Bridging the Gap

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Electronic Messaging between Home Health Care and General Practitioners

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Dissertation (PhD)

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Summary

Background and aim: Communication between health care providers is essential for the safe delivery of care to patients. In Norway, the Coordination Reform has given municipalities a greater responsibility regarding the treatment and care of patients, calling for improved collaboration between health care providers. However, the health care service is fragmented and dispersed, and the tools designed to support communication between health care providers has been unsatisfactory. In particular, home health care nurses and general practitioners (GPs) have encountered problems reaching each other when necessary. To meet these challenges, the Norwegian government's goal is for all municipalities, hospitals and GPs to adopt an electronic messaging (e-messaging) system by the end of 2014. The overall aim of this study was to explore and describe how home health care nurses and GPs experienced their communication practices when using an e-messaging system. A further goal was to explore how the introduction of an e-messaging system affected patient safety from the perspectives of home health care nurses and GPs.

Design and method: The study used an explorative and descriptive design employing several methods, such as focus group interviews, semi-structured interviews and a self-developed questionnaire. The focus group interviews and the semi-structured interviews were conducted in two municipalities with 23 home health care nurses and 11 GPs. The questionnaire was administered in 12 municipalities which had implemented and used an e-messaging system, and for comparison, in 16 municipalities that had not implemented the e-messaging system. In the e-messaging municipalities, 425 home health care nurses responded to the questionnaires, while in the comparison municipalities, 364 home health care nurses responded.

Results: The results show that the implementation of the e-messaging system initiated the establishment of communication procedures. The home health care nurses that used the e-messaging system reported that it was easier to contact the GPs and that the frequency of contact was higher compared to the home health care nurses who did not. Use of the e-messaging system did not lead to timelier communication, and except for the use of faxes, which decreased, the number of non-electronic methods of communication was not reported to have lessened for the home health care nurses who used the e-messaging system. The home health care nurses assessed the e-messaging system as an efficient tool for communication with GPs, and the assessment of the e-messaging system as easy to use was a strong predictor

for this. Statistically significant predictors for assessing the e-messaging system as easy to use were as follows: having received training, not being hindered by poor functionality and a high full-time equivalent percentage. Both home health care nurses and GPs reported that it was easier to connect when they used the e-messaging system and that the system made medication information more accessible. They also reported that the use of the e-messaging system eased the reconciliation of the patients' medication lists, the reviewing of the medications the patients were using and the discovery of errors. However, new and unexpected errors occurred due to omissions and a lack of functionality in the e-messaging system.

Conclusions: The findings of this study indicated that the e-messaging system had an assembling effect on home health care nurses, GPs and their communication. The introduction of the e-messaging system also promoted the formalisation of work routines between them with the establishment of communication procedures. Moreover, the e-messaging system supported informal communication between the home health care nurses and the GPs, which was an important requisite for collaboration and building knowledge about their common patients. With regard to medication information, the e-messaging system resulted in both increases and decreases in patient safety. Finally, both social and technical factors had an impact on the work system of the home health care nurses and GPs. This underlines the importance of taking a sociotechnical approach when developing and implementing an information and communication technology system into the work system of health care providers.

Terms and abbreviations

CG – comparison group

EG – e-messaging group

EHR – electronic health record

EHR system – electronic health record system

ELIN-k project – **el**ectronic **in**formation exchange in the municipalities (-**k**ommunene) project

E-messages – electronic messages

E-messaging system – electronic messaging system

GP – general practitioner

ICT – information and communication technology

List of papers

I. Lyngstad M, Grimsmo A, Hofoss D & Hellesø R (2014): Home Care Nurses' Experiences with Using Electronic Messaging in their Communication with General Practitioners *Journal of Clinical Nursing, article first published online: 20 Mar 2014 DOI: 10.1111/jocn.12590*

II. Lyngstad M, Hofoss D, Grimsmo A & Hellesø R: Predictors for Assessing Electronic Messaging as an Efficient Tool for Communication in Home Health Care Services – A Cross-Sectional Study – submitted

III. Lyngstad M, Melby L, Grimsmo A & Hellesø R (2013): Toward Increased Patient Safety? Electronic Communication of Medication Information Between Nurses in Home Health Care and General Practitioners. *Home Health Care Management and Practice* **25**, 203-211.

Contents

Figures

Tables

1 Introduction

This thesis addresses the communication between home health care nurses and general practitioners (GPs) when an electronic messaging (e-messaging) system is introduced into the Norwegian health care service.

Health care services are fragmented and disintegrated and do not take a shared responsibility of the totality of patients' health and care needs (Coleman 2003, Helse- og omsorgsdepartementet 2009, Stange 2009). In the last decade, there has been a shift from hospitals to municipal health care because of an increase in the number of patients with chronic diseases, demographic changes led by a rise in the elderly population and because people want health care services in their own homes. This trend is expected to continue (Tarricone & Tsouros 2008, Genet 2012). In Norway, this development is reinforced by the Care Coordination Reform, which requires municipalities to assume more responsibility for the patients in order to reduce fragmentation and lack of integration (Helse- og omsorgsdepartementet 2009). Because of the increased treatment and care occurring at home it is therefore a need for more efficient, better and closer collaboration and communication between health care providers, which includes home health care services and GPs (ibid).

Communication between health care providers has been emphasised as vital for ensuring safe and effective care (Institute of Medicine Committee on Quality of Health Care in 2001, Tange *et al.* 2003, Leape & Berwick 2005, Kaelber & Bates 2007, Helse- og omsorgsdepartementet 2009) However, ensuring communication between health care providers is generally challenging, and it is particularly difficult in distributed and separated practices, such as home health care services and GPs (Helse- og omsorgsdepartementet 2009). Until recently, the communication methods of nurses providing home health care services and GPs consisted of non-electronic methods, such as telephone calls, faxes, letters, meetings and nurses attending the offices of the GPs. The home health care services and GPs also use different electronic health record[1] (EHR) systems and have separate databases (Gandhi & Lee 2010, Helse- og omsorgsdepartementet 2012a). There is reason to believe that the lack of adequate methods for information exchange and communication could lead to difficulties obtaining patient information and problems making contact with each other when it is necessary to discuss and make decisions about the treatment and care of the patient, as in other divisions of health care services (Bourgeois *et al.* 2010, Hoffmann & Rohe 2010).

[1] The term *electronic health record* is used as an equivalent to *electronic patient record* throughout this thesis.

Studies exploring communication concerning patients who are receiving home health care services have mostly focused on hospitals and municipal health care services in terms of the discharge process and how communication might affect the quality of patient care (Hellesø *et al.* 2005a, Callen *et al.* 2008, Melby L. & Hellesø R. 2008, Paulsen & Grimsmo 2008, Melby & Hellesø 2010, Motamedi *et al.* 2011, Olsen *et al.* 2013a, Olsen *et al.* 2013b, Paulsen *et al.* 2013). Research concerning communication between home health care services and GPs has been scarce. The few studies conducted on communication between home health care services and GPs have revealed that they have difficulties getting in contact with each other and that access to information and communication is absent or is insufficient which could diminish patient safety and the quality of care (Street & Blackford 2001, Fairchild *et al.* 2002, Hofseth & Norvoll 2003, Robinson *et al.* 2009, Neergaard *et al.* 2010, Ruggiano *et al.* 2012, Vaidya *et al.* 2012, Røsstad *et al.* 2013).

Through a number of national strategies and white papers for information and communication technology (ICT) in health care, the Norwegian government set the goal that all patient care should be supported by electronic information exchange and communication (Helse- og omsorgsdepartementet 2008b, 2009, 2012a). The development of electronic communication was originally targeted towards the medical collaboration chain, particularly between hospitals and GPs (Christensen & Grimsmo 2005). Little attention has been given to electronic solutions for information exchange and communication between hospitals and home health care services focused on the nursing care chain (Riksrevisjonen 2008), and almost no consideration has been given to the electronic communication between home health care services and GPs.

A shift occurred in 2005, when the authorities expanded the development, implementation and use of electronic communication to include home health care and nursing homes to secure smooth collaboration in the patient transitions between the different levels of care (Helse- og omsorgsdepartementet 2008b). This expansion included not only electronic communication regarding the transitions between the levels of health care, such as municipality[2] and specialist health care, but also electronic communication between providers within municipality health care, such as home health care providers and GPs. As an extension of this, the Electronic Information Exchange in the Municipalities Project (ELIN-k Project 2005–2011) was initiated (Norsk Sykepleierforbund 2007). The project developed an e-messaging

[2] Municipality health care is used as a term for health care provided by the municipalities. This includes home health care and GP services.

system which was integrated in all the major EHR systems in Norway, thus making it possible to communicate and send information between home health care services, GPs and hospitals. The goal of the project was to increase and improve communication by using the e-messaging system. The system was tested and piloted in six municipalities and 16 GP offices (Norsk Sykepleierforbund 2011) and is now employed in home health care services and by GPs nationwide (Helse- og omsorgsdepartementet 2012a). By September 2014, 386 municipalities (of 428) had implemented the e-messaging system to facilitate communication between home health care services, GPs and hospitals, covering 95% of the Norwegian population. It is the goal of the Norwegian government for the e-messaging system to be implemented throughout the whole health care sector by the end of 2014 (Helse- og omsorgsdepartementet 2012a).

The government expects the implementation of the e-messaging system to help bridge the information and communication gap between home health care services and GPs (Helse- og omsorgsdepartementet 2008b, 2011). However, limited knowledge exists about how e-messaging would affect communication practices and patient safety within these services. As a result, I wanted to investigate how home health care nurses and GPs experienced communication after the e-messaging system was introduced, and gain their perspectives on how the use of e-messaging would affect patient safety in the medication information process. To the best of my knowledge, this is the first study to investigate this topic. The study is a part of the research project *'Bridging the information gap (BIG) in patient transitions in health care',* financed by the Norwegian Research Council. The overall objective of the BIG project is to develop knowledge about intra- and inter-organisational electronic interaction amongst health care providers.

1.1 Organisation of the thesis

The present study is comprised of three sub-studies, which are presented in original papers (I-III). The thesis has eight chapters. In Chapter 2, the overall aim and specific aims for the study are presented. Chapter 3 outlines the context for the study, describes EHR systems and the e-messaging system and elaborates upon the literature and research regarding information and communication in municipal health care services. Chapter 4 presents the theoretical approach of the study, which is the sociotechnical approach. The literature which forms the basis of Chapters 1, 3 and 4 was obtained from searches in the following databases: PubMed/MEDLINE, CINAHL, Scopus and SweMed+. Google Scholar has also been used for literature searches, but not systematically. The MESH terms applied were as follows: home care, home care services, general practitioners, communication, interdisciplinary communication, patient safety and electronic health record. Further, the key-words were: home health care, collaborative care, health information exchange, health information exchange systems, electronic messaging, electronic messages, electronic communication, medication safety, medication list, medication administration, medication information, sociotechnical approach and sociotechnical system theory. The terms were used alone and in various combinations.

Chapter 5 provides an overview of the design and methods used in the study. In addition, because the questionnaire was developed for this study, the development process of the questionnaire is thoroughly described in this chapter. The main results with regard to the study's aims are presented in Chapter 6. In Chapter 7, the results and the strengths and weaknesses of the methods applied are discussed. Finally, the conclusion and implications for practice and future research are presented in Chapter 8.

2 Aim of the study

The overall aim of this study was to explore and describe how home health care nurses and GPs experienced their communication practices when using an e-messaging system. A further goal was to explore how the introduction of an e-messaging system affected patient safety from the perspectives of home health care nurses and GPs. Three specific aims were investigated in three research papers:

1) To describe the experiences of home health care nurses with an e-messaging system and to determine how e-messaging influenced their communication with GPs.

- Paper I surveys and describes the communication procedures, timeliness of communication, non-electronic and electronic communication methods and the volume of contacts of home health care nurses who use e-messaging compared to those who do not.

2) To describe the home health care nurses' assessments of using an e-messaging system in their communication with GPs and to identify which factors predict e-messaging as an efficient tool for communication with GPs.

- Paper II describes the home health care nurses' satisfaction with the use of an e-messaging system, and identifies which individual, organisational and technical factors are important for ensuring that home health care nurses consider an e-messaging system to be an efficient tool for communicating with GPs.

3) To explore how the use of an e-messaging system influences patient safety in the medication information process from the perspective of both nurses in home health care and GPs.

- Paper III explores the home health care nurses' and GPs' assessments of using an e-messaging system in the medication information process and how it influenced patient safety.

3 Background

Home health care services in Norway form the context of this study. In this chapter, home health care and GP services are described for the purpose of giving a background for understanding the characteristics of the two separated services. Thereafter, a short description of the role of the EHR as an information repository is elaborated on as EHR is a prerequisite for home health care and GPs to communicate electronically via the e-messaging system. To gain insight into the e-messaging system, a comprehensive description of the e-messaging system used for communication between home health care nurses and GPs is presented. Finally, information and communication of patient care are elaborated on.

3.1 The study's context

3.1.1 Home health care services in Norway

According to the legislation, every person who resides in a Norwegian municipality has a right to health care services, including home health care (Helse- og omsorgsdepartementet 2010). In Norway, the development of the welfare state from the Second World War to the 1980s led to the rapid growth of municipal health care services. The expansion of home care services managed by the municipalities started in the 1960s (Ytrehus 2013). In Norway, home care services comprise both practical assistance, such as domestic help to clean houses and prepare meals, and home health care services. In the present study, only home health care services are included.

In the period from 1965 to 1980, the number of recipients of home health care services more than tripled from 24,000 to 75,000. This trend continued in the 1980s, but at a reduced pace (Helse- og omsorgsdepartementet 2013). However, when the deinstitutionalisation began in the 1990s, it became a pronounced governmental goal that people should live at home as long as possible. At the same time, major construction projects aiming to provide sheltered housing began (ibid). This type of housing was meant to provide easier access to different kinds of services, such as meal preparation, social activities and health care services. During this period, home health care services were further expanded (Ytrehus 2013). Since 2000, the services have become increasingly concentrated on those with the greatest health care needs (Helse- og omsorgsdepartementet 2013).

In 2011, when the present study was conducted, 134,295 persons were receiving home health care services in Norway (Gabrielsen *et al.* 2012). Figure 1 shows the total number of home health care recipients in 2011, distributed by age group. The figure is based on a report from Statistics Norway (ibid).

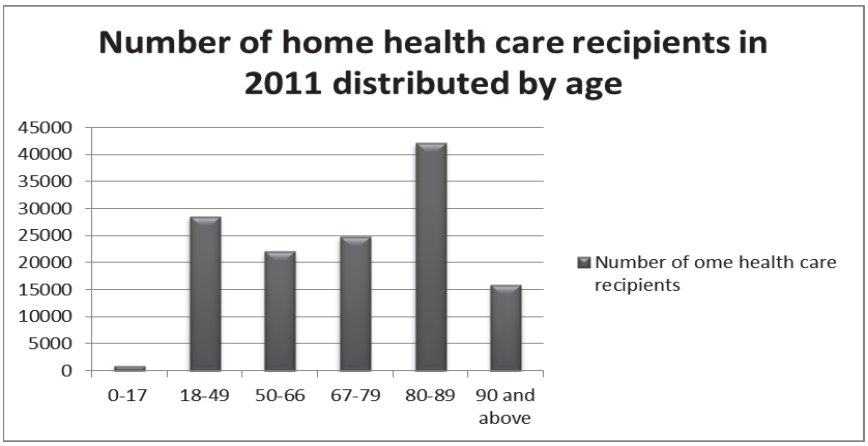


Figure 1 Number of home health care recipients in 2011 distributed by age group

The figure shows that home health care recipients vary in age, although most are 67 years of age and over. Most patients receiving home health care have complex chronic somatic or psychiatric care needs and require long-term, coordinated health care services (Helse- og omsorgsdepartementet 2011).

There were 30,483 nurses providing municipal health care services in Norway in 2011, when the current study was conducted (Norwegian Nurses Organisation 2012). However, this number includes all types of municipal health care services, such as emergency medical departments, nursing homes, refugee health services and home health care services. It has not been possible to determine the exact number of home health care nurses because there are no national statistics which provide this information. Home health care nurses work in an ambulatory setting and visit patients' homes (Hofseth & Norvoll 2003), providing 24/7 service (ECON 2009). The nurses are highly mobile during shifts and are seldom in their offices except during handovers between shifts and when they have breaks. They are responsible for collaborating with other health care providers concerning common patients and for ensuring that GPs receive timely information when they are informed that a patient uses medications prescribed by another physician than the patient's GP (Helse- og omsorgsdepartementet 2008a).

3.1.2 GPs in Norway

Municipalities in Norway are responsible for facilitating medical services to their residents (Helse- og omsorgsdepartementet 2012b). During the 20th century there was an extensive development in GP services. In the 1970s, the Norwegian health authorities and the Norwegian Medical Association agreed that municipality health care should form the foundation of health care. Several measures were introduced, such as improved localities, sharing practices with other GPs and contracts for reimbursements. In the 1980s, the municipalities became responsible for providing medical services (Sandvik 2006). At this time, the recruitment of GPs improved for some years before declining again. In the late 1990s, there was a lack of GPs, particularly in rural areas, and therefore insufficient access to GP services, especially for patients requiring long-term and coordinated health services (ibid). Consequently, the GP scheme was introduced in Norway in 2001. This aimed to improve the quality of general practice by assigning every citizen to one permanent doctor (Helse- og omsorgsdepartementet 2001).

By the end of 2011, when the present study was conducted, there were 4189 GPs in Norway (Helsedirektoratet 2011), most of whom were self-employed and contracted by the municipalities (Helse- og omsorgsdepartementet 2012b). Norwegian GPs meet with patients during office hours (Genet 2012) and providing care to an average of 1200 patients (Helseøkonomiforvaltningen 2011). The mean GP contacts per capita in 2011 distributed by age group are presented in Figure 2. The term 'contact' includes consultations, letters, home visits, interdisciplinary collaboration and administrative contacts.

