

## Computerized Decision Support System in Nursing Homes

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in Nursing Homes**

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## Abstract

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The overall aim of this thesis was to study the thinking strategies and clinical reasoning processes of registered nurses (RNs) and to implement and test a computerized decision support system (CDSS) integrated into the electronic health care record (EHR) for preventing pressure ulcers (PUs) and malnutrition among residents in nursing homes.

A think-aloud (TA) study with a purposeful sample of RNs (n=30) was conducted to explore their thinking strategies and clinical reasoning (Paper I). A quasi-experimental study with a convenience sample of residents (at baseline, n=491 and at follow-up, n=480) from nursing homes (n=15) allocated into two intervention groups and one control group was carried out in 2007 and 2009 (Paper II). In Paper III residents' records were reviewed with three instruments. Nursing personnel (n=25) from four nursing homes that had used the CDSS for eight months were interviewed and the CDSS was tested by nursing personnel (n=5) in two usability evaluations (Paper IV).

The results showed that the RNs used a variety of thinking strategies and a lack of systematic risk assessment was identified (Paper I). The proportion of malnourished residents decreased significantly in one of the intervention groups after implementing the CDSS, however there were no differences between the groups (Paper II). The CDSS resulted in more complete and comprehensive documentation of PUs and malnutrition (Paper III). The nursing personnel considered ease of use, usefulness and a supportive work environment as the main facilitators of CDSS use in nursing homes. Barriers were lack of training, resistance to using computers and limited integration of the CDSS within the EHR system (Paper IV). In conclusion, the findings support integrating CDSSs into the EHR in nursing homes to support the nursing personnel.

*Keywords:* computerized decision support, intervention study, malnutrition, nursing documentation, pressure ulcer, qualitative content analysis, think-aloud interviews, usability evaluation.

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## ORIGINAL PAPERS

This thesis is based on the following original papers;

- I. Fossum, M., Alexander, G. L., Göransson, K. E., Ehnfors, M., Ehrenberg, A. (2011) Registered Nurses' Thinking Strategies on Malnutrition and Pressure Ulcers in Nursing Homes: A Scenario-based Think-Aloud Study, *Journal of Clinical Nursing*, 20, (17-18), 2425-2435.
- II. Fossum, M., Alexander, G. L., Ehnfors, M., Ehrenberg, A.(2011) Effects of Computerized Decision Support System for Pressure Ulcers and Malnutrition in Nursing Homes for the Elderly, *International Journal of Medical Informatics*, 80,(9), 607-617.
- III. Fossum, M., Ehnfors, M., Svensson, E., Hansen M.L., Ehrenberg, A. Effects of a Computerized Decision Support System on Nurses Care Planning for Pressure Ulcers and Malnutrition in Nursing Homes (*Submitted*).
- IV. Fossum, M., Ehnfors, M., Fruhling, A., Ehrenberg, A. (2011) An Evaluation of the Usability of a Computerized Decision Support System for Nursing Homes, *Applied Clinical Informatics*, 2,(4), 420-436.

All papers are referred to in the text by Roman numerals. Reprints of papers I, II and IV were made with permission from the publisher.

## ABBREVIATIONS AND DEFINITIONS

CDSS	Computerized decision support system: The use of the computer to bring relevant knowledge to bear on the health care and well-being of the patient (Greenes, 2007, p. 6)
CIS	Computer information system
EBP	Evidence-based practice: A clinical problem-solving strategy that emphasizes the integration of best available evidence from disciplined research with clinical expertise and patient preferences (Sackett, 1997, p. 3)
EHR	Electronic health care record
EPUAP	The European pressure ulcer advisory panel
GUI	Graphical user interface
ICT	Information and communication technology
IS	Information system: The manual and/or automated component of a system or users or people, recorded data, and actions used to process the data into information for a user, group of users, or an organization (McGonigle and Mastrian, 2008, p. 456)
MNA®	Mini nutritional assessment (Guigoz, 2006)
Malnutrition	Inadequate nutritional status, used for either the undernourished or overnourished. Undernourishment is characterized by insufficient dietary intake, poor appetite, muscle wasting and weight loss (Chen et al., 2001, p. 139)
NA	Nursing aide
PARiHS	Promoting Action on Research Implementation in Health Services

PU	Pressure ulcer: A pressure ulcer is an area of localized damage to the skin and underlying tissue caused by pressure or shear and or a combination of these [EPUAP] (Beeckman et al., 2007, p. 683)
RAPS	Risk assessment pressure sores scale
RN	Registered nurse
TA	Think-aloud
TAM	Technology acceptance model
Clinical decision-making	Choosing between clinically alternatives (Thompson and Dowding, 2002)
Clinical practice guidelines	Systematically developed statements to assist practitioner and patient decisions about appropriate health care for specific clinical circumstances (Institute of Medicine, 1992, p. 27)
Clinical reasoning	A recursive cognitive process that uses both inductive and deductive cognitive skills to simultaneously gather and evaluate assessment data (Simmons et al., 2003, p. 701)
Thinking strategies	The thinking (“mental rules”) that nurses use in clinical practice (Fonteyn, 1998, p. 3)

## INTRODUCTION

Work in health care services is more than ever influenced by use of information and communication technology (ICT). Positive effects are expected by introducing computer information systems (CISs) to support clinical problem solving, reducing errors and increasing healthcare efficiency. In 2006, when I started my PhD studies, positive effects of implementing CISs, like electronic health care records (EHRs), seemed far from the reality for the health care professionals and the patients in the health care services. The CISs are expected to play a key role to increase the use of evidence-based practice (EBP), which is a major goal for the health care services. The introduction of CISs represents a considerable change in health care professionals' duties, pattern of cooperation and work processes. This emphasizes special concerns when designing, developing and implementing CISs in health care services. However, these challenges are often more behavioural than technical. Health care professionals produce an enormous amount of data and are increasingly put into situations where they have to think fast and process large amounts of data and information to carry out their work and make high quality evidence-based decisions.

Computerized decision support systems (CDSSs) can be used to organize available knowledge, evidence and risk factors and have shown potentials to improve patient outcomes (Garg et al., 2005; Kawamoto et al., 2005). EHRs, including CDSSs, have been proposed as a way to achieve optimal quality and continuity in health care services. However, despite the potential benefits of using CDSSs in health care services, studies examining how such a system can be used to support evidence-based decision-making of nursing personnel are sparse.

Nursing homes were chosen as the setting for this project because quality of care has been stressed (The National Directorate for Health and Social Affairs, 2005) and that nursing personnel have an expanded role with a high degree of responsibility for the quality of care provided. A recent research report describes concerns for the quality of health care for older people in Norway (Gautun and Hermansen, 2011). Thus, there is considerable potential for improvement of care quality, if nursing personnel are equipped with adequate support. The terms nursing personnel and nurses are used synonymously and include both registered nurses (RNs) and nursing aides (NAs).

To develop, implement and gain experiences of a CDSS to support knowledge-based care for older people are the motives for this thesis. Therefore this thesis addresses several aspects of nurses' clinical reason-

ing, decision-making and how a CDSS, incorporated in the EHRs, can enhance the content and completeness in nursing documentation and improve resident outcomes. A further purpose has been to evaluate the residents' outcomes on prevalence of pressure ulcers (PUs) and malnutrition and the nursing personnel's experiences of using a CDSS.

## **BACKGROUND**

The main goal of nursing practice is to provide high quality nursing care. The nursing personnel are responsible for having sufficient knowledge, skills, judgment and following policies and procedures to provide the residents with optimal care. However, there are several examples from studies of health care describing an existing gap between available knowledge and the actual care provided (Källman and Suserud, 2009; Persenius et al., 2008; Wipke-Tevis et al., 2004). Although performing PU risk assessment is recommended for residents in care for older people, studies have shown that valid and reliable PU risk assessment tools are underused or inappropriately used (Källman and Suserud, 2009; Wipke-Tevis et al., 2004). The Norwegian Knowledge Centre for the Health Services has recently conducted a review of randomly selected health care records from five hospitals. The results showed that 16 % of the hospital admissions included at least one adverse event and 8.9 % of the events led to prolonged hospital stay or more serious consequences such as increased mortality. Patient harm that led to death was the consequence in 0.7 % of the adverse events (Deilkås, 2010). Concerns about the quality of care in nursing homes have been reported (Gorski and Hackbarth, 2005; Malmedal et al., 2009; Slettebø et al., 2010; Wipke-Tevis et al., 2004).

EBP, as a thoughtful integration of the best available evidence, coupled with clinical expertise and resident preferences has been increasingly emphasised to improve the quality of care (Institute of Medicine Committee on Quality of Health Care in America, 2001; Kitson et al., 1998; Lemieux-Charles and Champagne, 2004). EBP involves clinical reasoning and decision-making on the best available evidence. A better understanding of the clinical reasoning processes used in clinical practice may contribute to increase the use of EBP.

