ym. 2011). Potilaat olivat tietoisia siitä, että heiltä oli pyydettävä lupa heidän tietojensa katseluun. Aina lupaa ei potilaiden mukaan ollut kysytty. Aikaisempien tutkimusten mukaan potilaat olivatkin alueellisen tiedon käytössä erityisen huolestuneita tietosuojasta (Simon ym. 2009).

Yhteiskäyttöinen tieto oli parantanut alueellista yhteistyötä potilaan hoidossa. Organisaatioiden ja terveydenhuollon ammattilaisten yhteistoiminta oli parantanut potilaan hoitoa, kun toisen organisaation tietoja pystyttiin hyödyntämään erityisesti niiden potilaiden kohdalla, joilla oli useita samanaikaisia sairauksia. Aikaisempien tutkimusten mukaan alueellinen yhteistyö oli parantanut potilaan hoidon koordinointia ja parantanut hoitokokonaisuuden hallintaa, kun potilaat kävivät hoidossa eri organisaatioissa (esim. Bjerkan ym. 2010, Patel ym. 2011). Toisaalta potilailla oli käsitys, ettei heidän hoitokokonaisuutensa ollut kenenkään hallinnassa, kun yksi erikoisala hoiti vain yhtä sairautta. Alueellisen yhteiskäyttöisen tiedon ei koettu tukevan riittävästi potilaan palvelukokonaisuuden hoitamista, koska tietojen välittymisessä oli puutteita ja tietoja ei aina ollut saatavilla. Kyse saattoi olla myös ammattilaisten toiminnallisista puutteista löytää tai hakea tietoja järjestelmästä. Omalääkärin puuttumisen on myös todettu heikentävän hoitokokonaisuuden hallintaa (ks. myös Vänskä ym. 2010). Potilaat kokivat olevansa nyt enemmän vastuussa omasta jatkohoidostaan. Toisaalta olikin niin, että potilaiden on todettu haluavan osallistua omaan hoitoonsa ja he halusivat itse katsoa potilastietojaan aluetietojärjestelmästä (Marchibroda 2008, O'Donnell ym. 2011).

Toimintatavoissa oli potilaiden mukaan tapahtunut muutoksia viiden vuoden aikana. Potilaat havaitsivat tietojensa saatavuuden parantumisen ja postitse tilattavien potilaspapereiden määrän vähentymisen. Tämä tehosti potilaan palvelua. Potilastietoja tarkistettiin enemmän, kun lääkäri katsoi aikaisempia tutkimustuloksia. Tämä myös vähensi päällekkäisiä tutkimuksia ja edelleen tehosti potilaan palvelua.

Tietosuojakäytänteiden selkiytyminen tehosti toimintaa sekä lisäsi potilastietojen luotettavuutta ja potilasturvallisuutta (ks. myös Patel ym. 2011). Aikaisempien tutkimusten mukaan alueellisten tietojärjestelmien käyttöönoton tarkoituksena on tehostaa terveydenhuollon toimintaa poistamalla muun muassa päällekkäisiä tutkimuksia. (Hansagi ym. 2008, Tripathi ym. 2009, Fontaine ym. 2010, Hincapie ym. 2011). Toisaalta potilaat havaitsivat, ettei toimintatavoissa ollut tapahtunut muutoksia eivätkä palvelut olleet tehostuneet, koska edelleen otettiin päällekkäisiä tutkimuksia esimerkiksi silloin, jos potilas kävi eri poliklinikoilla viikon välein.

Palveluiden tehostumattomuudesta potilaat toivat esille päällekkäisesti tehtävät laboratoriotutkimukset tilanteissa, joissa toisen organisaation jo ottamia kokeita ei otettu huomioon. Toisaalta potilaat havaitsivat palveluiden tehostumista siinä, että röntgentutkimusten ottamisen tarpeellisuutta arvioitiin entistä tarkemmin. Palveluiden tehostumisesta kertoi edelleen se, että potilaspapereiden tilaamisesta ja tietojen puuttumisesta johtuvilta turhilta lääkärin vastaanottokäynneiltä voitiin välttyä, kun tarvittavat tiedot voitiin tarkistaa aluetietojärjestelmästä (ks. myös Hansagi ym. 2008 Fontaine ym. 2010). Palveluiden tehostumattomuudesta potilaat puolestaan toivat esille vastaanottokäyntien riittämättömyyden. Myös samasta vaivasta saatettiin kirjoittaa monta lähetettä, ja vastuu potilaan hoidosta siirrettiin helposti erikoissairaanhoitoon.

PÄÄTELMÄT JA EHDOTUKSET HOITOTYÖN KÄYTÄNNÖN JA JOHTAMISEN KEHITTÄMISEKSI

Kun alueellinen yhteiskäyttöinen tieto oli ollut sairaanhoitopiirin alueella käytössä viisi vuotta, alueellinen tiedonkulku ja yhteistyö oli potilaiden mukaan parantanut. Potilaat eivät kuitenkaan kokeneet, että alueellisen tiedon käyttö sairaanhoitopiirin alueella olisi tukenut heidän hoitokokonaisuutensa hallintaa, vaan he kokivat olevansa enemmän vastuussa omasta jatkohoidostaan. He olivat halukkaita tulevaisuudessa myös itse katsomaan omia potilastietojaan.

1. Kroonisesti sairaiden potilaiden halu ottaa vastuuta omasta hoidostaan tulee aiempaa paremmin huomioida alueellisten palvelujen suunnittelussa ja kehittämisessä.
2. Potilaan osallisuus ja muiden ammattilaisten tuottama tieto ovat tärkeitä tekijöitä potilaan palvelukokonaisuuden hallinnassa.
3. Alueellinen yhteiskäyttöinen tieto tukee asiakkaan aseman vahvistamista ja valinnan mahdollisuutta edellyttäen, että ammattilaiset hyödyntävät toisessa organisaatiossa tuotettua tietoa.

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ABSTRACT

Patient experiences of regional health information exchange

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The purpose of this study is to describe the experiences of chronically ill patients regarding regional health information exchange (HIE). It was examined from the aspects of flow of information, collaboration and process redesign. The data (n=10) were collected by means of a thematic interview and analyzed using deductive-inductive content analysis.

The use of regional health information systems (RHIS) had improved patient access to information in the service situation in the patients' view. However patients had concerns about the management of their care, although regional HIE had improved cooperation between organizations in terms of care coordination. Changes in work practices had occurred, which was reflected in improvements in the patients' situation, such as improved access to patient information. Concerning inefficiency in health services, patients highlighted the duplication of examinations and treatments, when the results of the tests taken by another organization were not always taken into account.

The HIE was seen as not supporting the patient's overall health services. The patients felt they had more responsibility for their own further care, and were eager to see their own medical records in the future.

KEY WORDS

patient regional health information, flow of information, collaboration, process redesigns