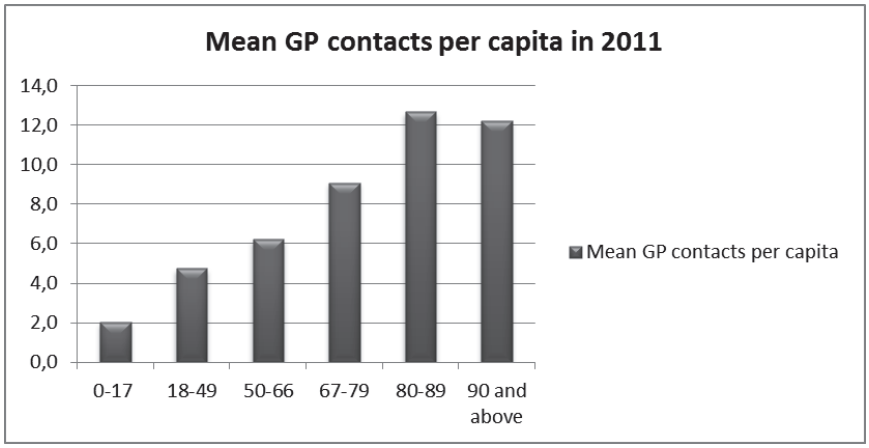


Figure 2 Mean GP contacts per capita in 2011 distributed by age group

The figure is based on data from a report presented by the Norwegian Directorate of Health (Helsedirektoratet 2014). It shows that the potential exists for a high number of contacts between home health care services and GPs, especially on behalf of common patients aged 67 and over.

According to the legislation put in place, municipalities are responsible for facilitating the collaboration of GPs and other health care providers within them (Helse- og omsorgsdepartementet 2012b). The same regulation places demands on GPs to coordinate their patients' medical services and to collaborate with other health care providers in the municipalities and specialist care services. GPs' responsibilities regarding their patients' medication lists and transferring medication information to other health care providers for their joint patients are also specified (ibid). According to a white paper on the Coordination Reform, the regular GP scheme does not work well for patients who face difficulties when seeking medical services on their own, such as frail, elderly people, people with mental illnesses, people with physical impairments and people who suffer from substance abuse (Helse- og omsorgsdepartementet 2009). When patients find it difficult to meet with GPs and are in need of home health care services, it is essential that the home health care services and GPs collaborate closely and that there are systems to provide sufficient access to information and communication between them.

3.2 EHR systems and the e-messaging system

3.2.1 EHR systems as a prerequisite for the e-messaging system

EHR systems provide the basis for information exchange and communication in health care. They are elaborated upon because they represent one of the most important tools in health care work for gathering patient information and communication with other health care providers, and because the e-messaging system is integrated in the EHR-systems.

The EHR is the most common way to collect information about a patient's health care needs. Health care providers gather patient data and produce information which is stored in the patients' EHRs, which are important sources and repositories of patient information. According to Norwegian legislation, an EHR is defined as a collection of recorded or registered information about a patient in connection with health care (Sosial- og helsedepartementet 2002). EHR systems contain individual EHRs and are used to register or

retrieve the information in them, to communicate and exchange information and to aggregate reports and statistics. EHR systems also encompass other systems used in the health care process. These systems are integrated within the EHR systems, and include patient administrative systems, laboratory systems and decisions support systems (Grimsmo & Brosveet 2002). The health information about patients is fragmented because different health care providers use different EHR systems and have separate databases (Marchibroda 2008, Bourgeois *et al.* 2010, Hoffmann & Rohe 2010, Helse- og omsorgsdepartementet 2012a, Unertl *et al.* 2013). While it is technically possible to use the same EHR system, until June 2014, Norwegian legislation did not allow it[3] (Helsedepartementet 2002). In hospitals, the EHR system serves as a communication tool, but in the distributed practices of home health care services and GPs who do not share an EHR system, there is a dependency upon other communication tools (Hoffmann & Rohe 2010, Helse- og omsorgsdepartementet 2012a). Nevertheless, some argue against using a single EHR system to address all the different work processes of these organisations and levels of care (Coiera 2009, Eason *et al.* 2012b). A shared EHR system could lead to information overflow due to an excess of raw data and a lack of processed data (Stead & Lin 2009, Collins *et al.* 2011). Conversely, not having access to other health care providers' EHR systems could lead to information fragmentation and reduced information flow (Unertl *et al.* 2013).

3.2.2 The e-messaging system

In order to enhance the access to information and to make communication between health care providers in Norway possible, an e-messaging system was introduced (Helse- og omsorgsdepartementet 2012a). The system makes it possible to send e-messages containing patient information and to communicate about the patient's treatment and care between different health care settings. The e-messaging system was developed between 2005 and 2011 and was integrated into all EHR systems used by home health care services and GPs (Norsk Sykepleierforbund 2011), meaning that it is a module of EHR systems that can be procured from vendors. Both home health care nurses and GPs participated in the design and development phase of the e-messaging system to ensure strong user involvement and that the system would fit with their work processes (Lyngstad *et al.* 2011). The system was piloted by 6 municipalities and 11 GP offices. In the pilot phase, changes and improvements to the e-

[3] In June 2014, the Norwegian Parliament adopted a new law, the Patient Record Act, which allows the sharing of one national database of patient information. https://stortinget.no/no/Saker-og-publikasjoner/Saker/Sak/?p=59667

messaging system were made according to the users' experiences (Norsk Sykepleierforbund 2011).

The e-messages are sent between home health care services and GPs via a secure and closed national electronic health net specifically assigned to distribute patient information. The health net makes it possible for all health providers in Norway to send and receive patient information, and it includes an address register that provides precise addresses (Norsk Helsenett 2013). The e-messaging system contains a set of standardised e-messages, each message of which has a specific and defined purpose. An overview of the different types of e-messages which are exchanged between home health care nurses and GPs, adapted from Lyngstad et al. (2014), is illustrated in Figure 3.

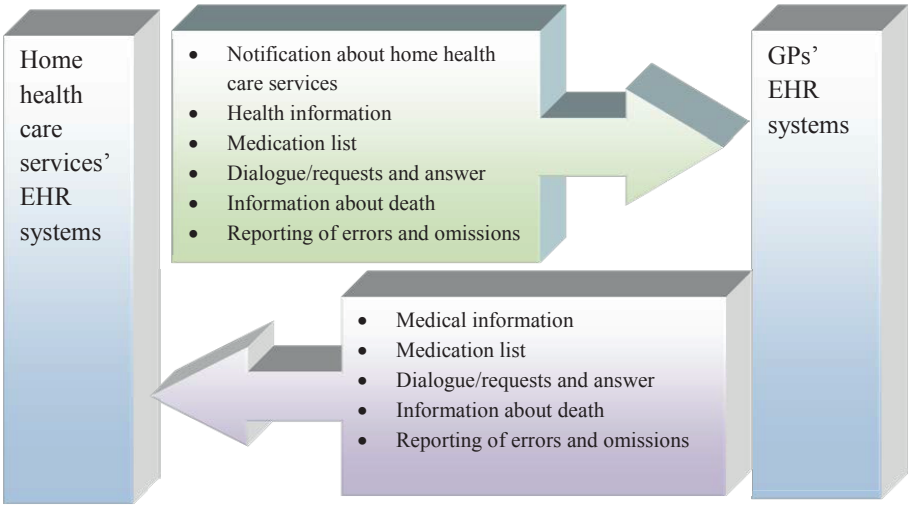


Figure 3 The e-messaging system with e-message types

An example of a standardised e-message is a notification from the home health care services provider to the GP explaining that one of his or her patients has been assigned to home health care services. The notification initiates and enables collaboration between home health care services and GPs when needed. Other e-message types include the following: health and medical information, medication list, a dialogue message designed for requests and discussions about the patients' medical issues and care needs, information about death and reporting of errors and omissions. The e-messages can be either structured or semi-structured. This means that much of the information is reused and automatically extracted from the EHR system into the e-message. The structured e-message types consist only of reused information,

such as the medication list. The semi-structured e-message types consist partly of reused information, but also provide the possibility to write free text (Alsaker 2008). The 'dialogue/requests and answer' message type is an example of a semi-structured e-message in which there is no predefined information except for the sender, the receiver and the patient's identity number, name and address. The rest of the e-message is free text and is generally informal.

Table 1 presents the different standardised e-message types aimed for home health care services to send to GPs, while Table 2 presents the different the e-message types that can be sent from GPs to home health care services. Both tables are adapted from Askevold (2012).

Table 1 E-message types sent from home health care services to GPs

E-message types	**Purpose**	**Degree of standardisation**
Notification about home health care services	1. To inform the GP of new patients and/or new home health care services so that collaboration can begin	Structured. Used to inform.
Health information to the GP	1. When there is a need for a patient evaluation by the GP 2. To inform the GP about changes in patient condition 3. To provide updated information to the GP as an orientation	Semi-structured with free text options. Used to inform and communicate.
Medication list	1. Sent according to the municipalities' routines regarding medication management 2. Answer to a request for medication information 3. When doctors other than the GP make changes regarding medication	Structured. Used to inform.
Dialogue/requests and answer: 1. Provision of health information 2. Updated medication list 3. Prescriptions 4. Doctor's appointment	1. New services, reassessments 2. Medication reconciliation 3. Renewal 4. Need for assessment from GP	Semi-structured with free text options. Used to inform and communicate.
Dialogue/request: other	1. Need for discussion or inquires and requests	Semi-structured with free text options. Used to inform and to communicate.
Information about death	1. Orientation	Structured. Used to inform.
Reporting of errors or omissions regarding patient information	1. Lack of information 2. Other	Semi-structured with free text options. Used to inform and to communicate.

Table 2 E-message types sent from GPs to home health care services

E-message types	Purpose	Degree of standardisation
Medical information	1. New patient receiving home health care services 2. Attachment to the patients' application for home health care services 3. After consultations 4. Continuous contact	Semi-structured with free text options. Used to inform and communicate.
Medication list	1. Changes in medication 2. Medication reconciliation	Structured. Used to inform.
Dialogue/requests and answer: 1. Status assessment 2. Renewal of prescriptions 3. Doctors' appointment	 1. Status updates 2. Answers 3. Answers	Semi-structured with free text options. Used to inform and communicate.
Dialogue/request: other	1. Need for discussion, inquiries and requests	Semi-structured with free text options. Used to inform and communicate.
Information about death	1. Orientation	Structured. Used to inform.
Reporting of errors or omissions regarding patient information	1. Lack of information 2. Other	Semi-structured with free text options. Used to inform and communicate.

One of the EHR systems used by home health care services allows for the electronic transfer of structured medication information without the need to manually input the medication information from the e-messages into the system's medication module. Thus, medication information is transferred directly from the e-message into the EHR system.

To illustrate how an e-message can be used as a dialogue between a home health care nurse and a GP, 3 anonymised e-messages are presented in Figure 4 and 5 (in Norwegian). The first is a 'dialogue/request: other' message which a home health care nurse has sent to a GP. This is a request to confirm the medication list after the home health care nurse has become responsible for administering the patient's medication. The GP has replied, confirming the medication list and adding a medication which was not on the list.

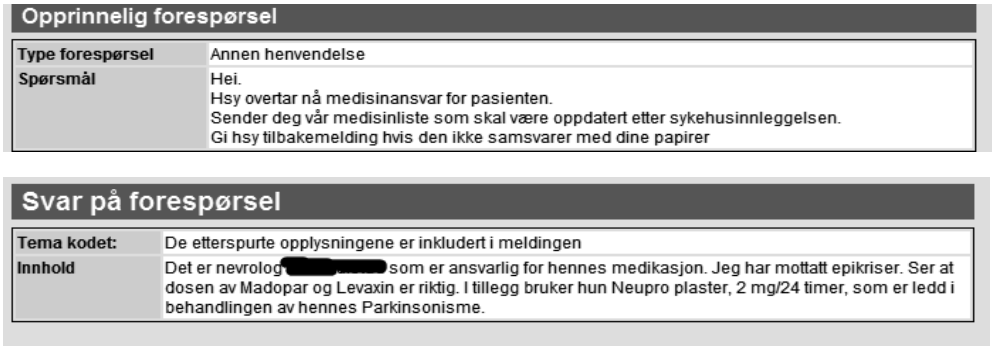
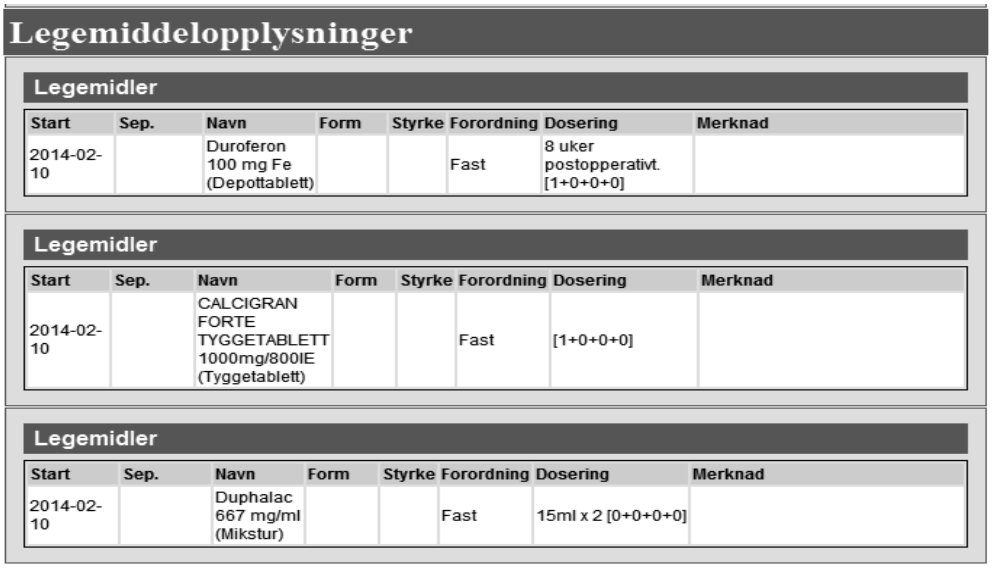


Figure 4 Example of a dialogue message.

The anonymised e-message in Figure 5 (in Norwegian) shows an example of a structured medication message.



Legemiddelopplysninger

Legemidler

Start	Sep.	Navn	Form	Styrke	Forordning	Dosering	Merknad
2014-02-10		Duroferon 100 mg Fe (Depottablett)			Fast	8 uker postopperativt. [1+0+0+0]	

Legemidler

Start	Sep.	Navn	Form	Styrke	Forordning	Dosering	Merknad
2014-02-10		CALCIGRAN FORTE TYGGETABLETT 1000mg/800IE (Tyggetablett)			Fast	[1+0+0+0]	

Legemidler

Start	Sep.	Navn	Form	Styrke	Forordning	Dosering	Merknad
2014-02-10		Duphalac 667 mg/ml (Mikstur)			Fast	15ml x 2 [0+0+0+0]	

Figure 5 Example of a medication message.

All of the e-messages above are presented in a style sheet format, which is in all the different EHR systems used by home health care nurses and GPs.

3.3 Information and communication of patient care

In this section, data, information and knowledge building about patient care through communication will be elaborated on in order to understand why there is a need for ICT systems that supports communication between health care providers. Secondly, the types and methods of communication will be presented because of their diversity and different characteristics. Afterwards, information and communication as an important foundation for patient safety will be elaborated upon. Finally, the adoption of ICT systems in health care will be discussed because this has implication for the efficient use of electronic tools for communication.

3.3.1 Communication as a means for knowledge building of patient care

Communication is a means for data, information and knowledge about patients to emerge and is therefore significant for clinical work and patient outcomes. In the following this is elaborated on.

Within the ICT field data, information and knowledge are central concepts for understanding how ICT can support a work practice (Graves & Corcoran-Perry 1989). In health care, this involves how data, information and knowledge about patients are managed with the assistance of ICT (ibid). The word 'data' originates from Latin and means 'something given' (English 1999). Data are symbols that represent entities or things from the real world, and make up the raw material for information. Meanwhile, information is a collection of elements of data put together in a context. Finally, knowledge is the information interpreted to transfer meaning (Blum 1986, Graves & Corcoran-Perry 1989, English 1999). For example, temperature and heart rate are data, information is that the temperature and heart rate have increased; and knowledge is that the temperature and heart rate have increased and it is likely that the patient has an infection, which requires examination.

In the ICT field, communication focuses upon the transmission of and access to data, information and knowledge (Meinel & Sack 2014). However, communication is also about how the data, information and knowledge emerge. The emergence and process of knowledge building concerning patient care is dependent upon effective communication between health care providers (Kohn *et al.* 2000, Coiera 2003). Understanding the distinctiveness of communication from both an ICT and a health care perspective is helpful for the development of ICT systems to be used in health care in such a way that they fit with the work processes. Communication between health care providers aims to produce the data, information and knowledge necessary to safely provide care to patients. In the present study, this involves communication between home health care nurses and GPs about their common homebound patients.

It is through communication that knowledge about patients and care actions is created and shared (Snyder Halpern *et al.* 2001, Tange *et al.* 2003, Weiner *et al.* 2005, Kenney & Androwich 2009, Nagle 2009, Saario *et al.* 2012). A modified model of the transaction concept from Tange *et al.* (2003), which helps to demonstrate the active communication between health care providers, is presented in Figure 6.

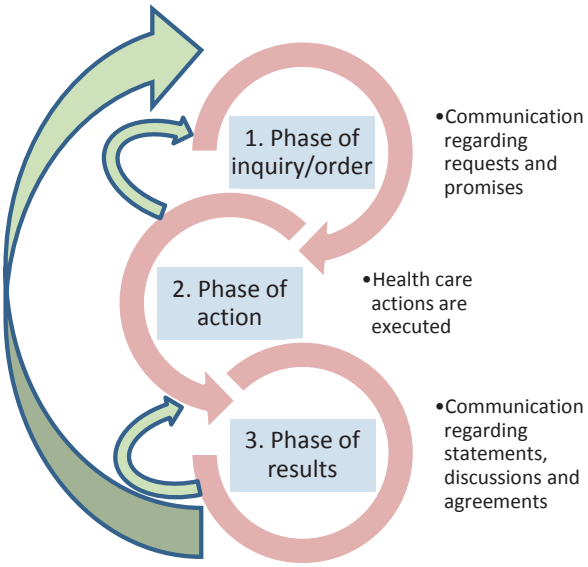


Figure 6 A modified model of the concept of transaction.