### **Clinical reasoning in nursing**

Clinical reasoning is an important part of nurses' performance and is central to the delivery of safe and effective high quality care (Simmons et al., 2003). Nursing personnel are working more and more autonomously and are taking responsibility for an increased number of clinical decisions in health care services (Dowding et al., 2009b). The concept clinical reasoning is often used synonymously with clinical decision-making and clinical judgment to describe thinking strategies that nurses use in their clinical analysis and when they make clinical decisions (Simmons, 2010).

Clinical reasoning can be defined as “a recursive cognitive process that uses both inductive and deductive cognitive skills to simultaneously gather and evaluate assessment data” (Simmons et al., 2003, p. 701). The measuring of the quality of judgment and/or decision-making in nursing practice is a very complex process (Dowding and Thompson, 2003) that requires methods and perspectives from different disciplines.

Different theoretical perspectives, such as normative, descriptive and prescriptive, have been used in studies of decision-making in nursing and can be separated into two theoretical categories: the systematic-positivist perspective and the intuitive-humanist perspective (Thompson, 1999). The systematic-positivist perspective is the theoretical basis for the Information Processing Theory (IPT) presented by Ericsson and Simon (1993). Their theory proposes that the human decision-making system can be separated into short-term and long-term memory with different capacities. Ericsson and Simon (1993) postulate that the information in the short-term memory is possible to verbalize. The IPT has been used as a basis in many studies in nursing to describe clinical reasoning in hospital care (Funkesson et al., 2007; Göransson et al., 2008; Simmons et al., 2003). In this work the IPT has been applied based on the belief that it is possible to support nurses to improve their clinical reasoning and decision making to increase the quality of care. In the IPT clinical reasoning can be described in different stages, including data gathering, data classification, data interpretation and explanation, as well as the selection of interventions.

Clinical reasoning strategies have mainly been studied in hospital care and rarely in nursing homes settings. More knowledge is needed on nurses’ clinical reasoning and decision-making as a basis for developing and implementing decision support systems to increase nurses’ evidence-based decision-making, especially for nursing home resident care.

## **Computerized decision support systems**

An information system (IS) can be defined as “the manual and/or automated components of a system or users or people, recorded data, and actions used to process the data into information for a user, group of users, or an organization” (McGonigle and Mastrian, 2008, p. 456). CDSSs are one sort of CISs. A CDSS can be defined as “the use of the computer to bring relevant knowledge to bear on the health care and well-being of the patient” (Greenes, 2007, p. 6). A CDSS, which may be passive or active, should be purposely designed to support ‘end-users’

decision-making. A passive system will provide 'end-users' with information, whereas more active systems may offer suggestions or actually present orders for decisions based on certain criteria (Greenes, 2007).

The implementation of CDSSs has shown to be an effective intervention to support EBP in that they can support the effectiveness of clinical judgment and decision-making with the potential to improve clinical performance and patient outcomes (Garg et al., 2005). As much as 50 % of CISs in general fail because of a poor developed system or because people do not use the CISs to their full potential (Lorenzi, 2004). It is therefore important to focus on all stages in the design, development, testing and implementation of CDSSs, especially non-technical challenges need to be looked at (Lorenzi, 2004; Lorenzi and Riley, 2000). However, not all areas of care are suitable for being supported by implementing CDSSs (Greenes, 2007).

The literature reports that most of the CDSSs, which have mostly focused on the performance of physicians, have been tested in laboratory experiments or in trials under controlled conditions (Kaplan, 2001). It is also important to evaluate CDSSs in natural settings before implementation on a large scale takes place. Sittig and colleagues (2006) studied physicians' experiences with the use of CDSS. The study concludes that many of the CDSSs were not always adhered to, but many clinicians appreciated the CDSS, stating that if they had enough time, they would have used the system more often.

In a systematic review of a 100 studies CDSSs improved practitioner (92 % of the studies had physicians as the primary users) performance in 62 (64 %) of 97 studies, but only 7 (13 %) of 52 trials showed improvement in patient outcomes (Garg et al., 2005), which rarely was addressed. CDSSs have shown positive effects on medication, prevention and treatment, as well as other parts of the medical treatment process but have not shown convincing effects on changing diagnostic procedures (Garg et al., 2005; Hunt et al., 1998). In a systematic review of randomized controlled trials Kawamoto and colleagues (2005) evaluated 70 studies with the aim to evaluate the ability of CDSSs to improve clinical practice. They found several features that were co-related with improvements in patient outcomes. These features were providing decision support automatically, delivering decision support at the time and location of decision-making, providing recommendation for action and using a computer to generate the decision support. Shojanian and colleagues (2009) conducted a systematic review (n= 28) to evaluate the effects on processes and outcomes of care attributable to on-screen computer reminders delivered to clinicians at the point of care. Their findings indi-

cate that point of care reminders generally achieve small to modest improvements in a clinician's behavior. The effectiveness of the CDSSs is also dependent on the quality of the knowledge-base that underlies it, together with the usability of these systems (Greenes, 2007). More research is needed to identify CDSSs' design and other technical factors associated with improvements.

CDSSs have been shown to have the potential to influence nurses' decision-making in integrating residents' data with evidence-based recommendations. The most effective CDSSs are integrated in the EHR (Anderson and Willson, 2008; Randell et al., 2007). Nurses are increasingly using CDSSs to support their clinical practice (Anderson and Willson, 2008; Randell et al., 2007). CDSSs have been tested in several areas of nursing care, including in the management of asthma (Eccles et al., 2002), diabetes (Cho et al., 2010), angina (Eccles et al., 2002) and triage assessments (Dowding et al., 2009a).

A national questionnaire survey from England examined the characteristics of the available CDSSs to nurses. The results showed that the availability of CDSSs for nurses varied depending on type of care (e.g., acute care, mental health care and primary health care) and the majority of these CDSSs did not have features associated with better patient outcomes or care processes (Mitchell et al., 2009). Most of the CDSSs were not systematically evaluated. In future research it is therefore recommended to focus on how CDSSs may have an impact on nurses' decision-making and the potential benefits from using CDSSs on patient outcomes (Mitchell et al., 2009). Two reviews on nursing studies regarding the development, use and application of CDSSs (Randell et al. 2007, Anderson & Willson 2008) showed that more research is needed to gain knowledge about how CDSSs can offer effective strategies for implementing EBP and how they should be designed. To obtain increased understanding of the factors influencing the implementation and acceptance of CDSS we also need to know more about facilitators and barriers that may have an impact on nurses' use of CDSSs.

To summarize, the literature shows that studies on the implementation of CDSSs are increasing and the results from these evaluations have demonstrated small to modest positive effects on mainly physicians' performance and patient outcomes. However, there is a lack of studies that evaluate nurses' use of CDSSs and their effects on health care outcome. The test settings have primarily been laboratories or under controlled conditions in clinical settings and the CDSS should be evaluated in more natural settings for its potential to support 'end-users' decision-making.

## **Implementation of new technology**

The investments in new technology, such as CISs to support health care, have dramatically increased in the past 30 years and the implementation of CISs often present significant challenges (Lorenzi, 2004). In 2003, monetary efforts to implement health information technology in Norway were estimated to be 52.2 million US dollars (Anderson et al., 2006). CISs must be accepted and used by the health care professional to produce the expected improvement in the quality of care and patient outcomes (Legris et al., 2003).

The technology acceptance model (TAM) developed by Davis (1989) is one of the most widely used models to understand peoples' use of CISs (Legris et al., 2003). The TAM model is presented in Figure 1. According to TAM, 'perceived usefulness' and 'ease of use' will lead to behavioral intention and ultimately to the actual use of technology. 'Perceived usefulness' is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989 p.320). 'Perceived ease of use' refers to "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989 p. 320). External variables such as management, economy, organizational challenges and time pressure can influence both the 'perceived usefulness' and the 'perceived ease of use' but can also have an impact on internal factors (e.g. attitude and behavioral intention to actually use the system) (Legris et al., 2003). A recent review conducted on studies using TAM in health care settings concluded that 'usefulness' may have a stronger impact on health care professionals' acceptance than 'ease of use' (Holden and Karsh, 2010). Additional research is recommended to develop a deeper understanding of the 'perceived usefulness' when developing, planning and implementing technology in health care (Holden and Karsh, 2010).