The figure illustrates communication through three phases, as follows: the inquiry/order communication, the health care action and the results communication. In the first phase, inquiries, requests and promises regarding health care actions are made. Next, health care actions are executed. In the last phase, the results are discussed and agreed upon. The concept of 'transaction' can be illustrated by one example of communication between a home health care nurse and a GP regarding a patient with congestive heart failure, which is one of the most common conditions suffered by the elderly (Brodtkorb 2008). A home health care nurse contacts the GP about a patient with known congestive heart failure who is experiencing increased shortness of breath and swollen legs. During this first phase, which is the inquiry phase, the GP and the nurse discuss different treatments and decide that the patient should receive an increased diuretic dosage. In the next phase, which is the action phase, the nurse begins the new treatment and observes the effect of the drug for some days. The nurse then reports to the GP that the dosage had only a minor effect, which is the results phase. Because the treatment did not have a sufficient effect, the process continues. The GP and nurse discuss and decide to administer other treatments and interventions, a new health care action is executed and the results are reported to the GP and then the discussion continues. The 'dialogue/request and answer' message can be used in this process. The phases do not necessarily follow a linear progression; instead, they often alternate and shift influenced by the preceding phases throughout the communication process. Thus, clinical work not only encompasses the passive sharing of information but also active communication. This active

communication produces new information and knowledge about the patient which results in changes in the patient's health (Sorrells-Jones & Weaver 1999, Tange *et al.* 2003).

3.3.2 Diversity in the types and methods of communication

Communication which connects the care actions of health care providers has been called the 'biggest information network' in health care (Coiera 2006). Whether or not communication is efficient depends upon a number of factors including the characteristics of the communication methods, the health care providers' knowledge about the patients and the environment and setting in which the health care providers operate (Coiera 2003, Dayton & Henriksen 2007). In order to provide an insight into the ways communication is manifested, the diverse types and methods of communication are presented in this section.

Communication in health care can be formal, informal or a combination of the two. According to Coiera (2002, p. 416), formal communication is 'when a message conforms to a predetermined structure (i.e., is in a predefined form)', while informal communication is 'when the message structure is determined solely by the communicating parties'. Informal communication has also been defined as the 'impromptu, brief and context-rich interaction' which is necessary for efficient communication (Chen *et al.* 2013, p. 308). It is within the informal communication process that discussions about patients' health problems and needs take place. These discussions can include inquiring, requesting, conferring, supporting decisions, tailoring and planning the right treatment and care interventions (Coiera 2000, Hardey *et al.* 2000, Ellingson 2003, Tange *et al.* 2003, Munkvold *et al.* 2006, Kuziemsky & Varpio 2010, Chen *et al.* 2013).

A variety of methods are used for communication between health care providers, each with different characteristics and consequences (Street & Blackford 2001, Alvarez & Coiera 2006, Brown *et al.* 2009, Allen *et al.* 2012, Gaskin *et al.* 2012). Informal methods include personalised notes, unplanned meetings and telephone calls, while formal ones include planned meetings, charts, standardised forms, letters, notes and summaries, electronic mail and EHRs (Hardey *et al.* 2000, Hellesø *et al.* 2005a, Munkvold *et al.* 2006, Brown *et al.* 2009). Studies have shown that health care providers prefer oral and face-to-face communication over ICT systems, especially in hospitals (Coiera & Tombs 1998, Hardey *et al.* 2000, Parker & Coiera 2000, Dayton & Henriksen 2007, Brown *et al.* 2009, Benham-Hutchins & Effken 2010, Belling *et al.* 2011, Marshall *et al.* 2011). In terms of home health

care, nurses and GPs have reported problems regarding oral and face-to-face communication due to their separation in time and space (Street & Blackford 2001, Fairchild *et al.* 2002, Robinson *et al.* 2009, Neergaard *et al.* 2010, Ruggiano *et al.* 2012, Vaidya *et al.* 2012, Røsstad *et al.* 2013).

The communication methods used are either synchronous or asynchronous (Coiera 2003). Synchronous methods depend upon the participants being available at the same time, though they do not have to be in the same place. These methods have been characterised as interruptive and could lead to cognitive strain, causing inefficient work performance (Parker & Coiera 2000, Edwards *et al.* 2009). In one study on inter-professional electronic documents and child health in England and Finland, the need for synchronous and face-to-face communication channels was emphasised because of their significance for professional knowledge transactions across organisational and professional boundaries (Saario *et al.* 2012). In another study focused on developing a model for EHR interdisciplinary communication in an intensive care unit, the participating health care providers reported that EHR retrieval and information seeking was inefficient compared to oral communication or paper-based notes (Collins *et al.* 2011). However, synchronous and oral communication are often criticised because of their fluidity, which could result in a loss of information, and their lack of transparency (Coiera 2003). On the other hand, synchronous and face-to-face communication methods provide instantaneous responses and allow participants to capture nuances and minimise misunderstandings, which is not possible with asynchronous communication methods. Conversely, asynchronous methods do not depend upon participants being available at the same time, nor do they have to be in the same place. Therefore, if the patient's situation is not urgent, asynchronous methods could be preferable (Coiera 2006). The e-messaging system in the current study represents an asynchronous method of communication.

3.3.3 Information and communication for ensuring patient safety

Patient safety is emphasised in connection with communication because the objective of communication between health care providers is to provide patients with safe and effective health care. Studies on patient safety and communication have generally been conducted in hospital settings (Gandhi & Lee 2010).

Patient safety has been defined as 'freedom of accidental injury' (Kohn *et al.* 2000) or the 'absence of adverse events' (Hoffmann & Rohe 2010). Adverse events are described as

injuries due to treatment and care – a lack of treatment and care – which take place in a health care setting and are not caused by an underlying illness (Hoffmann & Rohe 2010). While exact numbers are not available in Norway, within the hospital sector it has been estimated that adverse events occur during approximately 16% of all hospitals stays (Deilkås 2013). A large proportion of health care is delivered outside of hospitals through home health care, and there is reason to believe that adverse events and errors are also a major challenge in those settings (Sears *et al.* 2013), although information about these phenomena is limited (Absulem & Hardin 2011).

One of the most common causes of adverse events and errors reported in hospitals is a lack or failure of communication between health care providers (Kohn *et al.* 2000, Leape & Berwick 2005, Kaelber & Bates 2007). This lack or failure is also documented as a problem between home health care providers and GPs. Some explanations which have been suggested are an absence of documentation, an absence of formal communication structures and system-related problems (Jensen *et al.* 2003, Grimsmo 2006, Bakken *et al.* 2007). In the few studies regarding municipality health care, medication safety is probably the most investigated subject (Kaelber & Bates 2007, Gandhi & Lee 2010, Øvretveit 2011, Mangoni 2012). Older home health care patients are particularly vulnerable to medication errors. One study showed that almost a third of the home health care patients of two urban home health care agencies in the United States were subjected to medication errors (Meredith *et al.* 2001). In a study on the perceived care errors of home health care nurses, medication errors represented the highest proportion (40 %) of error (Absulem & Hardin 2011).

Errors in prescribing and administering medication have been shown to threaten patient safety (Kohn *et al.* 2000, Kaelber & Bates 2007, Tulner *et al.* 2009). In Norway, several studies have described differences in the medication lists of home health care providers and GPs, as well as omissions and errors within medication information processes (Jensen *et al.* 2003, Rognstad & Straand 2004, Grimsmo 2006, Wekre *et al.* 2010, Remen & Grimsmo 2011). There are several reasons for inconsistencies in medication records in home health care and GPS: errors in or incomplete discharge summaries from hospitals, intermediate care or nursing homes or other health care providers that fail to communicate changes in medication.

Errors in or incomplete discharge summaries received from hospitals, intermediate care or nursing homes or other health care providers that fail in communicating changes in medication are some of the reasons which are causing inconsistencies in the medication records of home care health care and GPs (Foust *et al.* 2012, Mangoni 2012). Further, the manual transfer of medication information from one health care provider's EHR system to another has also been shown to lead to errors (Callen *et al.* 2010).

Updating patient information, improving documentation and communication and developing better models for communication in municipality health care are among the suggestions for reducing medication errors and providing safe and efficient care (Absulem & Hardin 2011, Allen *et al.* 2012). There are high expectations that ICT could increase patient safety (Kohn *et al.* 2000, Aspden *et al.* 2005), but the evidence for this notion is contradictory (Vincent 2010, Institute of Medicine 2012). Some studies concerning medication safety have revealed that EHR systems and computer order entry systems have positive effects on patient safety. For instance, studies have shown that errors and unintended events caused by deficiencies in the exchange of medication information and problems in medication administration because of discrepancies and insufficient medication information have been reduced by implementing ICT systems targeted to support these tasks (Cortelyou-Ward *et al.* , Van De Castle *et al.* 2004, Or *et al.* 2009). In addition, a pilot study of electronic communication between home health care and GPs, indicated that treatment was started three days earlier compared to traditional practice where the phone was the main form of communication (Lotherington & Bakkevoll 2006). Another study showed that the implementation of a shared electronic summary resulted in a slight reduction in medication errors; otherwise, there was no evidence for increased patient safety (Greenhalgh *et al.* 2010). In contrast, other studies have shown negative results (Ash *et al.* 2004, Black *et al.* 2011, Institute of Medicine 2012). A systematic overview of 108 systematic reviews conducted between 1997 and 2010 revealed that there is a lack of evidence supporting the hypothesis that ICT enhances patient safety (Black *et al.* 2011). One study even showed that the patient mortality rate increased after the implementation of a computerised order entry system in a paediatric hospital (Han *et al.* 2005). Therefore, from the research results it is not possible to conclude whether information technology leads to increased patient safety. In the current study patient safety is investigated from perspective of home health care nurses' experiences with using e-messages in the medication information process.

3.3.4 Adoption of ICT systems in health care

In this section, the factors which promote or impede the adoption of ICT systems are elaborated upon in order to elucidate the reasons for success or failure when it comes to implementing ICT systems in health care.

The development and implementation of ICT is viewed as the solution to problems regarding access to information and communication in health care (Kohn *et al.* 2000, Marchibroda 2008, Helse- og omsorgsdepartementet 2009)). In previous studies, several technical solutions were suggested that could support communication. For instance, in one study, the majority of physicians (80%) and home care clinicians (90%) expressed that a common EHR and using secure e-mail would improve access to information and communication (Fairchild et al. 2002). The results of another study showed that health care professionals viewed the possibility of sharing EHR systems and databases as beneficial (Price and Lau 2013). In addition, the simple intervention of using structured electronic notes is expected to support communication (Bricon-Souf et al. 2007). A health information exchange (HIE) system is another tool that is believed to be useful. This is described as access to servers which could be integrated with the health care providers' EHR systems (but not sharing the EHR systems), and which implies the retrieval of information from a centralised database (Kuperman 2011).

The use of electronic tools for supporting communication in patient transitions and across health care organisations, however, is reportedly uncommon, and the adoption of health information technology has not progressed with the desired speed (Rudin *et al.* 2009, Greenhalgh *et al.* 2010, Karsh *et al.* 2010, Wachter 2010, Samal *et al.* 2013). The explanations for the slow uptake of ICT systems in health care are manifold. For instance, several studies have demonstrated that health care providers are dissatisfied with ICT systems and view them as inefficient, inflexible and incompatible with their work processes (Viitanen et al. 2011, Huryk 2010, Gagnon et al. 2012, Ash et al. 2004). The reasons for this are multifaceted and include the fact that there may be a lack of training and preparation prior to the implementation of the systems, resulting in less than optimal use or incompletely employed systems (Ludwick and Doucette 2009, Greenhalgh et al. 2010, Terry et al. 2009, Simon et al. 2013). Moreover, technical factors such as ease of use, design and functionality which fits with the work processes, access to adequate infrastructure and user support have been shown to be important for the adoption of ICT systems (Yoo et al. 2013, Viitanen et al. 2011, Gagnon et al. 2012, Huryk 2010, McGinn et al. 2011, Coiera et al. 2012, Institute of

Medicine 2012, Fontaine et al. 2010, Vedel et al. 2012, Lammintakanen et al. 2010, Ash et al. 2004). Health care providers' perceptions of the benefits of using the ICT system could affect the success of ICT implementation. (Berg 1999, Karsh et al. 2009, Ward et al. 2008, Ash et al. 2004). While nurses' attitudes towards ICT systems are mostly positive (Kaya 2011, Ward et al. 2008, Dillon et al. 2005), failure to address the above-mentioned issues could affect users' acceptance and assessments of the ICT systems' efficiency, which could amplify the trend of slow uptake (Ward et al. 2008).

4 An analytical approach to studying communication in health care

A sociotechnical approach was considered especially appropriate for exploring and describing how home health care nurses and GPs experienced their communication practices and how the communication practices affected patient safety after the introduction of an e-messaging system. This approach is appropriate for this thesis because it addresses the collaborating work processes between different health care providers rather than individual tasks (Berg 1999).

In today's research on information technology in health care, the sociotechnical approach is one of the most prevalent perspectives. This approach has arisen as a counter to the technologically deterministic view of developing and implementing information technology (Robey & Boudreau 1999). According to a technologically deterministic understanding of information systems, information technology must be in the foreground. An example of a deterministic research question is as follows: Will the information technology increase or decrease the quality of health care? The scope of the technologically deterministic approach is the way in which information technology brings about changes in organisations and work systems (ibid). It does not take into consideration how the technical system interacts with social systems such as organisations and individuals or how this affects the outcome of the implementation and use of the information system (Ash *et al.* 2004, Lee 2004).

The sociotechnical system approach emerged from the Tavistock Institute of Human Relations in London around 1950. It was a result of Trist and Bamforth's studies on the working conditions in the British coal industry, which featured low productivity, high production costs, high absenteeism among employees and numerous union conflicts (Fox 1995). These researchers' studies showed that the impact of technology on the physical and social work environment had mostly been overlooked and that this had to be taken into consideration in order to understand the problems which arose. They also emphasised that employees should work in groups, have shifting roles and have a high degree of autonomy and self-management. It was predicted that consideration of the whole work system when implementing technology combined with a more autonomous work practice would lead to better working conditions and higher productivity (Trist & Bamforth 1951).

In health care services, the sociotechnical approach has been directed at understanding how ICT systems are designed and developed and how they become part of a work system (Fox 1995, Berg *et al.* 2003). This means that an ICT system is a part of the sociotechnical system, which includes the organisation, people and technology. The organisation and the people within it, which together constitute the social aspect, are tightly intertwined with the technology; thus, these should not be viewed as different parts, but rather as a whole. This 'interdependency' between the technology and the people in a work system lies at the core of the sociotechnical approach. The technology affects the people and the people affect the technology (Eason 2014, Klein 2014). In the present study, the organisations are the home health care services and GP services, the people are the home health care nurses and GPs, and the technology is the e-messaging system.

The sociotechnical approach implies that the elements of the technical and social systems are linked together in a heterogeneous network and interact to shape the work practices and outcomes for patients, health care providers and organisations (Berg 1999). According to the sociotechnical approach, the integration of people, organisations and technology could consists of several networks which constitute the work system (Berg 1999, Eason 2014). Changes to the network or to one part of the network would lead to alterations in the whole system, not only the part which was initially changed. This approach has been fruitful for designing and studying information systems which have been put into practice and used in health care services (Berg 1999).

A sociotechnical work system is not a fixed and closed system. Rather, it evolves over time and changes according to the system's elements and different contexts and situations (Ludwick & Doucette 2009, Holden *et al.* 2013, Carayon *et al.* 2014). Klein (2014) has described the technology as both an independent and a dependent variable which affects roles, competencies, tasks, values, relations and the whole work system, and vice versa. This implies that an ICT system cannot be isolated and function on its own, but is rather shaped, constrained and reshaped by the people and organisations in the social environments and contexts in which it is used. Further, the technical system contributes to the shaping, constraining and reshaping of the organisations and people (Berg *et al.* 2003, Greenhalgh & Stones 2010). The interaction of the social and technical elements determines whether the implementation of ICT systems are successful or not (Ludwick & Doucette 2009).

The boundaries of the sociotechnical work system are not necessarily limited to one organisation (Eason 2014); in today's more complex work environment, collaboration across organisations is increasingly common. In health care services, there are several health care providers and organisations involved in patient care. There is a demand for collaboration across organisations, especially in patient transitions between the hospital and municipality health care, as well as within municipality health care between home health care services and GPs (Helse- og omsorgsdepartementet 2009). These providers or organisations constitute an extended work system and should be viewed as an open system which is influenced by external factors. An illustration of the sociotechnical work system is shown in Figure 7.

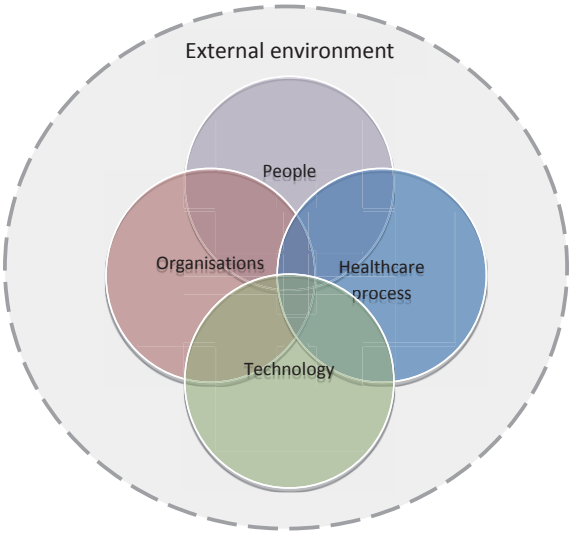


Figure 7 A modified model of a sociotechnical work system in health care.

This model has been modified from the sociotechnical view of ICT-assisted health care presented by the Institute of Medicine (2012, p. 62). This modified model is also inspired by the idea that the sociotechnical work system could exceed organisational boundaries and therefore include several organisations (Eason 2014). The model consists of several elements, such as organisations, individuals, technology and health care process. The organisational element refers to the way in which organisations implement the information technology in terms of training, procedures and user support and how the information technology is configured. The people are the health care providers and patients within the organisations. In the present study, health care providers, specifically home health care nurses and GPs, are included while patients are not. The technology comprises the software and hardware used

within the work system. Here the software represents the e-messaging system and the EHR systems in which the e-messaging system is integrated, while the hardware represents the computers, servers and broadband, among other things. The health care process consists of health care actions, such as planning, treating, caring and collaborating. The work system constitutes all of the previously mentioned elements, which are linked, and extends beyond organisational borders, which in this case refer to the home health care services and the GPs. The work system functions in the external environment and is affected by the regulations and requirements of the authorities (e.g., the technical standards for the e-messaging system). The broken line of the external environment illustrates that it is an open system.

There has often been debate on the best and most efficient way of developing and putting technology into practice. Both formal, top-down organisational decisions and bottom-up initiatives with informal decisions made by dialogues with colleagues and peers have been advocated (Robert *et al.* 2010). From a sociotechnical perspective it has been argued that a bottom-up process should be employed in the development and implementation of technology to gain a better and more comprehensive understanding of the work practices (Berg *et al.* 1998, Berg 1999). A combination of the top-down and bottom-up processes could be beneficial, focusing on both managerial goals and the users' needs.

The development and implementation of ICT systems in health care has not always been successful (Greenhalgh *et al.* 2010, Mair *et al.* 2012). The sociotechnical approach stresses an active and strong involvement by the people who will use the ICT system in an iterative development and implementation process. This will ensure that the technology fits the work processes and that the work processes fit the individual and organisational needs, ultimately resulting in change in the work system (Kensing & Blomberg 1998, Berg 1999, Berg *et al.* 2003, Ash *et al.* 2004, Christensen & Grimsmo 2005, Obstfelder *et al.* 2007, Laramee *et al.* 2012). The e-messaging system in the present study was developed and implemented with strong user involvement throughout the whole process (Lyngstad *et al.* 2011), which is in accordance with the sociotechnical approach.

The sociotechnical approach has been widely applied to patient safety and ICT research (Huckvale *et al.* 2010, Institute of Medicine 2012). The implementation and integration of information technology could allow several work system elements to come into play, thereby improving – or in some cases worsening – the outcomes for patients, healthcare providers and/or organisations (Holden *et al.* 2011). Often, the ICT system is blamed when errors and

adverse events occur, but the real cause could be the way in which the ICT system was used, insufficient training or a lack of sufficient material resources. Therefore, in order to understand the outcome it is necessary to investigate the whole work system, not just a single element of it (Institute of Medicine 2012).

The sociotechnical approach as presented here has been applied as a backdrop throughout the study, from the design of the study to the development of the instruments, and when analysing and discussing the results.

5 Design and methods

An exploratory and descriptive research design was applied in the present study. This approach is useful when there have been limited discussions about a problem area and when there is little control over the variables (Brink & Wood 1998). The purpose of such an approach is to observe, describe and document the aspects of a situation or process as it naturally appears, thereby possibly forming the basis for the theoretical development and generation of hypotheses for further research (Brink & Wood 1998). As presented above, he consequences of using a newly implemented e-messaging system as a tool for communication between home health care nurses and GPs have not been studied previously. In fact, few studies even describe the communication setting between home health care nurses and GPs when an e-messaging system is used. An exploratory and descriptive research design has therefore been valuable for gaining knowledge about this topic.

For the purpose of investigating the specific aims of this thesis, both quantitative and qualitative approaches were chosen. A self-developed questionnaire, focus group interviews and semi-structured interviews were applied. The combination of focus group interviews and individual interviews could provide a comprehensive and rich data capture (Morgan 1996, Lambert & Loiselle 2008), which was also the case in this study. When planning for the current study, we intended to survey both home health care nurses and GPs about their experiences using all the data collection methods. However, due to a GP response rate on 33 % from the questionnaire, we chose to include only the findings from the GPs obtained from the interviews and not those obtained from the questionnaire. Nevertheless, we still obtained useful information from the interviews of the GPs. Table 3 gives an overview of the specific aims and methods of the study.

Table 3 Overview of the methods used in the study

Sub-study	Aim	Methods
I	To describe the experiences of home health care nurses with an e-messaging system and to determine how e-messaging influenced their communication with GPs.	Questionnaire
II	To describe the home health care nurses' assessments of using an e-messaging system in their communication with GPs and to identify which factors predict e-messaging as an efficient tool for communication with GPs.	Questionnaire
III	To explore how the use of an e-messaging system influences patient safety in the medication information process from the perspective of both nurses in home health care and GPs.	Focus group interviews and semi-structured interviews

5.1 Setting

All municipalities in Norway which had used the e-messaging system for communication between home health care services and GPs for more than six months as of October 2011 were invited to participate. These municipalities were chosen because we presumed that the system was stable and any initial technical operational problems were reduced or eliminated. At the time the study began, 13 municipalities, hereafter called the e-messaging group (EG), had used the e-messaging system for six months or more. In the EG, two municipalities had fewer than 5000 inhabitants, three had between 5001 and 15,000 inhabitants, seven had between 15,001 and 100,000 inhabitants and two municipalities had more than 100,000 inhabitants.

For the purpose of comparison, 17 municipalities, hereafter called the comparison group (CG), were randomly selected from municipalities with approximately the same number of inhabitants as the EG. Two municipalities in the CG had fewer than 5000 inhabitants, three municipalities had between 5001 and 15,000 inhabitants, 11 municipalities had between 15,001 and 100,000 inhabitants and one municipality had more than 100,000 inhabitants. To avoid research weariness, the municipalities in both the EG and the CG were not participating in similar research or developmental projects (Gillham 2000).

Of the 30 municipalities which agreed to participate in the study, one withdrew from the CG before the study was started, and one in the EG was excluded because the nurses had not used e-messaging for a sufficient period of time. Thus, in total, 28 municipalities were included in the study. In the EG, three were situated in North Norway, one in Mid-Norway, three were in West Norway and six were in Southeast Norway. These were the only municipalities which met all of the inclusion criteria. In the CG, three municipalities were situated in Mid-Norway, six were in West Norway and eight were in Southeast Norway. In the CG, no municipalities were situated in North Norway because all of the North Norwegian municipalities were either already involved in a large implementation project or had not used the e-messaging system long enough.

Two of the EG municipalities were also invited to participate in a qualitative sub-study (sub-study III). In order to secure maximum variation, one was a large city and one was small (Patton 2002).

5.2 Sample

The inclusion criteria for the home health care nurses in the study were as follows: employment in a half time position or more, employment for more than three months and the ability to read and write in Norwegian. The nurses who participated in the EG in the questionnaire sub-studies and the interview sub-study also had to have at least three months' experience using e-messaging. Table 4 presents an overview of the samples in the sub-studies.

Table 4 Overview of the samples in the study

Sub-study	Method	Study setting	Sample
Sub-study I, Quantitative	Questionnaire	12 e-messaging municipalities 16 comparison municipalities	425 home health care nurses 364 home health care nurses
Sub-study II, Quantitative	Questionnaire	12 e-messaging municipalities	425 home health care nurses
Sub-study III, Qualitative	3 focus group interviews 15 semi-structured interviews	2 e-messaging municipalities	23 home health care nurses 11 GPs

The samples are presented in more detail in the following sub-chapters.

The samples in sub-studies I and II

One EG municipality was excluded because the home health care nurses had not used the e-messaging system for the required three months, and one CG municipality withdrew just before the study began. The EG comprised 12 municipalities, while the CG included 16. Figure 8 presents the sample of home health care nurses in the two groups. Of the 632 home health care nurses in the EG, 359 returned the questionnaire in the ordinary data collection. After a reminder, 66 additional nurses returned the questionnaire. In the CG, 326 home health care nurses returned the questionnaire in the first round, and an additional 38 nurses returned it after being reminded.

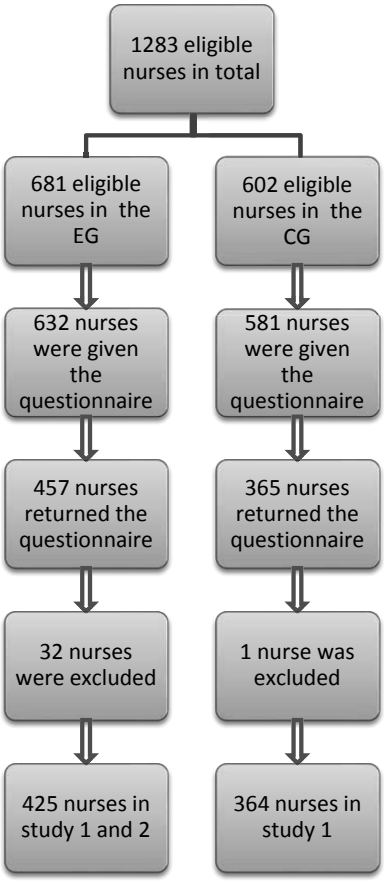


Figure 8 Overview of the samples in studies I and II.

In sub-studies I and II, 33 home health care nurses were excluded from the EG. In sub-study I, in addition to the nurses excluded from the EG, one home health care nurse from the CG was also excluded. The nurses were excluded from the EG if they had not used the e-messaging system long enough, and several nurses were excluded from both the EG and CG because they were employed in a position which was less than half-time.

The sample in sub-study III

In sub-study III, a purposive sampling of the two municipalities which had been using the e-messaging system for the longest time was applied to recruit both home health care nurses and GPs for the focus group interviews and semi-structured interviews. Table 5 shows an overview of the participants in sub-study III.

Table 5 Participants in focus group interviews and semi-structured interviews

Interviews	**Focus group interviews (N = 3)**		**Semi-structured interviews (N = 15)**		**Total**
Municipality	Municipality A	Municipality B	Municipality A	Municipality B	
GPs	4	2	3	2	11
Nurses	3	3	8	9	23
Total	7	5	11	11	34

5.3 Instruments and data collection procedure

5.3.1 Instruments

Interview guides

Focus group interviews and semi-structured interviews were used both to develop the questionnaire and to explore how the use of an e-messaging system influences patient safety in the medication information process from the perspectives of both nurses in home health care and GPs. In the present study, two interview guides were developed, one for the focus group interviews and one for the semi-structured interviews. The focus group interview guide concentrated on the following: 1) the implementation of the e-messaging system, 2) experience with using the e-messaging system, 3) home health care nurses' and GPs' general assessment of their communication and collaboration via the e-messaging system and 4) how they assessed the information content of the e-messages.

The interview guide for the semi-structured interviews included more detailed questions regarding the implementation of the messaging system, the use of the messaging system and communication and collaboration in general (Table 6).

Table 6 Interview guide for the semi-structured interviews

Themes	Questions
Implementation of the e-messaging system	1. How were you informed of the implementation of the e-messaging system? 2. What did you think about the implementation of the e-messaging system? What were your expectations? 3. What kind of ICT systems do you use? 4. How did you receive training in the use of the e-messaging system? 5. How have the employees been involved in the implementation of the e-messages? 6. Have you implemented new routines as a consequence of the implementation of the e-messaging system?
The e-messaging system	1. Which message types do you use? 2. How hard is it to organise and get time to write e-messages during a shift? 3. How often do you write e-messages? 4. How often do you receive e-messages? 5. Have there been any unanticipated experiences related to using the e-messaging system? 6. What are the most important experiences you have with the e-messaging system? 7. Is communication and information exchange different now, compared to before the e-messaging system was implemented? How is it different?
Communication and collaboration in general	1. With whom do you collaborate regarding patients? 2. How do you collaborate? 3. Who initiates the contact? 4. What kind of information is exchanged? 5. How do you give information? 6. How do you receive information? 7. Do you think that you have enough information most of the time to provide safe and proper health care? 8. If you do not have enough information, what do you do? What are the consequences? 9. Do you have written routines for information exchange? What are they like?
Conclusion	1. What do you think about the implementation of electronic tools for collaboration in the health care sector? 2. Which improvements would you like to see? Is there something that should have been done different regarding collaboration with your collaborators?

The questionnaire

A questionnaire can be used to describe a population in a standardised way, to compare group differences and to make inferences (Sapsford 2007). The questionnaire used in this study was developed through the process presented in Table 7, which builds upon the recommendations of Converse and Presser (1986), Haraldsen (1999), Lund *et al.* (2006), Sapsford (2007), Fowler (2009), Groves (2009) and Polit and Beck (2008).

Table 7 Development process of the questionnaire

Step	Description
1	Review of literature, previous research, recommended guidelines for the use of e-messaging, and the e-messaging standard
2	Focus groups and semi-structured interviews with home health care nurses and GPs
3	Drafting the first version
4	Review by the expert group using a relevance and measurement index
5	Revision of the first version
6	Pilot testing
7	Revision and final version

In the following sections, the process trhough which the questionnaire was developed will be presented in more detail.

Drafting the first version

Relevant published questionnaires which explored communication using e-messaging between home health care nurses and GPs were searched for in the following databases: CINAHL, PubMed, Scopus and HAPI. The search words used were as follows: information practice, information gap, communication, electronic health information exchange, electronic messaging, quality, patient safety, electronic information exchange, electronic communication and home health care and GPs. The search words were used alone and in combination. No questionnaires which could be used in their original form were identified. However, four questionnaires developed for exploring adjacent research questions in a different context were identified (Lærum 2004, Hellesø 2005, Paulsen & Grimsmo 2008, Christensen 2009). The first version of the questionnaire was developed based on the focus group interviews, the semi-structured interviews, previous studies (Lærum 2004, Hellesø 2005, Paulsen & Grimsmo 2008, Christensen 2009), recommended guidelines for the use of e-messages in health and care services in the municipalities (Skarsgaard & Askevold 2011) and the e-messaging system standard (Alsaker 2008). The first version of the questionnaire contained six sections and 71 items with closed-ended response alternatives. These sections are presented in Table 8.

Table 8 Overview of the questionnaire content with references

Section	Themes	Sources
1	Demographics	
2	Non-electronic communication a) Communication procedures b) Number of various non-electronic contacts c) Timely communication	Rotvold (2002), Hellesø *et al.* (2005a), Kvaerner *et al.* (2005), Halbesleben *et al.* (2008), Paulsen and Grimsmo (2008), Hellesø and Fagermoen (2010), Rahmner *et al.* (2010), Weiner *et al.* (2005), Street and Blackford (2001), Fairchild *et al.* (2002), Brown *et al.* (2009), Skarsgaard and Askevold (2011)
3	Information content	Hellesø (2005), Lammintakanen *et al.* (2010), Alsaker (2008)
4	Expectations for electronic communication and quality and patient safety	Kohn *et al.* (2000), (Ash *et al.* 2004), Van De Castle *et al.* (2004), Leape and Berwick (2005), Kaelber and Bates (2007), Kalseth and Paulsen (2008), Stock *et al.* (2008), Callen *et al.* (2010), Vincent (2010)
5	Electronic communication in general	Anthony and Preuss (2002), Han *et al.* (2005), Leape and Berwick (2005), Grimsmo (2006), Wentzer and Bygholm (2007), Melby L. and Hellesø R. (2008), Lammintakanen *et al.* (2010), Melby and Hellesø (2010)
6	Use of e-messaging	(Ash *et al.* 2004), Melby L. and Hellesø R. (2008), Huryk (2010), Melby and Hellesø (2010)

Expert group

In the present study, the expert group comprised six nurses who were strategically selected because of their mixture of skills, clinical experience, experience using the e-messaging system and research knowledge. The members were given written information about the study and asked closed- and open-ended questions about the items' relevance, measurability, sequence, comprehensibility, whether there were redundant or missing items and whether the response alternatives were suitable. They were also encouraged to elaborate upon their answers and suggest alternative items.

Revision of the first version

The first version of the questionnaire was revised according to the expert group members' responses. Four items were rephrased, two response alternatives were added, three items were removed and five new items were added. The second version had six sections and 73 items.

Pilot testing

To ensure internal validity and reliability, the revised questionnaire was pilot tested (Haraldsen 1999, Czaja & Blair 2005, Polit & Beck 2012). The Centre for the Development of Home Health Care Services in Oslo recruited 15 home health care nurses who had used e-messaging for more than three months. This municipality did not participate in the actual study. After the pilot test, 12 items were removed because of overlap or redundancy. One new item was added, and two items were rephrased.

Final version

The final questionnaire consisted of six sections which covered 62 items (Table 9). The nurses could respond on a 5-point scale in the following manner: (1) strongly disagree, (2) disagree, (3) neither agree nor disagree, (4) agree and (5) strongly agree. Three items could be scored as follows: (1) always, (2) often, (3) sometimes, (4) seldom and (5) never.

Table 9 The final questionnaire with number of items per section

Section	Themes	Number of items
1	Demographics	8
2	Non-electronic communication	19
3	Information content	12
4	Expectations for electronic communication and quality and patient safety	10
5	Electronic communication in general	3
6	Use of e-messaging	10

The results from Section 2 of the questionnaire are presented in Paper I (Lyngstad *et al.* 2013). The results from Section 3 will be presented in a future publication. The results from

Section 4 are presented in a peer-reviewed conference paper (Lyngstad & Helleso 2014). Finally, the results from Sections 5 and 6 are presented in Paper II (submitted).

5.3.2 Data collection

The data collection was conducted in two phases. The interview data were collected in the first phase, while the questionnaire data were collected in the second phase.

The invitation for participation in the studies was sent to the chief administrative officer of each municipality. All of the municipalities gave their permission before the study began.

The interviews took place between May and August 2011.The home health care nurses and GPs who participated in the focus group interviews and semi-structured interviews were recruited by the contact persons in the municipalities. It was decided that focus group interviews should be led by a moderator and an assistant moderator to keep the conversation within the scope of the topic (Krueger & Casey 2009). In this study, the interviews were led by another researcher involved in the project, and I was the assistant moderator. In focus groups, interactions between participants generate new ideas and reflections upon the topics that are discussed (Morgan 1993, Morgan 1996, Green & Thorogood 2009, Krueger & Casey 2009). Our focus group interviews were characterised by an open and free discussion of the topic; all of the group members were able to express their thoughts and experiences regarding e-messaging in all focus group interviews.

The semi-structured interviews were characterised by open conversation, and many follow-up questions were asked. The topics were steered by two interviewers using the interview guide. The responses from the home health care nurses and GPs and the dynamics that arose determined which information emerged (Green & Thorogood 2009).

All interviews were conducted at the home health care nurses' and GPs' workplaces. The focus group interviews lasted from 85 to 100 minutes, whereas the individual interviews lasted from 30 to 45 minutes. All of the interviews were taped and then transcribed verbatim by a research assistant and me.

The collection of the questionnaire data took place from late November 2011 to February 2012. The data collection was conducted by a contact person designated by the management in each municipality. The paper questionnaires were sent to the municipalities with an

information letter and a form on which the contact persons were to report the number of home health care nurses who fulfilled the inclusion criteria, the number of home health care nurses who were given the questionnaire and the number of home health care nurses who returned the questionnaire within the set time limit or after a reminder. The contact persons were responsible for recruiting the nurses who met the inclusion criteria; they were also in charge of distributing and collecting the questionnaires and reminding the non-respondents. The contact persons in the e-messaging municipalities also noted the number of e-messages which had been sent and received in their municipality's EHR system over one month. The contact persons were thoroughly informed about the study and reminded to collect the data, and they were contacted via e-mail and phone several times before and during the data collection period.

5.4 Data analysis

The data were analysed using quantitative and qualitative methods. Table 10 presents the overview of the data analyses applied in the study.