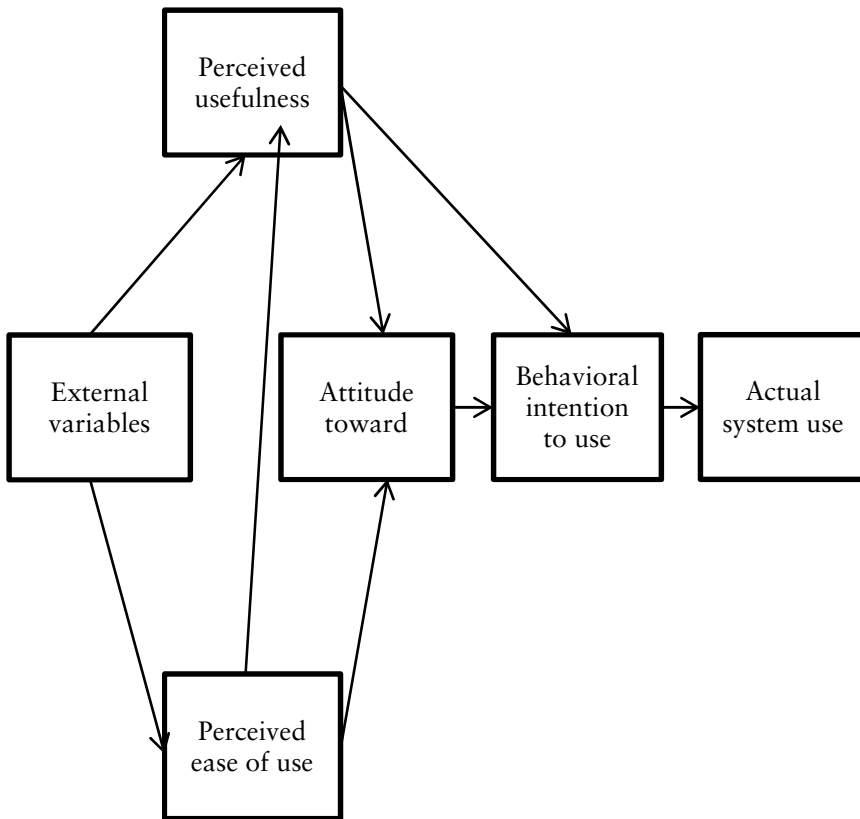


Figure 1. The technology acceptance model developed by Davis (1989) as illustrated by Legris et al. (2003, p. 193).

Several frameworks have been developed and evaluated to describe the process of transfer, translation and implementation of research evidence into daily clinical practice. Some models focus on the research used by individual clinicians (Stetler, 1989) and others focus more on contextual factors (Rycroft-Malone et al., 2002a). According to the Promoting Action on Research Implementation in Health Services (PARiHS) framework, successful implementation of research into practice is dependent on the quality of the context where the implementation should be conducted, the nature and level of the evidence being used and the type of facilitation required (Kitson et al., 1998; Perry et al., 2011).

The PARiHS framework has focused on context as one important factor together with evidence and facilitation. It is one of a few frameworks

that has been successfully tested in elderly care facilities (Perry et al., 2011). In addition, the study conducted in elderly care facilities showed that it is important to provide nursing personnel with enough time to adjust and adapt to the new ways of working (Perry et al., 2011).

The PARIHS framework has been developed by nurse researchers to support implementation of practice change in health care settings (Kitson et al., 1998; Rycroft-Malone et al., 2004a; Rycroft-Malone et al., 2002b). Reported factors by nursing personnel in individual and group interviews that are important for practice change showed good fit of the factors in the PARIHS framework (Perry et al., 2011).

In conclusion, several studies have indicated that many factors influence nurses' use of new technologies, including individual factors, external variables (e.g., management, economy, organizational challenges and time pressure), the nature and level of the evidence and the facilitation. However, few studies have explored the impact of 'perceived usefulness' and 'perceived ease of use' on nurses' use of CDSSs.

## **Facilitators and barriers in implementing computerized decision support systems**

In many countries there is pressure on nurses to take on more extended roles and work more autonomously in the healthcare system. CDSSs have been suggested to support nurses in these clinical practices (Dowding et al., 2009b). Nurses' use of CDSSs largely depends on their experiences and their ability to adapt the technology to 'fit' with local clinical practice and workflow. Rate of adoption of a new innovation is to which degree an innovation such as a CDSS is adopted by potential users. The different rates of adoption can be influenced by the compatibility between the innovation and if the innovation can be seen as consistent with existing values, past experiences and needs of potential adapters (Rogers, 1995). The ability of the CDSS to show relevance to clinical practice, through reduced variation and/or errors, is reported as essential for increasing the use of CDSS (de Veer et al., 2011; Dowding et al., 2009a).

A survey conducted to evaluate the implementation process on introducing new technology in health care in the Netherlands showed that only half of the implementation processes were positively evaluated by the nursing staff, including registered nurses (RNs) and nursing aides (NAs) (de Veer et al., 2011). Further, characteristics of the technology itself, the organizational and political context and the potential users are

regarded as critical factors on how nurses perceive new technology (de Veer et al., 2011). Technical skills, project management skills and people and management skills are needed to create a quality CIS in health care organizations (Lorenzi and Riley, 2003).

Two international evaluation studies have been published based on experiences using CDSSs in nursing homes (Alexander, 2008a; Alexander et al., 2007). Essentially, they showed that limited availability of equipment, training resources and limited presence of information technology support were associated with lower satisfaction among nurses when evaluating a CDSS (Alexander et al., 2007). To maximize benefits of a CDSS it is important that the nurses know how to use the system (Alexander, 2008a).

Another study of CDSS in seven Norwegian nursing homes showed significant changes in the endpoints: increased use of warfarin, decreased use of neuroleptics and a higher body weight rate (Krüger et al., 2011) as the use, understanding and perceived value of the CDSS increased among the health care professionals.

Several studies indicate the need to develop strategies to overcome barriers when implementing new technology (André et al., 2008; Patterson et al., 2005; Saleem et al., 2005; Toth-Pal et al., 2008). Furthermore, there is limited evidence about effective interventions to promote the adoption of CISs by health care professionals (Gagnon et al., 2009).

Barriers that may hinder a successful implementation of CDSSs have been reported by nurses in Australia. These barriers include work demands, lack of access to computers and lack of support (Eley et al., 2009). In a systematic review (André et al., 2008) health care personnel's negative attitude toward computer technology, lack of knowledge, role adjustment to the disruption of traditional work habits and changes in established work roles were identified as barriers.

The conclusion is that the number of studies on the implementation of CDSSs is increasing and demonstrating that the ability for the CDSS to show relevance to clinical practice is reported as essential for increasing the use. The CDSS should undergo systematic testing of its usability to increase the fit between nursing tasks and the CDSS. Such knowledge is important in increasing the use of CDSSs in nursing practice. More knowledge about the facilitators and barriers when implementing a CDSS is important for further development and testing in controlled studies in the care facilities of older people (Alexander, 2008b; Alexander and Wakefield, 2009; Krüger et al., 2011).

## **Nursing home care**

Society today has increasing requirements for quality and efficiency in health care services (though inadequate care frequently occurs, which, for example, has been reported by nurses in nursing homes) (Malmedal et al., 2009). An important goal for municipalities is to develop health care services that are characterized by good quality and continuity within limited means (The Ministry of Health & Care Services, 2009; The National Directorate for Health and Social Affairs, 2005). Older people in nursing homes have increasingly more advanced and complex requirements for professional health care services (Huber et al., 2009; The Ministry of Health & Care Services, 2009; The National Directorate for Health and Social Affairs, 2005). Differences in quality improvement activities in long-term care, including nursing homes and home-based care, have been reported (Kjøs et al., 2008). A recent empirical study conducted in Norwegian nursing homes described that both nurses and physicians faced difficult dilemmas based on inadequate staffing and lack of physicians and nurses (Slettebø et al., 2010). The demographic changes that results in an aging population, in conjunction with the lack of qualified health care professionals and the need to control health care costs without compromising quality and quantity, are suggested to be met with new technology (Institute of Medicine Committee on Quality of Health Care in America, 2001; The Ministry of Health and Care Services, 2009; The National Directorate for Health and Social Affairs, 2005).

Nurses have autonomy and responsibility for appraisal, planning, implementation and evaluation of health care in nursing homes. Documenting health care has been an obligation for nurses since 2001 in Norway (The Ministry of Health & Care Services, 1999). Nurses are responsible for the continuity of care and for information about residents' care to be available at all times. The residents' health records are central tools for nurses to deliver safe and high quality health care. Nurses are expected to use the nursing documentation in the EHR for efficient communication and collaboration.

High expectations have been expressed for more efficient and better quality health care as a result of the introduction of the EHR (The National Directorate for Health and Social Affairs, 2005), although results so far have been mixed (Cherry and Carpenter, 2011; Uslu and Stausberg, 2011). Nurses are the biggest group of employees in the care of older people and have the potential for making a major contribution to more efficient and better quality of care for residents in nursing homes.

## Quality indicators

To increase quality and safety in the care of older people in nursing homes it is crucial that care is more evidence-based. Quality indicators for nursing home care have been implemented in several countries (Australia, Denmark, England, Iceland, New Zealand, Norway and the USA), but there are variations in how these indicators have been developed and used (Hjaltadottir, 2012; Nakrem et al., 2009). Two examples of nursing sensitive quality indicators are PUs and nutritional status. For the present study, PUs and malnutrition were chosen as the topics for developing and implementing the CDSS. This choice was based on the close connection between these problems, the well documented challenges they present in nursing home care and their considerable potential for improvement of resident outcome. In addition, it is expected that nurses in nursing homes play a key role in the prevention of PUs and malnutrition.