Table 10 Overview of the data analyses used in the study

Sub-study I, Quantitative *Questionnaire*	**Sub-study II, Quantitative** *Questionnaire*	**Sub-study III, Qualitative** *Interviews*
Descriptive statistics	Descriptive statistics	Stepwise deductive inductive approach
Chi square test	Logistic regression analysis	
Mann-Whitney U-test		
Multilevel analysis		

Data analysis and statistical methods of sub-studies I and II

The data were analysed using IBM SPSS Statistics version 20 (2011) and MLwiN version 2.28 (2013) software. All of the questionnaire data were scanned into a readable file format for the respective computer programs.

In sub-study I, a descriptive analysis was used to present the characteristics of the samples. Because of categorical and non-normal distribution, a chi-square analysis and a Mann-

Whitney U test were used to compare the demographics between the EG and the CG. Moreover, a multilevel analysis was used to test the differences between the EG and CG. This was necessary because the sample was clustered by municipalities, which means that the respondents within the municipalities could be more similar to each other than respondents who were randomly drawn from all municipalities in Norway. Multilevel analysis controls for clustered and correlated outcomes by avoiding standard errors that are artificially small and cause false statistical significances (Hox 2010). P-values of 0.05 or less were considered statistically significant. Cronbach's alpha and inter-item correlation were used to test for internal consistency.

In sub-study II, a descriptive analysis was used to present the characteristics of the sample and the nurses' assessments of using e-messaging. Two logistic regression models were developed. Logistic regression analysis is used when the purpose is to the relationship between a dichotomous response variable and one or several explanatory variables or predictors (Hosmer & Lemeshow 2000). In the first logistic regression model, in order to create more variability the independent variable 'easy to use' was substituted by dummy variables. The dummy variables were divided into: dummy 1 = 'Strongly disagree, Disagree and Neutral', dummy 2 = 'Agree' and dummy 3 = 'Strongly agree'. Otherwise the variables were dichotomised as agree/strongly agree (4–5) and neutral/disagree/strongly disagree (1–3).

Data analysis for the interviews

The data analysis of the interviews was inspired by a stepwise deductive inductive (SDI) approach (Tjora 2012). This was an iterative and non-linear analytical process involving the literature, theory and data (Corbin & Strauss 2008, Tjora 2012). The analysis started with obtaining an overview of the data. Overall, the content in the interviews centred on communication, medication information and the use of the e-messaging system. Thereafter, using QSR NVivo version 9 (2010), meaningful units from the transcribed interviews were identified and coded as faithfully to the transcribed text as possible. An example of the analysis is shown in Table 11. For example the interview data 'There's a significant quality improvement in that we can document the medication communication' was coded into 'can document the medication communication'. The codes were then abstracted into sub-themes. In the example below, the sub-themes were documentation, written information and forwarding information. Finally, the sub-themes were discussed by the research team, and

informed by the research literature and theory, we grouped the sub-themes into themes. In the example below, we arrived at the theme 'making information accessible'.

Table 11 Example of the process of analysing the interview texts

Interview data	Coding	Sub-themes	Themes
'And given that the largest source of error is the incorrect use of medication, there's a significant quality improvement in that we can document the medication communication. It was hazardous before.'	Can document the medication communication	Documentation	Making information accessible
'When it comes to medication information, well … today we get it in writing'	Obtain the medication information in writing	Written information	
'But sometimes it ... not always corresponds with the medication, and if they have been admitted to the hospital, so it takes some time before the GP gets the information, and then it happens that we get the information before the GP, I send an 'e-link' with updated medical information.'	Forwarding updated information about what medication the hospital has prescribed	Forwarding information	

The transcribed interviews, codes and sub-themes were read several times and reinterpreted before the themes were finally established, as suggested by Tjora (2012).

5.5 Validity, reliability and trustworthiness

Validity, reliability and trustworthiness are different concepts used in quantitative and qualitative studies to assure quality in research (Lund 2005). Lincoln and Guba (1985) described the concepts of credibility, transferability, dependability and confirmability as the respective 'equivalents' to the concepts used in quantitative research, which are internal validity, external validity, reliability and objectivity. In this thesis, I have chosen to discuss the concepts for the quantitative and qualitative sub-studies separately.

Validity and reliability in sub-studies I and II

In this section, the validity of sub-studies I and II will be elaborated upon. Only relevant validity issues for these two sub-studies will be discussed.

Content validity concerns the extent to which an instrument contains items relevant to the measuring of a construct or concept. This should be confirmed by a literature search, using first-hand knowledge and clinical experience, consulting experts and conducting qualitative studies (Haraldsen 1999, Polit & Beck 2012). All of these strategies, including a pilot test, have been used in this study and are elaborated upon in this thesis for transparency.

Reliability

Cronbach's alpha was used to test the internal consistency of the subscales of the questionnaires presented in the papers. All alphas exceeded 0.7, indicating acceptable reliability (Nunnally 1978). Inter-item correlation was used to test the internal consistency of two subscales with less than 10 items. The results for these two subscales were 0.33 and 0.35, both of which are acceptable (Ferketich 1991). Performing a test/re-test of the questionnaire would help evaluate its stability (Polit & Beck 2012). However, this was not possible in the present study for practical reasons.

Trustworthiness in sub-study III

In sub-study III several researchers participated in the interviews and analysed the data together to improve the credibility. The analytical process was carried out by all the researchers reading the interviews, identifying codes and categories individually, and then discussing the results until an agreement was reached, as suggested by Tappen (2011).

Both dependability, which refers to whether the study can be repeated with the same results given the same conditions, and transferability, which refers to whether the results can be transferred to other settings and whether the description of the context and time of the study are comprehensive enough for others to apprehend, were ensured in this sub-study by a thorough description of the research process as recommended by Lincoln and Guba (1985) and Polit and Beck (2012). Moreover, a thorough description will make it easier for the reader to transfer the results of the study to other settings (ibid).

Regarding confirmability or the genuineness of the data (Polit & Beck 2012), I had to pay attention to how I, as a researcher, might unavoidably or unintentionally influence the research process and results. Since I had participated in the previously mentioned ELIN-k Project which developed the e-messaging system, first as project manager for two years, and later as the chairperson of the steering group for four years, it was particularly important that I focused upon this. I was not operative in the actual implementation of the project after I became the chairperson, and was never the public face of the project. Thus, few people knew of my previous role, and the participants' answers should not have been influenced in any specific way during the interviews.

Because of my previous role, I chose not to be the moderator in the focus group interviews. Instead, I served as the assistant moderator, and I did not lead the semi-structured interviews. I also had to be clear about my own foreknowledge, both because I had worked in this field and because I had participated in technology development for other projects. I had to make sure that it was not my opinion and experiences, but rather the empirical material that came to the foreground. In fact, my experience in the field helped to generate knowledge which might otherwise have been difficult to produce. I also had continuing discussions about this topic with other researchers with whom I collaborated to ensure that the participants' opinions remained in the foreground, during the data collection, the analysis of the data and in the presentation of the results (Lincoln & Guba 1985, Polit & Beck 2012).

5.6 Ethics

This study involved access to home health care nurses' and GPs' experiences regarding the use of e-messaging to communicate. A description of the project was sent to the secretariat of the Regional Committee for Medical and Health Research Ethics so that it could be determined whether it was necessary to apply for approval from the committee. The response was that there was no need for such approval when the purpose was to study health services. The method of data collection and the handling of interview and questionnaire data were approved by the Norwegian Social Science Data Services (Ref. no. 26230).

Written permissions were acquired from the chief administrative officers of each municipality before beginning the study.

The participants in the interviews were recruited by contact persons in their municipalities. They received oral and written information about the study and provided their written informed consent. None of the names of the participants were used in the transcribed documents. The participants were informed that their participation was voluntary and that they could withdraw from the study at any time.

The home health care nurses who were invited to answer the questionnaire received written information, including information that their participation was voluntary and anonymous. Returning the questionnaire was considered to be denote consent to participate in the study.

6 Results

The results of the sub-studies presented in the three papers are summarised in this chapter. Table 12 gives an overview of the aims, knowledge contribution and papers generated from the three sub-studies.

Table 12 Overview of the aims, knowledge contribution and papers

Sub-study	Aims	Knowledge contribution	Original paper
I	To describe the experiences of home health care nurses with an e-messaging system and to determine how e-messaging influenced their communication with GPs.	Description of the home health care nurses' assessments of the consequences of using the e-messaging system in terms of communication procedures, timeliness, non-electronic and electronic communication methods and the volume of contacts between home health care nurses and GPs.	Home Care Nurses' Experiences with Using Electronic Messaging in their Communication with General Practitioners
II	To describe the home health care nurses' assessments of using an e-messaging system in their communication with GPs and to identify which factors predict e-messaging as an efficient tool for communication with GPs.	Description of the home health care nurses' assessment of organisational and technical factors concerning the implementation and use of an e-messaging system. Identification of which factors predict an e-messaging system as an efficient tool for communicating with GPs.	Predictors for Assessing Electronic Messaging as an Efficient Tool for Communication in Home Health Care Services – a Cross-Sectional Study
III	To explore how the use of an e-messaging system influences patient safety in the medication information process from the perspective of both nurses in home health care and GPs.	Exploration of the home health care nurses' and GPs' assessment of the implications an e-messaging system had on patient safety. The results demonstrated that the use of the e-messaging system could both increase patient safety and also threaten it.	Toward Increased Patient Safety? Electronic Communication of Medication Information Between Nurses in Home Health Care and General Practitioners

6.1 Results of sub-study I

In sub-study I home health care nurses' experiences with an e-messaging system and how the e-messaging system influenced their communication with GPs was investigated.

The results showed a higher proportion of agreement in the EG on all the items concerning communication procedures than in the CG. The items were as follows: 1) sound guidelines for communication with GPs, 2) ease of getting into contact with the GPs, 3) regular nurses who are responsible for contact with the GPs and 4) ability to maintain contact with the GP when the regular nurses are absent. There were statistically significant differences in all of these items (items 1, 2 and 4, $p < 0.001$; item 3, $p < 0.05$). This demonstrated that the use of an e-messaging system resulted in the establishment of communication procedures.

For the items concerning the home health care nurses' experiences of timelier communication with GPs when using an e-messaging system, both the EG and CG had a median score of 3 (neither agree nor disagree). There were no statistically significant differences between the groups; thus, using the e-messaging system did not result in timelier communication.

The non-electronic contacts between the home care nurses and GPs included telephone calls, received and sent faxes, letters by mail or via the patients or next of kin, information received or given in meetings with the GPs and information given or received orally via the patients or next of kin. The home health care nurses in both groups reported that the number of non-electronic contacts with the GPs in one month was low, with mean numbers of contacts per home care nurse of 26.3 contacts and 35.4 contacts in the EG and CG, respectively. There were no statistically significant differences identified between the groups regarding the items, except for 'received and sent faxes' ($p < 0.05$), which was lower in the EG than in the CG.

However, using the e-messaging system led to more frequent contacts with GPs in the EG than in the CG. The mean number of e-messages per home health care nurse per month was 31.9. Adding this to the mean number of non-electronic contacts resulted in a total of 57.4 contacts in the EG, compared to a total of 35.4 contacts in the CG.

6.2 Results of sub-study II

In sub-study II the home health care nurses' assessments of using an e-messaging system in their communication with GPs and to identify what factors predict e-messaging as an efficient

tool for communication with GPs was described. These issues concerned which individual, organisational and technical factors could affect the assessments of using the e-messaging system.

In this sub-study, only the home health care nurses from the 12 municipalities in the EG were included because the assessment of using the e-messaging system was being investigated. The home health care nurses reported high agreement with the items 'e-messaging is an efficient tool for communication with GPs' (97% agreed or strongly agreed) and 'e-messaging is easy to use' (90% agreed or strongly agreed). A high proportion of the home health care nurses had received training (83% agreed or strongly agreed), but fewer agreed that they had access to user support (66% agreed or strongly agreed). A fairly high proportion of the nurses stated that they were neutral, in disagreement or in strong disagreement with the suggestion that they were hindered when using e-messaging because of poor functionality (31%), low system performance (31%), or software errors (32%).

To investigate the factors which could predict e-messaging as an efficient tool for communication with GPs, two logistic regression models were created. The first model showed that the odds were almost six times higher for agreement with 'e-messaging is an efficient tool for communication with GPs' if the nurses agreed that e-messaging was easy to use (odds ratio (OR)=5.9, B=1.772, p=0.017). If the nurses strongly agreed that e-messaging was easy to use, the odds were over 13 times higher (OR=13.4, B=2.596, p=0.024) for reporting that the e-messaging system was an efficient tool for communication with GPs. The effect of the intervention model was controlled for gender, age, years of experience as an registered nurse, full-time equivalent percentage and years in current position.

The second logistic regression model was then established to show which factors would influence the home health care nurses' assessments of e-messaging being easy to use. The results were that the odds of agreeing that e-messaging was easy to use were almost seven times higher if the nurses agreed that they were not hindered because of poor e-messaging functionality than if they did not agree (OR=6.91, B=1.933, p=0.007). The home healthcare nurses who agreed that they had received training were over six times more likely to agree that e-messaging was easy to use (OR=6.62, B=1.890, p<0.001). In addition, the odds that the nurses would agree that e-messaging was easy to use grew as their full-time equivalent percentage increased (OR=1.03, B=0.031, p=0.045). Gender, number of months using e-messaging, full-time equivalent percentage, being hindered by low system performance or

software errors or having access to user support were not statistically significant predictors for the assessment of e-messaging as easy to use.

6.3 Results of sub-study III

The aim of sub-study III was to explore how the use of an e-messaging system influences patient safety in the medication information process from the perspective of both home health care nurses and GPs. The results from the focus group interviews and the semi-structured interviews with both home health care nurses and GPs showed that, in their opinion, using an e-messaging system for communication and collaboration had implications for patient safety. The use of the e-messaging system resulted in the following: 1) easier connection, 2) increased accessibility to medication information and 3) the use of the e-messaging system as a tool for re-evaluating medication information. However, the results also showed that the use of the e-messaging system could be a threat to patient safety. These findings are detailed in the following paragraphs.

Connecting health care providers

By using the e-messaging system, the home health care nurses and GPs became connected, and the e-messaging system changed the ways they communicated about their patients' medication. The GPs expressed that they used the e-messaging system more than they would have anticipated before it was implemented. The home health care nurses said that it was easier to contact the GPs through the e-messaging system because they were not interrupting GPs' encounters with patients. It was also seen as an advantage that they could communicate with each other directly instead of via the GPs' receptionists, the patients or the patients' next of kin. The use of this asynchronous communication method was also experienced as time efficient because it only took a couple of minutes to write an e-message, whereas other methods of communication took longer. Phone calls were still used in urgent situations. In addition, both the home health care nurses and the GPs sometimes called after an e-message was sent to ensure that the issue in question was handled.

Making medication information accessible

Using the e-messaging system made the medication information more accessible because the communication was documented and stored in the home health care nurses' and GPs' EHR systems. The nurses and GPs expressed that they had a better overview of the medication and

that it was easier to detect and correct medication errors. Consequently, the home health care nurses and GPs had more assurance that their medication records were accurate.

Re-evaluating medication information

Using the e-messaging system as a tool for re-evaluating the medication information was significant for the reconciliation of the medication lists, the assessment of the existing medication and the discovery of medication errors. Communicating by e-messages enabled well-grounded inquiries and responses about the medication. The nurses and GPs had more time to think things through than when they were talking on the phone, which requires immediate answers.

The results of the interviews also indicated that the use of the e-messaging system could be a threat to patient safety because the patients' medication lists in the EHR systems were often not updated. These omissions could result in incorrect medication information being forwarded because the medication information was aggregated from the EHR system into the e-message. Errors could also occur because it was not possible to transfer the medication information electronically from the e-messages into the medication list in the patient's EHR; this meant that the medication information would have to be transferred manually.

6.4 Summary of the results of all three sub-studies

The results have been summarised and integrated in a sociotechnical work system model to illustrate which elements came into play when the e-messaging system was implemented. The results are numbered and placed in their respective circles.

1. The use of the e-messaging system initiated the establishment of procedures for communication.

2. The home health care nurses who used the e-messaging system reported to a higher degree that it was easy to get in contact with the GPs.

3. The home health care nurses had few non-electronic contacts about the patients with the GPs. However, by using the e-messaging system the frequency of contacts increased substantially.

4. The e-messaging system did not result in timelier communication.

5. After the implementation of the e-messaging system the home health care nurses used fax machines less frequently.

6. The home health care nurses assessed the e-messaging system as an efficient tool for communication with GPs.

7. The e-messaging system's ease of use was an important factor for the home health care nurses to assess it as an efficient tool for communication with GPs.

8. The e-messaging system was assessed by the home health care nurses as easy to use when the functionality was satisfactory, they had received adequate training and the higher full-time equivalent percentage they had.

9. Both home health care nurses and GPs experienced that it was easier to connect when they used the e-messaging system because they could contact each other when they wanted, which suited their busy schedules.

10. The home health care nurses reported that the e-messaging system made the medication information more accessible.

11. Both the home health care nurses and GPs reported that the e-messaging system eased the reconciliation of the patients' medication lists. However, new and unexpected errors occurred due to omissions and lack of functionality in the e-messaging system.

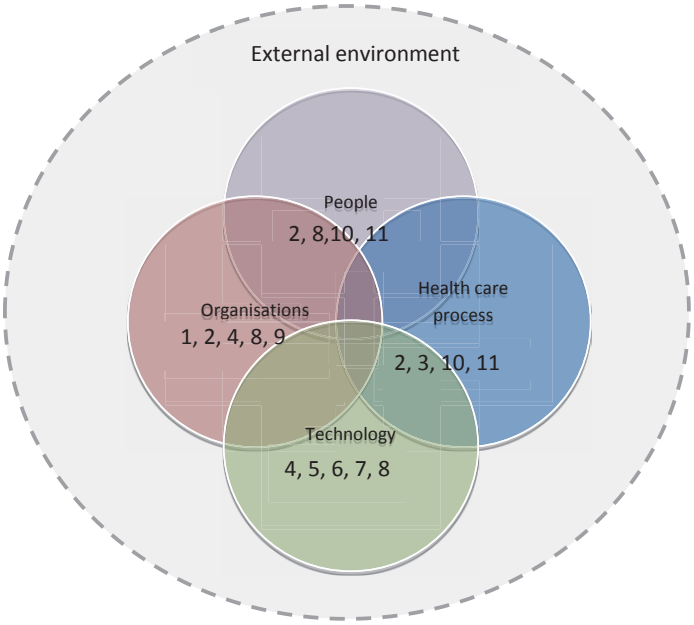


Figure 9 Synthesis of the results.