## Pressure ulcers

Nursing home residents are reported to be at risk for PUs in that impaired health may increase both the risk of PU and the number of PUs (Capon et al., 2007; Meesterberends et al., 2011; Vanderwee et al., 2007). Implementing risk assessment scales for PU prevention has been suggested to reduce this rate (Meijers et al., 2008); however, risk assessment tools are still underused in nursing home settings (Wipke-Tevis et al. 2004). Instruments used for detection of risk for PUs differ in ease of use and in their reliability and validity. However, there is no generally accepted instrument that serves as a gold standard for identifying risk for PUs (Defloor and Grypdonck, 2004). A systematic review conducted on the Norton, the Waterlow, and the Braden risk assessment scales to consider the validity and reliability showed that further work is needed to explore the use and quality of these risk assessment scales (Anthony et al., 2008).

The prevalence of PUs varies between 14 and 25 % in nursing homes (Vanderwee et al., 2007; Whittington et al., 2004; Woodbury et al., 2004). Risk Assessment Pressure Sores (RAPS) scale, which is used for risk screening of PUs, is a further development of the modified Norton scale. The commonly used RAPS scale was chosen (Paper II and III) based on the fact that the RAPS scale has demonstrated reliability and validity in studies in hospital settings (Lindgren, 2003; Lindgren et al., 2002).

## Malnutrition

Malnutrition is a major problem in many health care settings (Meijers et al., 2009a; Meijers et al., 2009b) especially for older and disabled people. The prevalence of malnutrition varies between 15 and 60 % in hospitals (Green and Watson, 2006; Guigoz, 2006; Kagansky et al., 2005; Meijers et al., 2009a; Mowé et al., 2006; Vanderwee et al., 2011). This variation is partly due to type of clinical screening instrument used for measurement. Few studies have screened residents in nursing homes but the results are comparable with those of hospitals (Capon et al., 2007; Meijers et al., 2009b; Thompson et al., 2005). In a Swedish study conducted in elderly care facilities in municipality care one third of the residents were assessed as protein-energy malnourished (Wikby et al., 2006).

Different nutritional guidelines are available for screening of nutritional status (Gaskill et al., 2008; Guigoz, 2006; Söderhamn et al., 2011). Lack of skills and knowledge as well as lack of resources has been reported as barriers to using nutritional guidelines. Nutritional guidelines contribute to an increase in assessment of nutritional needs in daily practice (Meijers et al., 2008). In 2009, the national guidelines on prevention and treatment of malnutrition in Norway recommended the use of risk assessment tools when performing assessments on residents in nursing homes (Guttormsen, 2009). A study conducted in Scandinavian hospitals showed that nutritional risk assessments were not common in clinical practice (Mowé et al., 2006). Nonetheless, different screening instruments have been tested in the Norwegian health care setting, such as the Nutritional Form for the Elderly (NUFFE) (Söderhamn et al., 2009) and the Mini Nutritional Assessment (MNA®) tool (Fossum et al., 2009). In our study (Paper II and III) nutritional status was assessed with the MNA (Guigoz, 2006). The MNA tool has shown to be a useful and a reliable method to measure nutritional status for people over 65 years of age (Guigoz, 2006; Vellas et al., 2006).

PU and malnutrition in the elderly are associated with poor clinical outcomes, but have also been associated with increased morbidity, mortality, length of hospital stay and medical costs (Capon et al., 2007; Isabel et al., 2003; Kagansky et al., 2005). Both PUs and malnutrition can be prevented if residents at-risk are identified early and relevant preventive measures are implemented (Baier et al., 2003; Kondrup et al., 2003). To our knowledge no initiative has been taken to implement national guidelines for risk assessment of nursing home residents in Norway.

## **Rationale for the study**

There exists a gap between available knowledge about effective strategies in health care and what is actually practiced. This gap may cause that residents do not get high quality care based on the best available evidence. EBP may increasingly be emphasized to improve the quality of care. The literature shows that clinical reasoning and thinking strategies have been studied in clinical practice in hospitals, but studies from nursing homes are scarce. It is of importance to study nurses' clinical reasoning and decision-making as a knowledge base for developing and implementing decision support tools to facilitate nurses' decision-making in the care of older people.

In previous research it has been shown that CDSSs have the potential to improve nurses' decision-making and increase the quality of care provided, although there is a lack of research conducted to evaluate nurses' use of CDSSs in natural clinical settings, as well as a lack of evaluations of the effects on resident outcomes.

A number of studies have shown that individual factors, external factors, the nature and level of the evidence and the facilitation are important for implementation of practice change. The ability of the CDSS to show relevance to clinical practice is essential to increase perceived usefulness. We need to know more about whether CDSSs offer an effective strategy for translating evidenced-based knowledge into nursing practice. More research is needed to gain knowledge about how a CDSS can support effective strategies for implementing EBP and factors influencing the adoption of CDSS.

## AIMS

The overall aim of this thesis was to study RNs' thinking strategies and clinical reasoning processes, and to implement and test a CDSS integrated into the EHR for preventing PUs and malnutrition among residents in nursing homes. The thesis is based on four papers with the following specific aims:

- I. To explore the thinking strategies and clinical reasoning processes that RNs use during simulated care planning for malnutrition and PUs in nursing home care.
- II. To evaluate the effects on the risk for and prevalence of PUs and malnutrition of implementing a CDSS to improve prevention and care of PUs and also to improve nutrition in the elderly in nursing homes.
- III. To assess the effects of a CDSS on the completeness and comprehensiveness of the documentation of PUs and malnutrition in nursing homes.
- IV. To describe facilitators and barriers that impact the ability of nursing personnel to effectively use a clinical CDSS for planning and treating PUs and malnutrition and for following the suggested risk assessment guidelines for the care of nursing home residents.

## METHODS

This thesis includes three studies reported in four papers (I-IV). The studies have been conducted between 2007 and 2009 in nursing home settings in Southern Norway.

### Setting

The Norwegian healthcare system for older people has many similarities to the healthcare systems in the other Nordic countries. One common feature is that the health care services for older people are regulated as a part of the public health care services. The main differences are that Norway has the highest number of older people living in institutions (Hermansen, 2011), and that Norway, Finland and Iceland have focused more on institutional care and the service is organized more from a medical care model as compared with Sweden and Denmark, where the social model is common (Szebehely, 2005). The municipalities in Norway are responsible for providing care for older people (Blackman, 2000). At the time of the present studies, the nursing home settings included 997 institutions with 41318 beds in 435 municipalities, organized in 19 counties (Statistics Norway, 2010).

The residents in Norwegian nursing homes are mainly in need of long-term care and are provided with care 24 hours a day. A study conducted in 26 nursing homes (Selbaek et al., 2007) showed that of 933 residents, 20.1 % had mild dementia, 26.7 % had moderate dementia and 33.6 % had severe dementia, although only 48.8 % of the residents had the diagnosis dementia in their records. The residents are provided with assistance to all their activities of daily living, including medical care. Mainly RNs, NAs and nursing assistants (nurses without formal education) are working shift in the nursing homes. Some nursing homes provide the residents with physiotherapy and occupational therapy. The residents will be provided with medical care based on assessed needs. The physicians visit the nursing homes regularly, as well as being on call, but the number of hours and services provided varies between municipalities.

The nursing homes are organized differently based on economic resources of the municipalities, which may influence the composition of nursing personnel and the care provided (Szebehely, 2005). However, a systematic review on the relation between nurses and the quality of care in nursing homes showed that most of the studies were conducted in US nursing facilities and it was difficult to draw conclusions and offer recommendations related to the connection between staff-level employees and care provided (Spilsbury et al., 2011).

## **Overview of designs and methods**

This project is based on data collection with multiple designs and methods. Paper I had an explorative design and Paper IV had a descriptive design. Paper II and III have a quasi-experimental design, with two intervention groups and one control group. The design for the intervention study (Paper II and III) was chosen to study the effects of a CDSS. An overview of designs, samples and research methods for the four papers is given in Table 1. Figure 2 gives an overview over the time line for the intervention study (Paper II and III).

**Table 1.** Overview of the study designs, samples and research methods.

Papers	Design	Sample	Data collection	Data analysis
Paper I	Explorative design.	A purposeful sample of 30 RNs.	Think-aloud interviews.	Deductive content analysis.
Paper II	Quasi-experimental design with two intervention groups (IG1 and IG2) and one control group (CG).	A convenience sample of 491 residents before (2007) and 480 residents after (2009) the intervention.	Pre- and post measures using the MNA tool and the RAPS scale, including skin assessment.	Descriptive statistics. Non-parametric statistics: Kruskal-Wallis test and standard deviate test.
Paper III	Quasi-experimental design with two intervention groups (IG1 and IG2) and one control group (CG).	A convenience sample of 150 records before (2007) and 141 after the intervention (2009).	Record audits with three data collection instruments: 1. EPUAP guidelines modified for audit. 2. MNA data collection instrument. 3. The CIND.	Descriptive statistics. Non parametric statistics: Wilcoxon-Mann Whitney test and the Bonferoni-Holm adjustment.
Paper IV	Descriptive design.	A purposeful sample of 25 nurses for the group interviews and 5 nurses for the usability evaluations.	Group interviews and usability evaluations.	Content analysis.