Figure 9 shows an overview of the results which are integrated into the sociotechnical work system. The model illustrates that all the elements in the work system came into play. These elements were not mutually exclusive, but instead overlapped. For instance could result 2 – 'The home health care nurses who used the e-messaging system reported to a higher degree that it was easier to get in contact with the GPs' – be a consequence of several of the elements in the sociotechnical work system such as the people (the home health care nurses and GPs), the organisations and the health care process. In light of this model, it is possible to synthesise the findings in three main topics, as follows:

1. The e-messaging system had features for supporting the home health care nurses' and GPs communication and knowledge building about the patients' health and care
2. Using the e-messaging system assembled the home health care nurses and GPs by enabling the:
    a. Establishment of a work system across organisational borders
    b. Equalisation between the home health care nurses and GPs
    c. Unveiling and documenting of the communication and collaboration between home health care nurses and GPs

3. The premises for the adoption of the e-messaging system were dependent on the interplay between the different parts represented in the sociotechnical work system.

7 Discussion

In this chapter, the main findings of the study are discussed, followed by a discussion of the methodological considerations.

7.1 Discussion of the main findings

Instead of organising the discussion of the main findings by the specific aims of this thesis, I will use the synthesis of the results in the discussion. The key points of the synthesis were as follows: 1) communication and knowledge building in health care work, 2) assembling the home health care nurses and GPs and 3) the premises for the adoption of the e-messaging system. Patient safety and the sociotechnical approach are common threads throughout the discussion.

7.1.1 Communication and knowledge building about home health care patients

The results of the current study show that the e-messaging system had features that went beyond information retrieval and exchange about home health care patients in terms of the way in which it facilitated communication. The home health care nurses and GPs expressed that using the e-messaging system provided a communication process which allowed them to build new knowledge about their common patients. This became evident from how they communicated throughout their re-evaluations of the patients' medication lists and their assessments of existing medications. Thus, they discovered errors or inadequate medications in the medication lists and altered the medication. This illustrates how communication provides a process by which information and knowledge to emerge, and if the means or opportunities for communication are lacking, the patients' safety could be at risk (Kohn *et al.* 2000, Leape & Berwick 2005, Kaelber & Bates 2007).

Informal communication has been emphasised as essential for efficient communication (Chen *et al.* 2013). The characteristics of certain e-messaging types, such as the dialogue message, may have triggered an increase in the informal communication between the home health care nurses and GPs. This is evident from the rise in the number of contacts between them, and because the nurses and GPs expressed that the dialogue message was valuable in the discussions regarding patients' medication. These findings are supported by studies showing that discussions of treatment and care are more often conducted informally (Coiera 2000, Ellingson 2003, Kuziemsky & Varpio 2010, Chen *et al.* 2013). Secure e-mail communication,

or in this case e-messaging, could also have a positive effect on patient safety insofar as it complements the methods for communication, as suggested in other studies (Absulem & Hardin 2011, Allen *et al.* 2012).

In today's discussion about ICT in the health care services the trending view is that sharing a national EHR system with one database which covers all citizens in the whole country would be the best solution for information management, information flow and communication (Helse- og omsorgsdepartementet 2012). In Norway a debate has arisen after the government proposed to change the legislation to allow a shared national EHR system throughout the whole health care service will be allowed[4][5][6][7][8]. The Patient Record Act and the Health Register Act were passed by the Norwegian Parliament in June 2014[9]. However, international examples show that the implementation of common solutions for sharing patient information has been slow and problematic (Greenhalgh *et al.* 2010, Eason *et al.* 2012a). There are several reasons for this. A single, common database could provide access to a lot of raw data which have not been processed for the needs of all the different health care providers and this could ultimately result in information overload (Stead & Lin 2009, Collins *et al.* 2011). A Swedish study concerning physicians in primary and secondary care who shared a common EHR revealed that they were satisfied with the possibility to access data and information. However, they also experienced overload of data and information and reported that it was difficult to get an overall retrospective picture of the patients' health and care. The study demonstrated that knowledge about patients was often absent due to lack of documentation about why treatments had been initiated or changed, and future plans; thus, it was left to each physician to produce this knowledge through the access of the data and information in the EHR system (Tully *et al.* 2013).

[4] Pasientdata til salgs http://www.nrk.no/ytring/pasientdata-til-salgs-1.11488350
Prøvekaniner på det åpne markedet?
[5] http://www.dagensmedisin.no/blogg/liv-arum/provekaniner-pa-det-apne-markedet/
Slår alarm om ny pasientjournallov: - Private opplysninger er ikke trygge * Leger skriver hemmelige «skyggejournaler» for å beskytte pasientene
[6] http://www.vg.no/nyheter/innenriks/helse/slaar-alarm-om-ny-pasientjournallov-private-opplysninger-er-ikke-trygge/a/10147452/
[7] http://www.vg.no/nyheter/innenriks/helse/uetisk-og-et-overgrep-mot-pasientene/a/10124077/
Krav fra Venstre: - Pasienten må bli spurt
- Alarmklokkene ringer i denne saken, sier helsepolitisk talsmann i venstre, Kjetil Kjenseth
[8] http://www.vg.no/nyheter/innenriks/helse/krav-fra-venstre-pasienten-maa-bli-spurt/a/10124485/

[9] https://stortinget.no/no/Saker-og-publikasjoner/Saker/Sak/?p=59667

Another point is that one size does not fit all. The results of a study evaluating the implementation of a detailed electronic care record system in England showed that the system did not fulfil the needs of the health care organisations and required extensive adaptation at the local level (Eason & Waterson 2013). Further, whether communication tasks could be replaced by information tasks are debatable (Coiera 2000, Parton 2008). A replacement may cause an undesirable situation featuring a lack of clinical discussion and knowledge-building about patients, which may result in less-than-optimal care and, potentially, harm to the patients. According to the results of the present study, home health care nurses and GPs used the e-messaging system to discuss their common patients' treatment and care and to solve problems, which is illustrated by the transaction model (Figure 7).

Parton (2008) has criticised the introduction of electronic solutions and common databases, claiming that they cause a shift from the social and communicational to the informational. Consequently, important contextual knowledge gets lost. Data are considered to be facts, and information is data put into a specific context. While information is static and fixed and can be retrieved from databases, knowledge gives information meaning and specifies the relationship between pieces of data and information (Blum 1986, Graves & Corcoran-Perry 1989, English 1999). Discussions about the access to and sharing of patient information through a common EHR system do not necessarily concern knowledge in the sense that information is understood by health care providers from the different parts of health care services. However, when these health care providers communicate, they connect bits of data and information and create knowledge. Thus, communication is a requisite for the emergence of information and knowledge (Tange *et al.* 2003, Saario *et al.* 2012). In the current study, the e-messaging system helped the home health care nurses and GPs to shift from acting informationally to acting communicationally; in addition to the system making it easier for them to get in contact with one another more frequently, they also used the e-messages to ask questions, and to inquire about and discuss the patient's care and treatment. This finding was of particular significance in terms of knowledge-building and patient safety. The modified model of the concept of transaction helps to illustrate that home health care nurses and GPs are both part of a collaborative problem-solving process supported by the e-messaging system (Tange *et al.* 2003). The e-messaging system contributed to communication – and; therefore, knowledge-building – about patients, which might not have been accomplished otherwise. This is also in line with the sociotechnical approach, which emphasises the interdependency

of the technical (i.e. the e-messaging system) and the social (i.e. home health care nurses and GPs) for solving and producing outcomes (Berg 1999, Eason 2014, Klein 2014).

In order for health care providers to communicate most effectively, they must possess a shared understanding or knowledge of the topic they are discussing (Pirnejad 2011). Health care providers from different parts of health care services may possess different types of knowledge and understandings about the patients, their conditions and the care they require (Hellesø *et al.* 2005b, Wibe *et al.* 2014). The content of a database or another provider's EHR system could be understood differently than was intended, depending upon which parts of the health care services the health care professionals have a background in; this could pose a threat to patient safety. Therefore, it is important that the information is processed with the purpose of providing outside health care providers with the context-specific information they need. Studies have also shown that health care providers especially appreciate summary information (Unertl *et al.* 2013). Making such summaries available in a common database could be a possible solution to information overflow. However, a message must be sent to the responsible health care providers to ensure that they follow up with the patient and inform them that such information is available. Thus, both access to common databases or others health care providers' EHR systems and communication using e-messages could therefore be complementary and useful.

7.1.2 Bridging the gap – assembling home health care nurses and GPs

The results of the current study showed that, by using the e-messaging system, home health care nurses and GPs became assembled rather than separated. In municipality health care settings, communication between health care providers is often difficult to accomplish, especially within the distributed practices of home health care nurses and GPs, who have few opportunities to meet or reach each other by telephone or other means during a busy working day (Vaidya *et al.* 2012). The results of the current study show that the e-messaging system became a part of and changed the home health care nurses' and GPs' work system and provided them with a new communication method and made it easier to connect. The e-messaging system did not replace other non-electronic communication methods after it was put into use, except in the case of faxes. However, the establishment of communication procedures and increases in the number of contacts between home health care nurses and GPs indicate that a previously uncovered need has been fulfilled. This finding illustrates how the organisation, people and technology have come into play and corresponds with the

sociotechnical approach, which declares that the different parts contribute to the shaping and reshaping of the work system (Berg 1999, Berg *et al.* 2003, Eason 2014).

ICT systems can mediate and build connections and alliances between actors in a work system who share the responsibility to perform a task (Cresswell *et al.* 2010, Greenhalgh & Stones 2010). Health care providers depend upon communication with one another to ensure patient safety and to provide efficient care to their common patients. The e-messaging system made communication easier and may have helped to extend and strengthen the work systems of home health care nurses and GPs. This is in line with Eason (2014), who proposes that a sociotechnical work system could cross organisational borders.

The e-messaging system contributed not only to the assembling of the home health care nurses and GPs but also to more equalised relationships. Hierarchical relationships may discourage people from contacting others when needed (Dayton & Henriksen 2007). In the present study, the home health care nurses expressed that, when using the e-messaging system, they felt that they were not interrupting the GPs, and that they received more information than before; meanwhile the GPs expressed that they used the e-messaging system more than they had anticipated and often inquired about the opinions of the home health care nurses regarding the patients' medications. E-messaging may have reduced the barrier between home health care nurses and GPs, thereby making communication more efficient. These findings are in accordance with studies which have shown that ICT may influence the hierarchies between professions due to changes in the distribution of tasks and because inquiries and requests are followed up in a better manner (Berg 1999, Melby & Hellesø 2014). Home health care nurses have expressed that when their inquiries were documented by e-messages in the EHR, GPs paid more attention to them than when such inquiries were delivered via Post-It note (Melby & Hellesø 2014) .

The previous use of Post-It notes and telephone calls caused communication to be concealed and seldom documented; the e-messaging system helped to unveil the communication between home health care nurses and GPs. The system made it possible to store e-messages in the EHR, which were then accessible to other home health care nurses who participated in a patient's care. The contacts and communication between home health care nurses and GPs became visible and transparent, which had both retrospective and prospective implications. With the system, it was easier for other home health care nurses to obtain information about a patient's history and discussions and care decisions about his or her future, thereby improving

continuity and patient safety. These findings correspond with Coiera (2003) view that asynchronous, written text makes communication detectable and visible.

7.1.3 Premises for the adoption of the e-messaging system

The findings of this study showed that communication through the e-messaging system was highly valued by the home health care nurses and GPs, and that the nurses considered the e-messaging system to be an efficient tool for communicating with GPs. ICT systems which involves few changes to the work system may be easy to adopt (Eason & Waterson 2013). The e-messaging system in the current study is an example of an ICT system that did not demand many changes to the technical part of the work system, as it was already integrated into the home health care nurses and GPs EHR systems. This is supported by the findings, which showed that the majority of the home health care nurses assessed the e-messaging system to be an easy-to-use and efficient tool for communicating with GPs. However, the e-messaging system did demand changes within the organisation because of the need for offering training and from the individuals because of the need to learn to use the e-messaging system. This is in line with other studies, which have documented that ICT training is essential for the adoption of ICT systems (Ash *et al.* 2004, Gagnon *et al.* 2012). In the present study, most of the home health care nurses had received training, which was discovered to be a strong predictor for assessing the e-messaging system as easy to use, as well as not be hindered by poor functionality.

Implementing systems with functionality which is not compatible with health care processes could lead to workarounds, the re-establishment of paper systems and the use of other communication methods (Eason 2009). The home health care nurses reported insufficient functionality of the e-messaging system (i.e. it was not possible to write comments or ask questions about each medication in the message). In addition, because medication information was automatically transferred from the EHR system into the medication message, errors in the medication list from the GP's EHR system were forwarded to the home health care nurses, and vice versa. These deficits created extra work and led to errors and omissions, which is in line with other research performed in hospitals (Callen *et al.* 2010). Such deficits could ultimately cause harm to the patients and illustrates an unsuccessful outcome of the sociotechnical work system.

The development and implementation of the e-messaging system is an example of a middle-out approach, comprising local or bottom-up and top-down initiatives designed for the development and implementation of new technology (Coiera 2009, Eason *et al.* 2012b). Locally, the involvement of end users during development and implementation is important for avoiding constraints or workarounds that inhibit work processes, this is consistent with the sociotechnical approach (Berg *et al.* 1998, Berg 1999). Knowledge about the organisation of health care work is considered to be essential to the development and implementation of ICT in health care services (Ash et al. 2004). To accommodate this, home health care nurses participated in the development and implementation of the e-messaging system (Lyngstad *et al.* 2011), which may have made adoption easier for the nurses and GPs and caused them to feel that it was compatible with their health care processes.

From a top-down perspective, the Norwegian authorities aim to link health care services so that patients experience them as integrated and coordinated. EHR systems and e-messages are important tools supporting this linkage; the e-messaging system will be employed by every health care service by 2015 (Helse- og omsorgsdepartementet 2012a). Thus, Norwegian authorities have proposed regulating of the e-messaging standards through legislation[10] in order to ensure that all providers have implemented the standards and can exchange information and communicate electronically; if not, the e-messaging system will not succeed due to uncertainties about which providers can communicate electronically. Enforcement of the use of e-messaging standards could be viewed as a part of the external environment, which could also come into play and impact the outcome of the sociotechnical work system.

7.2 Methodological considerations

In this section, I will address the methodological considerations regarding the design of the study, the instruments, the data collection and the results.

7.2.1 Design

The design of the present study is both descriptive and exploratory and comprises both quantitative and qualitative research methods. The sociotechnical approach encompasses the application of different methods. Although the most common methods used in the

[10] http://www.regjeringen.no/nb/dep/hod/dok/hoeringer/hoeringsdok/2013/horing-av-forslag-til-forskrift-om-ikt--.html?id=731556

sociotechnical approach are qualitative, including ethnographic methods and case studies, quantitative methods are also used (Berg 1999, Stoop 2003, Li 2010, Aarts 2013). According to Berg (1999), quantitative methods are useful for measuring the application of and satisfaction with the ICT systems or the extent to which the ICT system is used. This includes determining which parts of the system are employed and how often the system is accessed. However, quantitative measures should be embedded in the qualitative data to preserve the context and make understanding of the results simpler (Berg 1999). In order to accommodate this, a thorough description of the context and setting of the study is presented in the papers and the present thesis.

7.2.2 Instruments

Using self-developed questionnaires for studies is not recommended (Polit & Beck 2012). However, because no questionnaires which were appropriate for the present study had been developed, and because it was desirable to generate data from many respondents, we chose to develop the questionnaire ourselves. For transparency, the development process is carefully presented in the design and methods chapter. Because using a questionnaire assumes that the researcher and the respondents understand the words and statements in the questionnaire in the same way (Rattray & Jones 2007), it is imperative that the questionnaire undergo a thorough developmental process and pilot test, as was done in this study. Since questionnaires should not be used if the topic they discuss has not been studied before (ibid), we used interviews to explore the topic before developing the questionnaire. Thus, we obtained both an in-depth and broader understanding of home health care nurses' and GPs' communication practices and their experiences with using an e-messaging system (Lund *et al.* 2006).

The questionnaire contained only closed-ended questions, which may have resulted in the loss of some participants' perspectives. However, closed-ended questions can be answered more efficiently and may cause fewer dropouts (Polit & Beck 2012). The interview guide for the focus group interviews contained themes to provide focus to participants' discussions. The interview guide for the semi-structured interviews contained mostly open-ended questions. Some questions were simple and concrete, while others were more reflective. The combination of the questionnaire and the interviews provided us with comprehensive data.

7.2.3 Data collection

In sub-studies I and II involving the questionnaire, it was difficult to completely control the data collection. Because of the large number of participating municipalities, we depended upon the contact persons in each of the municipalities to collect the data. The contact persons had to collect data in addition to their regular work, so this could have been a challenge and might have influenced the response rate. However, given the relatively high response rate it did not seem to create any challenges (Polit & Beck 2012) .

In sub-study III focus groups and semi-structured interviews were used to collect data. The data collected in the focus groups were rich and provided valuable information about the home health care nurses' and GPs' perspectives on communication. Two focus groups were homogenous, comprising only home health care nurses or GPs, while the third focus group was heterogeneous, with a mix of home health care nurses and GPs. Some argue that focus groups should be homogeneous so that the differences between participants are not disruptive (Stewart *et al.* 2007, Krueger & Casey 2009), but others claim that one common but important characteristic is enough, even if the group is composed of people of different professions, gender and age (Barbour 2007). Heterogeneity could be an advantage if the individuals in the group works or collaborates together, which could result in naturally occurring data (Kitzinger 1995). We included both home health care nurses and GPs in one of the focus group interviews to ensure that we would obtain data which showed the dynamics and interaction between them; this could not have been obtained if all the groups were homogenous. In this group, one common feature was the introduction and use of e-messaging. Another common feature was that they all provided health care to patients living at home and were dependent upon the communication and exchange of information between one another. In order to obtain the opinions of all the participants, everyone was asked to express their view on the topics which were discussed.

7.2.4 Results

Internal validity means that alternative explanations for the findings, rather than the independent variable, are taken into account (Lund 1996). This study could have featured selection bias, meaning that the home health care nurses who responded to the questionnaire had certain characteristics that could lead to specific responses (Lund 1996, Creswell 2009). For instance, the nurses in this study who chose to answer the questionnaire could have been

especially optimistic about technology because they were the first to use the e-messaging system, potentially resulting in falsely positive results.

The timing of a study of an ICT system implementation is important, and careful planning is recommended so that the validity of the study is not influenced. For instance, the validity could be impacted if too few users have sufficient experience with the ICT system (Nykanen *et al.* 2011). In order to prevent this it was ensured that the home health care nurses had at least three months' experience in using the e-messaging system.