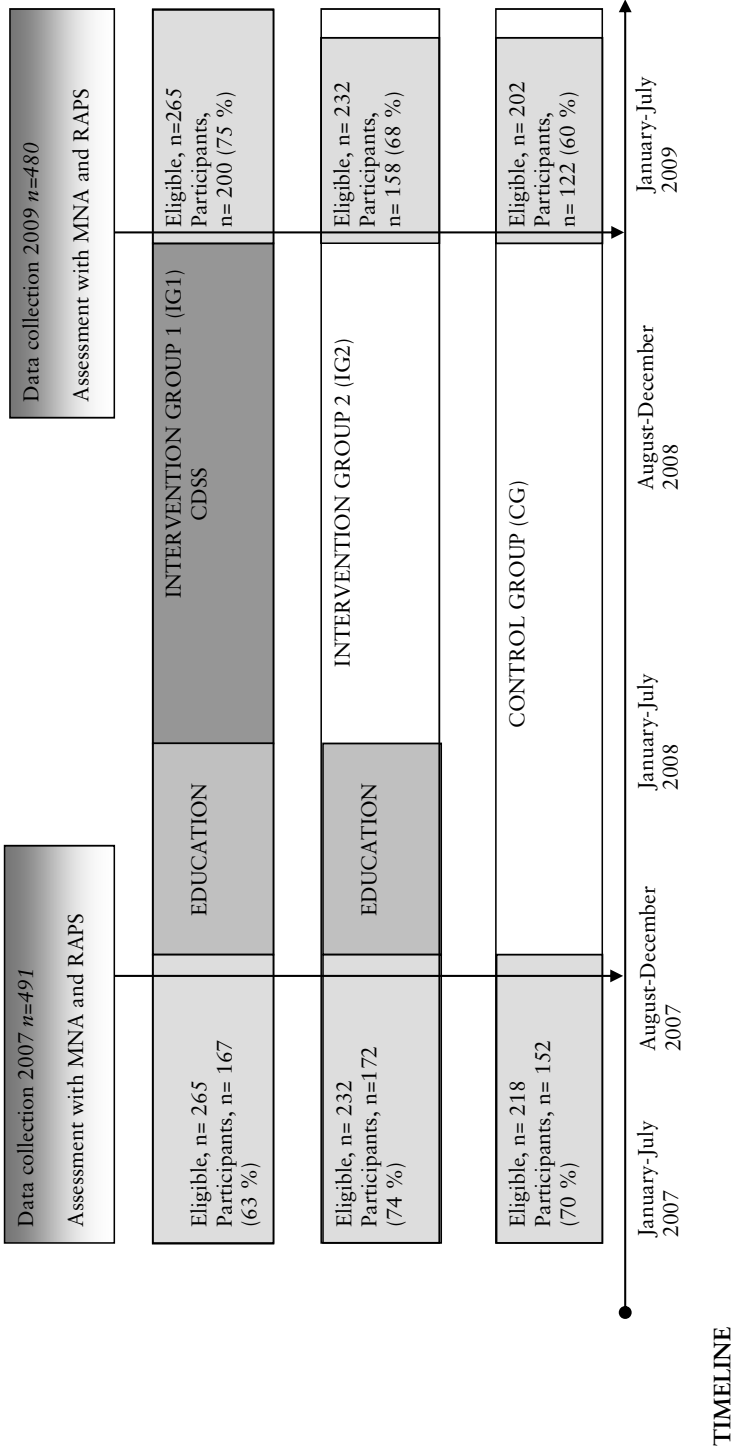


Figure 2. Overview of the study design and timeline for the intervention study (Paper II and III).

## Sample

Research participants were RNs, NAs, a special needs educator and residents from 15 nursing homes in Southern Norway. RNs, NAs and the special needs educator interact with residents or a group of residents on a daily basis.

Paper I included a purposeful sample of RNs (n=30) from nine nursing homes in four counties in Southern Norway. The 15 nursing homes that had accepted to participate in the intervention study were asked to recruit participants for the study (Paper I). The inclusion criterion was at least one year of experience from working in nursing homes. Nine nursing home managers assisted in recruiting the participants. The 30 RNs' (29 women and one man) age ranged between 25-62 years (median 45), with a mean age of 44.1 years (standard deviation, SD 12.3). Five participants had postgraduate education and all had one year or more of clinical practice within the past five years. One RN was excluded because she had less than one year of experience. The number of participants included was based on recommendations in similar studies using the think-aloud (TA) method (Fonteyn et al., 1993; Simmons et al., 2003).

Paper II included a convenience sample of 491 residents at baseline in 2007 and 480 residents at follow-up in 2009. All residents in the 15 nursing homes eligible to participate were 715 residents in 2007 and 699 residents in 2009. The reduced number of residents in 2009 was because one unit was closed. The nursing homes were recruited based on telephone contact with the local managers in the municipalities. The nursing homes varied in size from 19 to 94 residents both in 2007 and 2009. Sample characteristics for Paper II and III are displayed in Table 2.

**Table 2.** The residents' characteristics in Paper II and III before and after the intervention.

Demographics	Paper II		Paper III	
	2007 (n=491)	2009 (n=480)	2007 (n=150)	2009 (n=141)
Gender				
Female, n (%)	369 (75)	354 (74)	117 (78)	109 (77)
Male, n (%)	122 (25)	126 (26)	33 (22)	32 (23)
Age, mean age (SD <sup>a</sup> )	84.5 (8.4)	84.1 (8.6)	83.8 (8.7)	83.3 (8.4)
Length of stay				
Median months	18	20	19	27
(Q1;Q3) months	(8;33)	(10;38)	(8;32)	(10;43)

<sup>a</sup> Standard deviation

A power calculation was performed together with a statistician to estimate the number of residents required for the intervention study (Paper II and III). In all, 600 residents divided into three groups were estimated as necessary to have 80 % power to discover a minimum effect of 10 % change in prevalence of the outcome measures (PUs and malnourishment) between the three groups at a level of significance of 5 %. Exclusion criteria for the intervention study were residents with terminal illness, residents who resided less than 24 hours in the nursing home, lower extremity amputation or residents who received enteral or parenteral nutrition. A total of four residents were excluded in 2007 and five in 2009 because of terminal illness, lower extremity amputation and received enteral or parenteral nutrition. Special units for rehabilitation were excluded. Special units for residents with dementia were included (five units in the control group and seven units in each of the two intervention groups were units for residents with dementia). However approximately 80 % of the residents were suffering from dementia (The Ministry of Health & Care Services, 2007). It was difficult to reach the estimated number of residents based on the power calculation because several residents or their proxies declined participation. Residents did not participate for the following reasons: 21 residents died and two had incomplete information in the data collection in 2007 and in 2009, 20 residents died and 13 residents had incomplete information. The residents included in the intervention study did not differ significantly from the non-consenting residents regarding age, gender and length of stay.

Inclusion criteria for Paper III were that the records collected in the intervention study should indicate either PU stage I to IV and/or a MNA score lower than 17 assessed with the MNA full-form. Sample characteristics for Paper III are displayed in Table 2.

Four group interviews with 25 participating nursing personnel were performed after the intervention period, one interview at each of the four nursing homes included in the intervention group 1. The sample consisted of RNs (n=19), a special needs educator (n=1) and NAs (n=5), all women with a mean age of 39.5 years (SD 11.9). All participants had experience using the CDSS, but there was variation in how extensively they had used the CDSS.

Participants for the two usability evaluations were two RNs and three NAs from one nursing home, all experienced in the use of the CDSS. All worked full-time and their ages were as follows: two were less than 30 years old, one was between 30 and 39 years old and two were between 40 and 49 years old. A sample size between 5 and 8 has been found to detect 80 % of the problems with interfaces (Lazar et al., 2010).

## **Instruments**

### **Risk assessment pressure sores scale**

The RAPS scale contains ten variables, in which nine variables are rated on a scale from 1 to 4: general physical condition (from good to very bad), physical activity (from walks with or without aids to confined to bed), mobility (from no limitation to completely immobile), moisture (from dry or normal moistness to constantly moist), food intake, (from normal portion to less than one-half portion), fluid intake, (from > 1000 ml/day to < 500 ml/day), sensory perception, (from no impairment to completely lacking response to painful stimuli or sensory impairment over almost the whole body), body temperature (from afebrile, 36.0-37.5°C to low temperature, < 36 °C) and serum albumin level (from 36-42 g/l, 32-35, 26-31 g/l to < 25 g/l). The variables friction and shear are rated from 1 (no problem) to 3 (large problem). Skin inspection with PU classification stage I (persistent discoloration), stage II (epithelial damage), stage III (full thickness damage without a deep cavity) and stage IV (full thickness damage with a deep cavity) is also included as a part of the data collection instrument (Lindgren 2003). The sum score of the RAPS scale with 10 variables ranges from 10 to 39 points, with low scores indicating greater risk for PU development. A cut-off point of  $\leq 31$  was used. Residents with  $\leq 31$  were defined at risk of developing PUs

based on results from earlier studies (Lindgren, 2003). Permission to translate and use the RAPS scale was obtained by writing to the author (Associate Professor Margareta Lindgren) (Personal communication M Lindgren).

### **Mini nutritional assessment**

The MNA full-form contains the following dimensions: demographic data, food intake, weight loss, mobility, psychological stress or acute disease, neuropsychological problems, body mass index (BMI), independent living, drugs per day, PUs or skin ulcers, number of daily meals, protein intake, amount of fruit or vegetables, fluid, mode of feeding, self-view of nutritional status, self-view comparison with other people of the same age, mid-arm circumference and calf circumference. Each answer has a numerical value and the sum of all the items gives the total MNA scores (maximum 30). Lower MNA scores indicate a greater risk for malnutrition. The MNA scores divided the residents into three groups; normal (MNA $\geq$ 24), risk (MNA 17-23.5) and malnourished (MNA $<$ 17). The MNA full-form was used for this intervention study. However, a recent study reported high sensitivity for MNA short-form, which indicates that it could have been sufficient to use (Wikby et al., 2008).

Permission to use the MNA full-form was obtained by writing to the copyright holder Nestlé Nutrition Institute. The Norwegian version of the MNA® is available at ® Société des Produits Nestlé S.A., Vevey, Switzerland, Trademark Owners, which holds the copyright of the instrument: [http://www.mna-elderly.com/forms/MNA\\_norwegian.pdf](http://www.mna-elderly.com/forms/MNA_norwegian.pdf)

Both the MNA tool (Guigoz, 2006) and the RAPS scale (Lindgren, 2003) have been translated into Norwegian according to recommended translation procedures (Swaine-Verdier et al., 2004). The Norwegian version of MNA has been tested in a small study group and the results gave support for reliability and validity (Fossum et al., 2009).

### **Data collection instruments for the record audit**

In the record audit (Paper III), the resident records were assessed with two or three data collection instruments, depending on whether the resident record met the inclusion criteria for the presence of risk for PUs, PUs, or a MNA score below 17. The completeness in nursing documentation regarding PUs was assessed with a data collection instrument based on the European Pressure Ulcer Advisory Panel (EPUAP), modified for audit of patient records by Gunningberg and Ehrenberg (2004). The

presence of nursing assessments for problems related to risk of PU and/or grade, size and location of PUs and prevention were identified and scored as “yes” (otherwise, the score was “no”). If presence (yes) of the problem was found in the documentation, the extent of the problem was also audited.

The data collection instrument for completeness in nursing documentation regarding for nutrition was developed purposely for the study and the presence of nursing assessment of residents nutritional status, interventions and prevention of malnutrition were identified and scored as “yes” (otherwise, the score was “no”). If presence (yes) of the problem was found in the documentation, the extent of the problem was also audited.

The data collection instrument for the comprehensiveness in nursing documentation (CIND) (Ehnfors and Smedby, 1993) has five ordered levels of increasing comprehensiveness. The criteria of the scores are: Score 1, the problem was described or intervention (s) was planned or implemented. Score 2, the problem was described and intervention(s) planned and/or implemented. Score 3, the problem was described, intervention (s) planned and/or implemented and nursing outcome noted. Score 4, was given when the problem was described, intervention (s) planned and implemented and nursing outcome was noted. Score 5, a good description of the problem, interventions and outcomes of relevance for nursing care (Ehnfors and Smedby, 1993). The CIND has been used in several other studies and tests of observer agreement has shown Cohen’s kappa values between 0.57 and 1.0 (Ehnfors and Smedby, 1993; Ehrenberg and Ehnfors, 1999a; Ehrenberg and Ehnfors, 1999b; Gjevjon and Hellesø, 2010; Gunningberg and Ehrenberg, 2004; Gunningberg et al., 2009). Scores 3, 4 and 5 meet the Norwegian recommendation for documentation (The Ministry of Health and Care Services, 2000).

## **Methods for qualitative data collection**

Paper I used a qualitative explorative design. The method was chosen to obtain a deeper understanding of the thinking strategies and the clinical reasoning processes that RNs use during simulated care planning for PUs and malnutrition in nursing home care. Data were collected in 2007-2008 using the TA method. The TA method has been well described by Ericsson and Simon (1993). Resident scenarios in written format presented with a focus on the primary task have been commonly used as a stimulus for evaluating thinking strategies (Fonteyn et al. 1993, Simmons

et al. 2003, Göransson et al. 2008). The resident scenarios for this study were developed in collaboration with nurses in nursing homes. Figure 3 depicts one example of a scenario used in the study (Paper I). During the interviews, RNs were asked to verbalize their clinical reasoning by thinking aloud.

Part 1: A woman, 84 years old, arrived from her home to a nursing home. You are responsible for the nursing care of this resident. Her body weight is 52 kg and she is 164 cm tall. She has been using a wheelchair for the past two months. She has been diagnosed with dementia and has coxarthrosis in both hips. The resident expresses that she has considerable pain and information on the pillow case tells you that she uses a lot of pain killers (Codeine 3 times a day). In addition, she uses Aricept and Furosemide. The physician at the hospital considers her not topical to undergo hip surgery. She has both upper and lower dentures. She is blind and has hearing loss. The resident said she would like to go to bed.

Part 2: After two weeks in the nursing home, you find the woman with high body temperature and sweaty. The resident looks at you when you talk to her, but she does not respond. You contact the physician and he finds that the resident has pneumonia. The physician prescribes antibiotics. In the electronic health care record your colleague has written that the resident ate and drank very little the past three days.

Part 3: Three months after the resident was admitted to the nursing home, her body weight is 48kg. She uses a wheelchair approximately two hours once a day. On questions she answers yes and no; otherwise, she does not speak very much. In the electronic health care record you can read that your colleague last night observed a red area on her back. A serum albumin test shows a low value. The resident drinks less than three glasses of liquid a day and eats porridge for breakfast and dinner; sometimes she gets bread without crust with jam.

*Figure 3. Resident scenario no. 1.*

Paper IV used a qualitative descriptive design. Data were collected in June 2009 using group interviews and two usability evaluations tech-

niques: a cognitive walkthrough observation and a graphical user interface (GUI) usability evaluation.

Group interviews were conducted with participants at their work site. A semi-structured interview guide with a list of 21 questions was developed for the study (Paper IV). The semi-structured interview guide, developed in collaboration with members of the research team, included questions based on a review of research literature. The interview guide was supposed to cover all areas of interest for the aim of the study (Paper IV). The semi-structured interview guide helped to structure and decide how to best use the time available (Patton, 2002). The interview guide included four areas of interests: training on how to use the CDSS, use and ease of use of the CDSS in the unit, perceived facilitators and barriers and experiences gained from using the CDSS. For every area of interest, open-ended questions were ordered in a logical sequence. In group interviews a guide is essential to keep the dialog and discussion focused (Patton, 2002). The participants were encouraged to talk freely about all topics and follow-up questions were used. The group interviews were conducted by the principal investigator (MF).

A feature central to the success of CDSSs in health care is the design of an effective interface to guide clinicians. Problem representation and a problem solving task are two important decision-making elements in developing the design for CDSSs. When the types of information emphasized in the decision-making elements match, the problem solver formulates a mental representation and the presentation will facilitate the decision-making process (Vessey and Galletta, 1991). The cognitive walkthrough observations and the GUI usability evaluations with a questionnaires-based self-reported survey with five nursing personnel in a natural setting in nursing homes were performed in 2009 after the intervention.

These cognitive walkthroughs involved that the researcher observe the nurses' while they talked through the performance of the three pre-designed tasks while using the CDSS. The three resident datasets allowed the participants to do PU risk assessment. In this situation the learning module interface from Prosys was used. Prosys was the vendor of the EHR system that developed and integrated the CDSS used in this project. The nurses were asked to explain aloud what they were thinking as they performed the tasks using the application. This gave the researcher an opportunity to compare the actions and processes that users went through. The feedback from a cognitive walkthrough is used to further improve the user-interface. Users could give comments, which will give information about their level of understanding of the system. In general,

comments from users can guide the designer's understanding of the system for further development of the system (Ball et al., 2010; Lazar et al., 2010).

The usability evaluation questionnaire was developed from a questionnaire used by Fruhling (2006). Questions were translated from English into Norwegian and modified for the planned study (Paper IV). The instrument was pretested by two RNs to increase the quality.

## **Procedure**

A quantitative approach was chosen for describing characteristics and comparisons of risk for PUs and malnutrition and prevalence of PUs and malnutrition between residents recruited for the three groups: intervention group 1 (IG1), intervention group 2 (IG2) and the control group (CG). The residents were enrolled from nursing homes in 2007 and 2009.