The validity could also have been influenced by the novelty effect, which states that it is not the essentials of intervention that cause the effect, but rather the novelty (Polit & Beck 2012). In the present study the e-messaging system was new, which could have caused the nurses to be particularly enthusiastic; however, the opposite reaction is also likely. For instance, one study discovered that nurses' positive attitudes towards a new ICT system declined over time due to changes in workflow, numerous functionality adjustments and unmet expectations (Laramee *et al.* 2012). In this study the home health care nurses had from three to 48 months' experience in using the e-messaging system, and the attitudes of those nurses who had used it for the longest time may therefore have been less positive. However, the results show that this did not occur in the way that a high proportion of the home health care nurses agreed or strongly agreed that the e-messaging system was an efficient tool for communication with GPs

External validity refers to generalisations of the findings to fit a larger population (Polit & Beck 2012). There are several threats to external validity: For example, the study population could be homogenous and feature little variation, or the study population could be misrepresentative of the population as a whole (Lund 1996). In sub-study I, the demographic data showed that the mean age in both the EG and CG was 39 years, though the mean age is 43 in the total nurse population in municipal health care services (Norwegian Nurses Organisation 2012). The demographic data also showed that 9.6% of the nurses in the EG were male, while only 5.2% of nurses in the CG were male. However, the total male nurse population in Norway was 11.1% at the time of this study (Statistics Norway 2013). Thus, in both groups, the number of male nurses was lower than the total male nurse population and there were statistically significant differences between the groups. However, it is not possible to obtain exact age and gender statistics for nurses in home health care service in Norway because there are no specific official demographic statistics regarding this. The official

statistics regarding the age of home health care nurses includes all municipal health care services, such as nursing homes, in addition to home health care services. Gender data encompasses the whole nurse population in Norway, including hospitals and other specialist health care services. There were also statistically significant differences between the groups regarding the providers' full-time equivalent percentage and the total years they have spent in their current position, meaning that external validity could have been threatened because of response bias. This should be considered when interpreting the results.

The response rate in the present study was acceptable, at 67% in the EG and 62% in the CG (Polit & Beck 2012). Another strength of the study is that all of the municipalities that fulfilled the inclusion criteria for the EG participated.

More background information regarding the home health care nurses could have strengthened the findings. However, having too many items on a questionnaire could make it too lengthy to answer, which could lead to more dropouts and a lower response rate (Sahlqvist *et al.* 2011). We therefore decided to limit the number of items in our questionnaire.

8 Conclusion

This thesis has contributed to the understanding of home health care nurses' and GPs' experiences with using an e-messaging system to communicate and collaborate, and how this can affect patient safety.

Overall, the findings from this study showed that e-messaging systems had an assembling effect on home health care nurses and GPs. The significance of this is twofold: The e-messaging system not only helped to connect home health care nurses and GPs, which made communication easier, but also helped to make gathering and producing information and building knowledge through communication about common patients' treatment and care easier.

The home health care nurses and GPs considered the e-messaging system to be an easy-to-use and efficient tool for communicating with GPs.

The introduction of the e-messaging system also promoted the formalisation of work routines and helped to establish communication procedures. However, informal communication is still needed. The results show that the e-messaging system supported informal communication, which was an important requisite for knowledge-building and collaboration.

The e-messaging system did not lead to timelier communication, and with the exception of faxes, it did not replace, but instead complemented, previous communication methods.

Further, the results revealed that patient safety both increased and decreased in terms of medication information: Use of the e-messaging system reduced the number of adverse events, but it also introduced new variants of adverse events.

Finally, it was discovered that both social and technical factors could affect the work systems of home health care nurses and GPs both in a positive and negative way, underlining the importance of a sociotechnical approach when developing an ICT system and implementing it into a work system.

8.1 Implications for practice

The present study has shown that technology which can support asynchronous communication across organisational borders is highly valued by health care providers. Communication is a central and essential aspect of health care work which must not be underestimated. It may serve as a powerful filtering of data and information, and is an

important tool for improving the efficiency of information exchange. Additionally, knowledge about patients can be lost if the opportunities and means to communicate do not exist. This is especially hazardous when patients cross organisational borders and when several health care providers from different divisions of the health care services are jointly responsible for the treatment and care of patients. Regardless of which technologies are put into practice, health care providers are in need of access to technology which can facilitate asynchronous communication and knowledge-building about patients across organisational borders.

This study also indicates that health care providers' participation in technology development and implementation lays the foundation for its success or failure. The e-messaging system was developed and implemented with the involvement and participation of home health care nurses and GPs. Such an approach ensures that the voices of the people who will actually use the technology are heard. This will help contribute to consistency between users' needs and the developed technology as well as providing legitimacy and a high chance of technology adoption.

8.2 Implications for future research

This study has contributed new knowledge about home health care nurses' and GPs' experiences with using an e-messaging system to communicate and how the e-messaging system influenced patient safety. However, this study has not aimed to measure how the e-messaging system directly affects patient safety in terms of endpoints, such as fewer readmissions to hospitals, implementing treatment and care at earlier stages of an illness, fewer adverse events and postponed admission to long-term care in nursing homes. This list is not exhaustive, and more items could be added. The value of the e-messaging system in terms of these issues should be evaluated further.

The e-messaging system has now been in use for several years in Norwegian municipalities, and it would be interesting to investigate how the e-messaging system has been adopted and normalised into the work system.

Exploration of the content of the communication between home health care nurses and GPs is also warranted, along with the ways in which different message types are used.

The GPs response rate to the questionnaire was too low to make any conclusions. Therefore, GPs' experiences should be further investigated in order to obtain a broader understanding their experiences of their use of the e-messaging system.

In addition, studies investigating time use and how the e-messaging system are integrated with the work processes in home health care and GP offices should be performed to evaluate the system's efficiency and user-friendliness.

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I

II

Predictors for assessing electronic messaging as an efficient tool for communication in home healthcare services: a cross-sectional study

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Abstract

Background

Nurses providing home healthcare services are dependent on access to patient information and communicating with general practitioners (GPs) in order to deliver safe and effective healthcare to patients. Information and communication technology (ICT) systems are viewed as powerful tools for this purpose. In Norway, a standardized electronic messaging (e-messaging) system is now being deployed in healthcare. The aim of this study was to explore home healthcare nurses' assessments of using the e-messaging system to communicate with GPs and to identify what factors predict e-messaging as an efficient tool for communication with GPs.

Methods

The study was conducted using a cross-sectional approach. The data were collected using a questionnaire sent to home healthcare nurses (n = 425) who used e-messaging. The data were analyzed using descriptive and logistic regression analyses.

Results

A high proportion (97%) of the home healthcare nurses assessed the e-messaging system as an efficient tool for communication with GPs. The odds for reporting that e-messaging was an efficient tool were over five times higher (OR = 5.9, p = 0.017) if the nurses agreed, and over 13 times higher (OR = 13.4, p = 0.024) if the nurses strongly agreed, that e-messaging was easy to use. Factors predicting e-messaging as easy to use showed that the odds were nearly seven times higher (OR = 6.9, p = 0.007) if the nurses were not hindered by poor functionality. Additionally, if nurses received training in the use of e-messaging, the odds were over six times higher (OR = 6.6, p < 0.001) that they would assess e-messaging as being easy to use.

Conclusions

This study has shown that individual, organizational, and technical factors have an impact on home healthcare nurses' assessments of using e-messaging to communicate with GPs. By identifying these factors, it is easier to determine which interventions are the most important when developing and implementing ICT systems in home healthcare services.

Keywords

Home healthcare services, electronic messaging, home healthcare nurses, information and communication technology,

Background

The healthcare service is characterized as fragmented and dispersed [1, 2]. This is particularly challenging for the delivery of safe and effective healthcare to patients who receive home healthcare services. Nurses in home healthcare services are dependent on access to accurate and relevant patient information [3]. It is also essential that nurses in home healthcare services have the opportunity for clinical communication and discussions about patient care with general practitioners (GPs) [2]. In Norway, where the current study was conducted, the home healthcare service is managed by municipalities, and the GPs are self-employed [4], and use different electronic health record (EHR) systems from the municipalities [5]. This makes it especially relevant to improve and implement new methods for information exchange and clinical communication between these two healthcare providers. Information and communication technology (ICT) systems are viewed as powerful tools with which to alleviate this situation [6]. One of the most important goals for ICT development and implementation in healthcare is to make the exchange of information, care coordination, and communication between healthcare workers more efficient [7]. However, implementing new electronic tools in healthcare is not always successful [8, 9]. Studies have shown that healthcare professionals may assess the tools as inefficient or find that they do not align with their work practices [10, 11]. Healthcare professionals' beliefs, assessments, and satisfaction with the ICT systems affect the structure, process, outcomes of care, and safety for patients and their next of kin [3, 12, 13]. Developing and implementing new electronic tools for communication also has high costs, and it is therefore important to reduce the risks of low or incorrect use, or of not fully utilizing the systems [8, 14].

According to the socio-technical perspective, which aims to understand how ICT systems are developed, implemented, and become a part of work practices [15], the integration of ICT systems into work practices is dependent on the interaction between individual, organizational, and technological factors. This determines whether the implementation and use of ICT systems will be successful [14]. This implies that a technical system cannot be isolated and function on its own, but is shaped and reshaped by the people and organizations in the social environments and contexts in which it is used [15]. This perspective emphasizes the need for active user involvement in an iterative development and implementation process, and considers strong user involvement as important for adopting ICT systems, and for assessing them as efficient [7, 13, 16-18].

Previous studies have shown that several factors have an impact on healthcare professionals' assessment of the efficiency of ICT systems. These factors include the health professionals' participation in the development of the ICT systems [17], the design of the ICT systems [10, 11, 19], the user interface and functionality of the ICT systems [13], their ease of use [19, 20], their compatibility with work practices [10, 13, 19], and how the ICT systems are put into practice; that is, training and user support, technical infrastructure, and resources [6, 10, 13, 19-22].

In Norway, a standardized electronic messaging (e-messaging) system is now being deployed in primary health services [23]. The e-messaging system consists of several standardized, semi-structured message templates that are customized for different purposes such as patients' health information and medication lists, and a dialog message designed for requests, inquiries, and discussions about patients' health issues and special care needs [24]. The e-messaging system is integrated into all of the major EHR systems that are used in home healthcare services and GP offices in Norway. The e-messages are sent between the different healthcare providers' EHR systems via the Norwegian Health Net, which is a secure and closed net used solely for health information exchange and clinical communication. The development of the e-messaging system was initiated and managed by healthcare professionals, in close cooperation with the vendors [25], and was consequently characterized by strong user involvement as suggested in other studies [13, 17, 18]. The Norwegian government's goal is that all home healthcare services, nursing homes, GPs, and hospitals will have implemented e-messaging by the end of 2014 [5].

The aim of this paper is to describe home healthcare nurses' assessments of using the e-messaging system to communicate with GPs and to identify which factors predict e-messaging as an efficient tool for this purpose.

Methods

The study used a cross-sectional approach with a questionnaire administered between November 2011 and February 2012.

The questionnaire

The focus of this article is home healthcare nurses' assessments of using e-messaging and what factors predict the e-messaging system as an efficient tool for communication with GPs.

We searched the literature but did not find any questionnaires that measured the use of e-messaging between home healthcare services and GPs. We therefore developed a questionnaire through two phases [26]. First, we explored the recommended guidelines for the use of e-messages [27], the description of the standards for the e-messaging system [24], the results from previous contiguous research [28-31], and conducted focus groups and semi-structured interviews with home healthcare nurses from two municipalities. The results from the interviews showed that both organizational and technical factors were assessed as important dimensions for the use of e-messaging [32]. Second, we developed the questionnaire. It was reviewed by six registered nurses with clinical, ICT, and research skills, and was also tested by 15 registered nurses who worked in home healthcare services. This provided significant and valuable information, used to revise the questionnaire. The final version of the questionnaire contained 62 items in six sections: 1) demographics; 2) procedures for, number of, and quality of communications; 3) communication content; 4) expectations for electronic communication; 5) electronic communication in general; and 6) the use of e-messaging. A copy of the questionnaire is in Additional File 1. Here, we report the results from sections 1) demographics and 6) the use of e-messaging, which consisted of the items shown in Table 1. The explanatory variables selected for this study have been documented in previous studies as important for healthcare providers' assessments of health information systems. References for each of the items are set out in Table 1.

Table 1 Questionnaire items on the use of e-messaging

Dimensions	Item	References
Organizational	Received training	[6, 8, 10, 13, 19-21]
	Access to user support	[6, 10, 13, 19-21]
Tool/technology	Hindered by poor functionality	[11, 13, 22]
	Hindered by low system performance	[10, 13, 20]
	Hindered by software error	[10, 13]
Outcome	Easy to use	[19, 20, 33]
	Efficient tool for communication with GPs	[10, 19]

The questionnaire items were rated on a five-point Likert scale as follows: (1) strongly disagree; (2) disagree; (3) neither agree nor disagree; (4) agree; and (5) strongly agree. The Cronbach's alpha exceeded 0.7, indicating acceptable reliability [34].

In order to test the validity of the questionnaire, a selection of the items was summarized and correlated against the item "efficient tool for communication with GPs" which is the questionnaire's last and overall and concluding question. Pearson's r was 0.57 ($p < 0.001$),

indicating a fairly strong correlation between the overarching concept and the operationalization we used, but also that there may be items or facets of items that should have been included in the questionnaire. However, we also wanted to keep the questionnaire short, to achieve a high response rate.

Data collection

The questionnaire data were collected from home healthcare nurses in 12 municipalities in Norway. The inclusion criteria for the municipalities were that the e-messaging system had been in use for more than 6 months. After this time, we assumed that its usage would have become stable [35]. These municipalities were the first in Norway to introduce e-messaging to support communication between home healthcare nurses and GPs, and were the only municipalities that met this inclusion criteria at the time. All the home healthcare nurses were employed in a 50% FTE or more position, had been using e-messaging for 3 months or more, and were able to read and write Norwegian. The home healthcare nurses received the questionnaire, information letter, and return envelope at their workplaces from a designated contact person in each municipality. The contacts were responsible for distributing collective reminders and for collecting the envelopes with the questionnaire. There were 681 nurses qualified to answer the questionnaire, and it was given to 632.

Ethical considerations

The home healthcare nurses who were invited to answer the questionnaire received written information explaining that their participation was anonymous and that returning the questionnaire meant that they were considered to have agreed to participate in the study. The method for data collection and for handling the interviews and questionnaire were approved by the Norwegian Social Science Data Services, which is the official data protection agency for research in the University of Oslo (Ref. nr. 26230).

Data analysis

In the pre-analysis of the data, we searched for outliers on the continuous variables and the results showed that it was not necessary to transform any of them. We used +/−3.30 standard deviation (SD) for monitoring the outliers, as implied by Altman [36]. Two variables had outliers: ‘years in current position’ with 24 years (0.9 %) in the positive direction and ‘number of months using e-messaging’ with 37 months (1.3 %). However, there is no reason

to believe that working for a long time in the same position or having used the e-messaging system for 37 months could affect the results.

We also checked for homoscedasticity in both logistic regression models by using a one-way analysis of variance of the standardized residuals. In the first model predicting the e-messaging system as an efficient tool for communication with GPs, the item "easy to use" was tested and there were no statistically significant differences ($p = 0.76$) between the prediction errors in the group that found the e-messaging system an efficient tool for communication with GPs and the group that did not. In the second model predicting the e-messaging system as easy to use, we did the same with the predictors "received training" ($p = 0.88$), "hindered by poor functionality" (0.84), and "full-time equivalent percentage" ($p = 0.77$).

We also tested for possible multicollinearity among the independent variables in both models, using the Pearson correlation. No correlations were above 0.76, which was between age and years of experience as an RN, indicating that there was no multicollinearity [37]. We used descriptive analysis for presenting the characteristics of the sample and the nurses' assessments of using e-messaging. Two logistic regression models were developed to determine which factors, and to what extent, influenced the odds that the nurses would report that e-messaging was an efficient tool for communication with GPs and that it was easy to use. In the logistic regression analysis, we dichotomized the variables as agree/strongly agree (4–5), and neutral, disagree, and strongly disagree (1–3).

In the first logistic regression model predicting e-messaging as an efficient tool for communication with GPs, drawing on the interview results, previous research and literature, we chose to include the independent variables of 'easy to use' and the home healthcare nurses' demographic characteristics of 'age', 'gender', 'full-time equivalent percentages', 'years of experience as a registered nurse (RN)', 'years in current position', and 'number of months using e-messaging'. The independent variable 'easy to use' was replaced by dummy variables. The dummy variables were divided into: dummy 1 = 'Strongly disagree, Disagree and Neutral', dummy 2 = 'Agree' and dummy 3 = 'Strongly agree'. The p-value of the Hosmer and Lemeshow goodness of fit statistic for the first model was 0.516.

In the second logistic regression model, the dependent variable of 'easy to use' was combined with the independent variables of 'received training', 'access to user support', 'hindered by

poor functionality', 'hindered by low system performance', and 'hindered by software error', in addition to the home healthcare nurses' characteristics. The p-value of the Hosmer and Lemeshow goodness of fit statistic for the second model was 0.650. The data were analyzed using the IBM SPSS Statistics version 20.

Results

Characteristics of home healthcare nurses participating in the quantitative phase

Four hundred twenty-five (67%) home healthcare nurses completed the questionnaire. The demographic information is presented in Table 2.

Table 2. Demographic information about the home healthcare nurses

Demographic characteristics	Mean		N = 425
Gender:			
Female (n)	90.4	(383)	424
Male (n)	9.6	(41)	
Age mean (SD)	39.6	(10.1)	424
Years of experience, mean (SD)	11.5	(9.1)	421
Full-time equivalent percentage, mean (SD)	90.9	(14.2)	425
Years in current position, mean (SD)	5.8	(5.6)	422
Number of months using e-messaging, mean (SD)	10.21	(7.5)	382

Home healthcare nurses' assessments of e-messaging

The vast majority of home healthcare nurses (97%) agreed or strongly agreed that e-messaging was an efficient tool for communication with GPs, as shown in Table 3.