The managers at the nursing homes were asked about the number of beds in the unit and staffing level. All residents were assessed with the MNA tool and the RAPS scale, and outcome variables were risk for PU and malnutrition. In the intervention study (Paper II) prevalence of PUs and malnutrition served as the outcome variables. The residents were followed in the three groups (IG1, IG2 and CG). Data collection was done by two or three nurses recruited by the local managers at each nursing home included in the study. These nurses were regarded as 'super users'. The 'super users' were trained individually or in small groups by the principal investigator (MF) in how to use the RAPS scale and MNA tool, as well as how to use the CDSS. The 'super users' were given a telephone number that they could call whenever they had questions during the data collection period in 2007 and 2009. The data collections in 2007 and 2009 were organized and supervised by the principal investigator (MF). The 'super users' had written information that they could use for an oral presentation to residents about the intervention study together with the informed consent form.

## **Developing a computerized decision support system for nursing homes**

The CDSS was developed in a collaborative effort among the University of Örebro, the University of Agder and the software vendor, Prosys ([www.allvara.no](http://www.allvara.no)). The project, initiated by researchers, was funded by

the University of Agder and the development process can be described as a cooperation project between the researchers, clinicians and the vendor. In the development process methods and routines in the clinical practice of nurses were analyzed in order to identify the needs of clinicians in different phases of the care process.

In this study the detection, prevention and treatment of two difficult clinical problems (PUs and malnutrition) commonly found in nursing homes were studied in order to examine the development, implementation, and effect appraisal of a CDSS. The CDSS developed for this intervention study was based on clinical guidelines and current literature available in the area. The RAPS scale and the MNA tool were integrated as a part of the CDSS in the Prosys EHR software system.

The CDSS was changed and updated based on continuous feedback from the users, through the IS specialist working full-time with the Prosys EHR system. A screenshot of the CDSS is displayed in Figure 4.

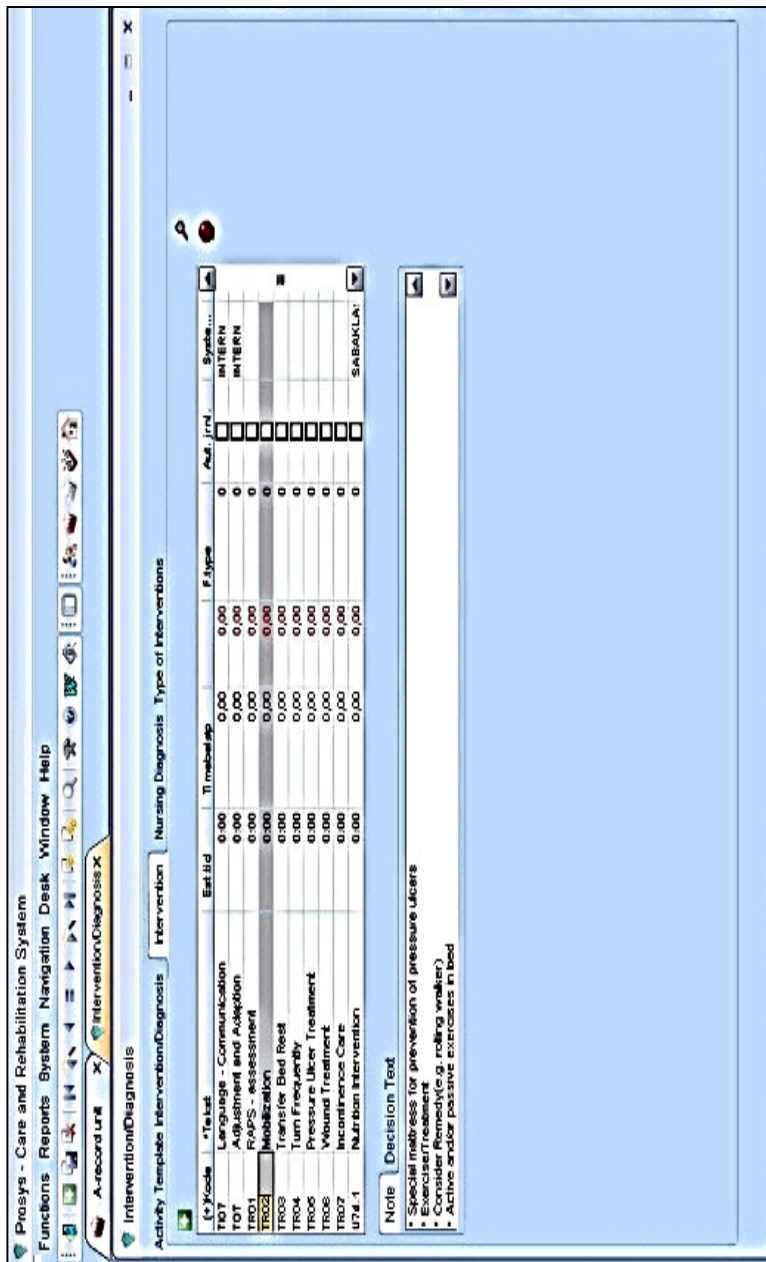


Figure 4. Screenshot of the computerized decision support system, showing a view displayed after the Risk Assessment Pressure Sores (RAPS) scale had been performed. The interventions are based on evidence and clinical expertise. (The Prosys graphical interface copyright Alvara AS, [www.alvara.no](http://www.alvara.no)).

The interfaces of the CDSS were similar to all the other interfaces in the EHR system Prosys. The key components of how the CDSS was integrated in the workflow of the clinical decision-making process are illustrated in Figure 5.

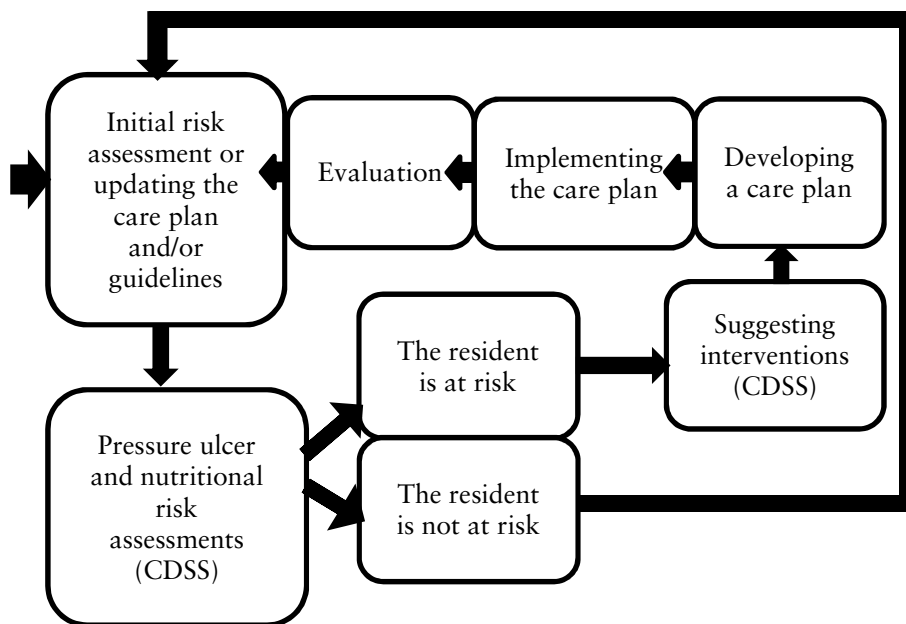


Figure 5. Chart of the integration of the computerized decision support system in the workflow in the four nursing homes.

### The intervention

Nurses in intervention group 1 (IG1) and 2 (IG2) received education about prevention and management of PUs and malnutrition and how to assess residents at risk. The education was carried out in two sessions of 45 minutes each in each nursing home. In addition, IG1 participated in the development of the CDSS and had the CDSS implemented in their EHR. The CDSS used in this intervention study was based on two clinical practice guidelines combined with an active rule-based system. Both

these approaches have been well tested and used in previous developments of CDSSs (Greenes, 2007).

A group of four RNs from each of the nursing homes in IG1 and an IS specialist worked closely with the vendor during the development of the CDSS during one year before the intervention took place. For building the CDSS, the RAPS scale and the MNA tool were chosen for assessing risk for PU and malnutrition. The evidence-based interventions were developed by the research team together with a group of RNs and NAs from IG1. The CDSS with the RAPS scale, the MNA tool and the evidence-based interventions was integrated into the Prosys EHR system.

In the intervention groups the nurses were expected to use the CDSS to assess residents at risk for PUs and malnutrition. Based on the results from these assessments, nurses were provided with a variety of evidence-based interventions in the CDSS.

The evidence-based interventions to support care planning were based on clinical experience, earlier research and systematic literature reviews on PU (Candice, 2002) and malnutrition (Persson et al., 2007). A broad definition of what counts as evidence was used in this work (Rycroft-Malone et al., 2004b). Research, residents' experiences, residents' experiences and preferences, as well as information and clinical experiences from the local context or environment, as described by Rycroft-Malone and co-workers (2004b), were used. The 'super users' were involved in the study in meetings and workshops with consensus discussions to decide which interventions should be included in the CDSS.