Table 3 Assessments of using e-messaging (N = 425)

Dimensions	Item	Strongly disagree % (n)		Disagree % (n)		Neutral % (n)		Agree % (n)		Strongly agree % (n)		Total %	Missing n
Organizational	Received training	2	(7)	6	(24)	9	(35)	51	(203)	32	(130)	100	26
	Access to user support	1	(5)	4	(14)	29	(114)	53	(206)	13	(50)	100	36
Tool/technology	Hindered by poor functionality	19	(74)	50	(198)	23	(92)	7	(26)	1	(5)	100	30
	Hindered by low system performance	19	(77)	50	(196)	24	(93)	6	(25)	1	(5)	100	29
	Hindered by software error	22	(85)	46	(181)	17	(68)	13	(52)	2	(9)	100	30
Outcome	Easy to use	0	(1)	1	(6)	9	(34)	53	(210)	37	(147)	100	27
	Efficient tool	-		1	(3)	2	(8)	32	(127)	65	(261)	100	26

For the easy to use e-messaging item, most of the home healthcare nurses agreed or strongly agreed (90%) that e-messaging was easy to use. A high proportion of the home healthcare nurses agreed or strongly agreed that they had received training (83%), while the rest were neutral or disagreed. The home healthcare nurses agreed to a lower degree that they had access to user support (66%). Finally, a relatively high proportion of the home healthcare nurses were neutral or agreed that they were hindered when using e-messaging because of poor functionality (31%), low system performance (31%), or software errors (32%).

Predictors that affected the nurses' assessments of e-messaging as an efficient tool for communication with GPs

The logistic regression model showed that the 'easy to use' item gave a statistically significant contribution to the model (Table 4).

Table 4 Logistic regression model examining predictors affecting assessments of e-messaging as an efficient tool (N = 391)

	B (S.E)	**p-value**	**Odds ratio (95% CI)**
Gender	−0.226 (1.167)	0.847	0.798 (0.081–7.857)
Age	−0.089 (0.048)	0.064	0.915 (0.832–1.005)
Years of experience as an RN	0.002 (0.045)	0.956	1.002 (0.918–1.094)
Full-time equivalent percentage	0.027 (0.019)	0.160	1.028 (0.989–1.068)
Years in current position	0.134 (0.092)	0.146	1.144 (0.954–1.371)
Easy to use (dummy 2)	1.772 (0.745)	0.017	5.882 (1.365–25.337)
Easy to use (dummy 3)	2.596 (1.152)	0.024	13.408 (1.403–128.090)
Constant	3.026 (2.641)	0.252	20.605

The odds for reporting that e-messaging was an efficient tool were over five times higher (OR=5.9, p= .017) if the nurses agreed, and over 13 times higher (OR=13.4, p=0.024) if the nurses strongly agreed, that e-messaging was easy to use. The model was controlled for the demographic variables of gender, age, years of experience as an RN, full-time equivalent percentage, and years in current position.

Predictors that affect the nurses' assessments of e-messaging as easy to use

The next question that arose was what factors would influence the assessment of e-messaging as easy to use. The results from the logistic regression model (Table 5) show that the

independent variables ‘hindered by poor functionality’, ‘training received’, and ‘full-time equivalent percentage’ were statistically significant.

Table 5 Logistic regression model examining predictors affecting assessments of e-messaging as easy to use (N = 364)

	B (S.E)	p-value	Odds ratio (95% CI)
Gender	−0.561 (0.796)	0.480	0.570 (0.120–2.713)
Age	−0.049 (0.038)	0.193	0.952 (0.884–1.025)
Years of experience	−0.015 (0.039)	0.701	0.985 (0.913–1.063)
Full-time equivalent percentage	0.031 (0.016)	0.045	1.032 (1.001–1.064)
Years in current position	−0.030 (0.043)	0.488	0.971 (0.893–1.056)
Number of months using e-messaging	−0.030 (0.030)	0.318	0.971 (0.915–1.029)
Hindered by low system performance	−0.633 (0.731)	0.387	0.531 (0.127–2.226)
Hindered by software error	−0.094 (0.548)	0.863	0.910 (0.311–2.664)
Hindered by poor functionality	1.933 (0.712)	0.007	6.914 (1.713–27.899)
Received training	1.890 (0.494)	<0.001	6.622 (2.515–17.437)
Having access to user support	0.170 (0.479)	0.722	1.186 (0.464–3.031)
Constant	1.053 (2.001)	0.599	2.867

The higher the full-time equivalent percentage the nurses worked, the higher the odds that they would experience e-messaging as easy to use. If the home healthcare nurses agreed that they were not hindered by poor e-messaging functionality, the odds of agreeing that e-messaging was easy to use were over 6.9 times higher than if they did not agree. The home healthcare nurses who agreed that they had received training had odds of over 6.6 times higher of agreeing that e-messaging was easy to use. The home healthcare nurses’ gender, number of months using e-messaging, full-time equivalent percentage, being hindered by low system performance or software errors, or having access to user support were not statistically significant predictors for assessment of e-messaging as easy to use.

Discussion

The results from this study show that individual, organizational, and technological factors are interrelated and affect home healthcare nurses’ assessments of using e-messaging to communicate with GPs. This is in line with a socio-technical approach [18]. This study demonstrated that the majority of the home healthcare nurses assessed the e-messaging

system as an efficient tool for communication with GPs. The realization of an ICT system relies on the participation of the people who are intended to use it [17]. This is a key factor, so that the system fits the needs and working practices of the users, in this case, home healthcare nurses. ICT development and implementation projects in healthcare could be controversial because ICT systems change organizational routines and relations between different healthcare professionals. To prevent resistance and non-utilization of the ICT systems, users need to be thoroughly and systematically involved at an early stage in the development and implementation process [18]. When the e-messaging system was developed and implemented, several home healthcare nurses did participate both in specifying the requirements, and in the development and implementation phases [25]. Their involvement in the development and implementation may have resulted in the e-messaging system aligning better with nurses' needs and working practices than it otherwise would have, and therefore led to a positive assessment of the e-messaging system.

The only statistically significant predictor for the home healthcare nurses assessing e-messaging as an efficient tool for communication with GPs was that they considered e-messaging easy to use. This is supported by a study of healthcare professionals' adoption and use of a clinical information system, which showed that advanced use of the system required that it was easy to use [33].

Ease of use is one of the most frequent factors reported among studies of facilitators and barriers to the adoption of ICT systems in healthcare [19]. Ease of use is related to individual factors, technical factors, and organizational factors. We found that only one individual factor, full-time equivalent percentage, was a statistically significant predictor for e-messaging being easy to use. Previous research has reported opposing evidence that individual factors such as age, gender, years of experience as a nurse, and full-time or part-time work affect the assessment of ICT systems [3, 7, 38-40]. However, we did find that the higher the full-time equivalent percentage the home healthcare nurses worked, the more likely they were to assess e-messaging as easy to use. This could be explained by the hypothesis that the more time home healthcare nurses spend at work, the more they have access to training, user support, and help from their colleagues, and thus the more familiar they become with using e-messaging. This could result in a more positive experience and assessment of the e-messaging system.

Tools/technical concerns such as functionality and system design are important factors both as barriers and facilitators for the implementation and use of ICT systems in healthcare [22]. In our study, not being hindered in their use of e-messaging because of poor functionality was the strongest predictor for the home healthcare nurses' assessments of e-messaging as easy to use. This is supported by another study on nurses' assessments of healthcare technology, which revealed that poor system design was among the most common factors for negative attitudes [11]. Ease of use is also related to the technical environment and the integration between ICT systems. In a study on usability, the results showed that physicians rated ICT systems as low because integration between the ICT systems was insufficient [10]. In this study, the technological environment was important for the way in which the e-messaging system was integrated into the EHR systems which the home healthcare nurses were already using. The user interface was well known, which lowered the threshold for implementing and adopting it, and therefore for assessing it as easy to use [14].

Assessments of ICT systems are affected by organizational aspects such as offering user support and training [10]. Our results show that a high proportion of the home healthcare nurses had received training, and that this was a strong predictor for assessing the e-messaging system as easy to use. Training has previously been identified as a key factor for the successful implementation of ICT systems in complex systems such as healthcare services [6, 8, 13, 41, 42]. Training and education are important in ensuring that the systems are used in the intended way, and in reducing the risk of incorrect use, which jeopardizes patient safety [6, 13, 21]. Nurses' use of ICT systems is affected by training in both basic ICT and the specific software [3, 22, 43]. Education and training in using ICT systems is not prioritized in nursing education [44, 45]. This means that newly-educated nurses are often not prepared for the reality that meets them when they start work. Training at different levels should therefore be offered by organizations and must be tailored to the individual needs of home healthcare nurses [46].

By applying the socio-technical perspective, it has been possible to detect and predict which factors were important for the development and implementation of e-messaging. All of these factors are interrelated and shape the socio-technical system that should be considered when developing and implementing new technology in home healthcare services [18].

Limitations

The mean full-time equivalent percentage may have been falsely high because one of the inclusion criteria for participation in the study was that the nurses had to be engaged in a 50% FTE or more position. This was necessary to ensure that they had enough experience of using e-messaging. According to the Norwegian Nurses Organization, in 2011, 56% of the nurses in primary care in Norway worked in a part-time position, and 15% of those had less than a 50% position [47]. The odds for the full-time equivalent percentage predictor could therefore have been higher than the results showed. Another factor that may have biased the results was that the home healthcare nurses who participated in this study worked in the municipalities that were the first in Norway to implement e-messaging. This may have caused the home healthcare nurses to be especially encouraged and enthusiastic, as well as technologically optimistic and positive toward e-messaging.

The strength of this study is in the sample, which consisted of home health care nurses in all the municipalities that had used the e-messaging system for 6 months or more at the time of the study. The response rate of the study was 67%, which can be considered fairly good for a questionnaire study [48].

Conclusions

By identifying factors that affect home healthcare nurses' assessments of e-messaging in their communication with GPs, we are better able to determine which interventions are most important when developing and implementing e-messaging. This study has demonstrated that home healthcare nurses assessed e-messaging as an efficient tool for communication with GPs. It also shows that ICT systems have to be easy to use in order to be assessed as an efficient tool, and that working a higher full-time equivalent percentage, having received training, and not being hindered by poor functionality are important predictors for the assessment of the e-messaging system as easy to use. Our results imply that users should be actively involved in the development and implementation of ICT systems. Future studies should have a socio-technical approach, which takes into consideration the whole range of factors that could affect working practices, and the outcomes for the patients and organizations involved. These insights may help to increase understanding about effective strategies for developing and implementing ICT systems in home healthcare services.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

ML designed the work, conducted the analysis, and wrote the first draft of the paper. DH contributed toward the design of the work and to the statistical analysis. AG contributed to the design of the work and to the statistical analysis. RH contributed toward the design of the work, the data collection, and to the statistical analysis. All of the authors revised the manuscript, and read and approved the final manuscript.

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III

Appendix

Questionnaire

Om deg selv *(kryss av og skriv i boksene)*

1 Hvilken kommune jobber du i? _____

2 Er du kvinne ☐ mann ☐

3 Hva er din alder? ☐☐ år

4 Hvor lenge har du jobbet som sykepleier? ☐☐ antall år

5 Hvilken stillingsstørrelse har du? ☐☐ % stilling

6 I hvor mange år har du vært i nåværende stilling? ☐☐ antall år

7 Hvor mange pasienter er det i din sone/avdeling/gruppe? ☐☐ ca. antall

8 Hvor mange ansatte er det i din sone/avdeling/gruppe? ☐☐ ca. antall

Om informasjonsutveksling med fastlegene

9. Jeg opplever at ……..
(Vennligst svar på alle delspørsmålene)

		Helt uenig	Uenig	Verken enig eller uenig	Enig	Helt enig
a	det finnes gode retningslinjer for hvordan vi skal utveksle pasientopplysninger med fastlegene ..…….……	☐	☐	☐	☐	☐
b	det er lett å få kontakt med fastlegene ……..	☐	☐	☐	☐	☐
c	vi har faste personer som er ansvarlig for å ta i mot opplysninger og henvendelser om pasientene fra fastlegene……	☐	☐	☐	☐	☐
d	samarbeidet med fastlegene følges opp ved ansattes fravær i hjemmesykepleien (syk, ferie, turnus, redusert stilling) …….	☐	☐	☐	☐	☐

10. Jeg opplever at ……..

(Vennligst svar på alle delspørsmålene)

		Alltid	Ofte	Noen ganger	Sjelden	Aldri
a	jeg gir god informasjon til fastlegen før pasienten skal til legetime ..……	☐	☐	☐	☐	☐
b	jeg får god informasjon fra fastlegen når pasienten har vært til legetime …….	☐	☐	☐	☐	☐
c	jeg får god informasjon fra fastlegen hvis det oppstår endringer i pasientenes tilstand eller situasjon ……..	☐	☐	☐	☐	☐

T T

11. Ca. hvor mange ganger de siste 14 dagene har du <u>mottatt</u> opplysninger eller henvendelser om pasientene fra fastlegene på følgende måte? *(Vennligst svar på alle delspørsmålene)*

		Ca. antall ganger
a	Telefon ……..	
b	Brev ……	
c	Brev/notat som leveres med pasienten/pårørende ……..	
d	Møte ……...	
e	Muntlig beskjed via pasient/pårørende ……...	
f	Telefaks ……..	

12. Ca hvor mange ganger de siste 14 dagene har du <u>gitt</u> opplysninger eller sendt henvendelser om pasientene til fastlegene på følgende måte? *(Vennligst svar på alle delspørsmålene)*

Ca. antall ganger

Om innholdet i informasjonsutvekslingen

13.	**Jeg mener at følgende informasjon er viktig <u>å få fra</u> fastlegen for å utføre god helsehjelp til en pasient** *(Vennligst svar på alle delspørsmålene)*	Helt uenig	Uenig	Verken enig eller uenig	Enig	Helt enig
a	Legemiddelopplysninger …… ……	☐	☐	☐	☐	☐
b	Cave/Allergier ……..……..	☐	☐	☐	☐	☐
c	Medisinske diagnoser…..……	☐	☐	☐	☐	☐
d	Hvilken behandling og oppfølging pasienten får ……..…	☐	☐	☐	☐	☐
e	Pasientens funksjonsnivå …….....	☐	☐	☐	☐	☐
f	Informasjon gitt til pasient/pårørende ……	☐	☐	☐	☐	☐

14.	**Jeg har som oftest oppdaterte opplysninger i pasientjournalen om……** *(Vennligst svar på alle delspørsmålene)*	Helt uenig	Uenig	Verken enig eller uenig	Enig	Helt enig
a	Legemidler …….	☐	☐	☐	☐	☐
b	Cave/Allergier ……	☐	☐	☐	☐	☐
c	Pasientens problemer og behov.. …….	☐	☐	☐	☐	☐
d	Hvilken behandling og oppfølging pasienten får ……..…	☐	☐	☐	☐	☐
e	Pasientens funksjonsnivå ……	☐	☐	☐	☐	☐
f	Informasjon gitt til pasient/pårørende ……	☐	☐	☐	☐	☐

T T

Om dine forventninger til elektronisk informasjonsutveksling med fastlegene

15. Jeg tror at bruk av elektronisk informasjonsutveksling mellom hjemmesykepleien og fastlegene fører til
(Vennligst svar på alle delspørsmålene)

		Helt uenig	Uenig	Verken enig eller uenig	Enig	Helt enig
a	Færre legemiddelhåndteringsfeil	☐	☐	☐	☐	☐
b	At det er færre feil knyttet til behandling og omsorg	☐	☐	☐	☐	☐
c	At behandling og tiltak starter raskere	☐	☐	☐	☐	☐
d	Bedre kjennskap til pasientenes problemer og behov	☐	☐	☐	☐	☐
e	Mer direkte pasienttid …….....	☐	☐	☐	☐	☐
f	Bedre dokumentasjon av helsehjelp …….	☐	☐	☐	☐	☐
g	Mer oppdaterte opplysninger i pasientjournalen …….	☐	☐	☐	☐	☐
h	At jeg bruker mindre tid på å få kontakt med fastlegen	☐	☐	☐	☐	☐
i	At det blir lettere å samhandle med fastlegene……..	☐	☐	☐	☐	☐
j	En økning i antall henvendelser fra fastlegene ……	☐	☐	☐	☐	☐

Om elektronisk informasjonsutveksling med fastlegene

*(Spørsmål 16 – 20 besvares **kun** hvis du har tatt i bruk elektronisk informasjonsutveksling med fastlegene)*

16. Hvor lenge har du kommunisert elektronisk med fastlegene? ☐☐ Antall mnd

.

17. Hvis du forventer svar på en elektronisk melding fra fastlegen, når får du vanligvis svar?
(Vennligst svar på ett alternativ)

a Samme dag ……..... ☐
b Etter 1 - 2 virkedager ……..... ☐
c Etter 3 virkedager eller mer..... ☐

T T

18. Hvis du ikke får svar fra fastlegene innen 3 virkedager hva gjør du da? *(Det kan krysses av for flere alternativer)*

a Ringer ……..... ☐
b Sender ny elektronisk melding ..…….. ☐
c Drar til kontoret til fastlegen…….. ☐
d Sender brev i posten ……..... ☐
e Sender telefaks ……. ☐
f Kontakter legevakten……. ☐

Om bruk av de elektroniske meldingene

19. Jeg opplever at jeg hindres eller forsinkes i å bruke de elektroniske meldingene
(Vennligst svar på alle delspørsmålene)

		Helt uenig	Uenig	Verken enig eller uenig	Enig	Helt enig
a	fordi datamaskinene er i bruk av andre	☐	☐	☐	☐	☐
b	pga. av datafeil, systemhavari eller andre datamaskinavhengige problemer	☐	☐	☐	☐	☐
c	fordi pleie- og omsorgssystemet arbeider for langsomt ….	☐	☐	☐	☐	☐
d	pga. dårlig funksjonalitet i pleie- og omsorgssystemet……	☐	☐	☐	☐	☐

20. Jeg opplever at …
(Vennligst svar på alle delspørsmålene)

		Helt uenig	Uenig	Verken enig eller uenig	Enig	Helt enig
a	jeg har tilgang til brukerstøtte ..……	☐	☐	☐	☐	☐
b	jeg har fått opplæring i bruk av de elektroniske meldingene.	☐	☐	☐	☐	☐
c	det er lett å bruke de elektroniske meldingene	☐	☐	☐	☐	☐
d	det er for mange typer elektroniske meldinger ……...	☐	☐	☐	☐	☐
e	det er vanskelig å velge hvilken melding jeg skal bruke …..	☐	☐	☐	☐	☐
f	de elektroniske meldingene er et godt verktøy for informasjonsutveksling med fastlegene ……	☐	☐	☐	☐	☐

Tusen takk for at du tok deg tid til å svare på spørreskjemaet!