The interventions were based on the identification of the residents as being at risk for PUs or malnutrition or both. When a resident was assessed at risk for malnutrition according to the MNA tool, nine interventions with associated activities were provided to choose from. If the resident was assessed as malnourished according to the MNA ten interventions with associated activities were provided to choose from. For all activities, free-text could be added and activities that the nurses judged to be irrelevant for the resident could be deleted. One example is 'increase the activity', with the following activities: providing a pressure relieving mattress, mobilization, processing walking training, determine whether the resident needs physical therapy, whether the resident needs crutches, walker, or wheel-chair and whether the resident needs occupational therapy.

When the nurses had chosen among the recommended interventions in the CDSS and adjusted the care plan to the individual resident's requirement, the interventions were automatically transferred into the resident's care plan. The usual care provided in the nursing homes was not based

on systematic assessment and clinical practice guidelines were not routinely used. The intervention took place over eight months.

## **Content analysis**

In Paper I interviews were recorded and data were transcribed verbatim and imported to QSR NVivo 7.0 (QSR International Pty Ltd, Doncaster, Australia) for structured qualitative data analysis. The amount of transcribed data was comprehensive and it was judged that this deductive analysis would benefit from being performed with a computer program.

All the verbal protocols were read as a whole to obtain a broad sense of the meaning (Patton, 2002). The analysis was performed using deductive content analysis (Patton, 2002) to explore the RNs' clinical reasoning based on Fonteyn's 17 thinking strategies (Fonteyn, 1998). The 17 thinking strategies include making choices, forming relationships, drawing conclusions, providing explanations, searching for information, asserting a practice rule, generating hypotheses, posing questions, judging the value, setting priorities, starting a proposition, recognizing a pattern, pondering, qualifying, making a generalization, making assumptions and making predictions (Fonteyn, 1998). In Paper I some of the data were presented as text and some presented as frequencies, often used in more quantitative content analysis (Waltz et al., 2010). Finally, data were analyzed to explore the RNs' clinical reasoning processes and whether there were similarities and differences in the way they conducted the clinical reasoning process. Three elements from the nursing process were chosen as codes for the analysis, namely, 'collection of data', 'assessment' and 'planning'. When RNs expressed that they were looking for data in the scenarios, collection was used as a category. When the RNs judged the information from the scenarios, assessment was used, and finally, when RNs stated the residents' needs and their planned nursing interventions, planning was used as a category.

Verbal protocols from four sessions were analyzed separately by the four researchers and coding categories were compared and discussed until agreement was reached. This was based on the recommendation that a part of the transcribed data is coded by more than one individual to increase credibility (Munhall, 2007; Patton, 2002; Waltz et al., 2010).

## Statistical analysis

Descriptive statistics was used to describe the study groups (Paper II and III), including frequencies, proportions (%), means (m), SD, range, median and inter-quartile range (Q1,Q3) depending on the properties of the variables (Altman, 1991).

The main outcome variables were the frequency of residents at risk for PUs or with PUs and residents at risk for malnutrition and/or malnourished. Because the variables of interest were measured on an ordinal scale, non-parametric statistical tests were used according to Altman (1991) and Svensson (2001).

In the analysis of the differences before and after the intervention the standard normal deviate test was used (Altman, 1991), and in accordance with Wilson's method, a 95 % confidence interval (CI) for the differences between two proportions was calculated (Newcombe and Altman, 2000).

In Paper III differences in scoring comprehensiveness between the groups were evaluated by the Wilcoxon-Mann-Whitney Test, with correction for discrete data (ties) (Siegel and Castellan, 1988). A p-value less than 5 % was considered as significant after the Bonferroni-Holm adjustment for multiple test (Holm, 1979).

The Statistical Package for Social Sciences, version 16.0 (SPSS, Inc., Chicago, IL, USA) was used for data management.

## Reliability and validity

In science reliability and validity are essential characteristics of any measuring tool or method (Altman, 1991). Reliability refers to "the degree of consistency or dependability with which an instrument measures an attribute" (Polit and Beck, 2012 p.741). Validity refers to "the degree to which inferences made in a study are accurate and well-founded; in measurement, the degree to which an instrument measures what it is intended to measure" (Polit and Beck, 2012 p. 745).

Using a quasi-experimental design invariably raises questions about internal and external validity of the study. Unfortunately, randomization of the nursing homes was not an option. It is therefore unknown whether the effects were due to the CDSS intervention or to other external variables (Polit and Beck, 2012). The manner in which the study was planned and performed is essential to increase reliability and validity. Validity may have been strengthened by using the full-form of the MNA tool in our study (Guigoz, 2006) to increase the specificity and sensitivity of the

assessment. However, it could have caused unnecessary work with the data collection for the nursing personnel and may have resulted in challenges to implement the CDSS. Implementation of clinical practice guidelines will often raise questions about a choice between high specificity and sensitivity as well as the number of items included in the clinical guidelines. Implementations of clinical practice guidelines have been reported from nursing personnel in nursing homes to be overwhelming together with all the other 'paper work' (Colon-Emeric et al., 2007). However, other nursing personnel reported that implementation of clinical practice guidelines promotes EBP and that guidelines is useful as training materials (Colon-Emeric et al., 2007).

All the nursing homes included in the intervention study signed a contract, where it was specified that the nursing home managers were responsible for providing the nurses with opportunities to participate in the pre-intervention education provided in the intervention study. However, because of time pressure and a high work load during the study, it was sometimes difficult for the nurses to attend the educational sessions. Characteristics of the context, economical aspects and cost effectiveness may have had an influence on the results, but has not been examined in this study (Paper II and III).

Based on the follow-up over a period of three years during the intervention study, these nursing homes represent differences in EHR use and documentation practices. This observation and information may give support to the view that these nursing homes reflect a national variance of nursing homes.

A challenge when conducting record reviews is inter-observer reliability. The percent differences reported in Paper III between the two raters were acceptable and give support to the reliability.

The MNA tool has been tested in several studies (Guigoz, 2006) and has been translated into Norwegian and tested by the research group, as described previously. The RAPS scale was also translated into Norwegian and tested with the same procedure as recommended by Swaine-Verdier and colleagues (2004). Tested assessment instruments were chosen to increase the quality of the intervention study (Polit and Beck, 2012). When entering data into SPSS, data cleaning was important to increase the reliability of the results (Polit and Beck, 2012). The cleaning involves checks for outliers and wild codes and a consistency check performed on processing output tables from SPSS.

Reliability and validity are not common concepts when assessing the rigour of qualitative studies. Concepts suggested for assessing and describing rigour in qualitative studies are trustworthiness, credibility, de-

pendability and conformability (Patton, 2002). In Paper I the four resident scenarios were developed and tested in close collaboration with nurses from nursing homes. Verbal protocols from four sessions were analyzed separately by four of the researchers and coding categories were compared and discussed until agreement was reached to increase credibility (Patton, 2002). In Paper IV the interview guide for the group interview was developed in collaboration with two of the 'super users' and changed based on feedback. This procedure was important to strengthen the trustworthiness of the study (Paper IV). Two of the researchers coded each of the interviews independently and differences were discussed until agreement was reached to increase credibility (Swaine-Verdier et al., 2004).

### **Ethical considerations**

For Paper I and IV, all the participating nurses received written information about the studies. The participants signed a written informed consent. For Paper II and III, the residents were informed verbally and in writing about their right to withdraw without any effect on their care. The 'super users' that performed the data collection knew the residents well and that might have limited the extra strain to the residents during the data collection, although it could also have made some residents compelled to participate. These issues were discussed in meetings with the 'super users' to clarify the voluntary nature of participation.

A blood test was taken as a part of the data collection for the RAPS assessment. If the resident had taken a serum albumin test in the past month, the results from that test was used to avoid unnecessary procedures.

After data collection in 2007, it was decided to give all the nursing homes participating in the project information about the results from the data collection. All the nursing homes were offered a one-hour presentation by the principal investigator (MF). The presentation provided the nursing home personnel with information about the number of residents from their nursing home that had been identified at risk for PUs, with PUs or at risk for malnutrition or malnourished.

Many older people in nursing homes suffer from dementia. Thus, written informed consent was obtained from the residents or their proxies, if residents themselves could not provide an informed consent. All the data were made anonymous to protect the identity of the residents and therefore no paired comparisons could be done. The project was approved by

the Regional Committee for Medical Research Ethics in Southern Norway (REK Sør, reference number S-07212b) and by the Norwegian Social Science Data Services (project number 16822).

## RESULTS

The main findings from Paper I-IV are presented and summarized in the following order: thinking strategies and clinical reasoning (Paper I), effects of the CDSS on PUs and malnutrition (Paper II), effects of the CDSS on completeness and comprehensiveness in nursing documentation (Paper III) and facilitations and barriers in using a CDSS (Paper IV).

### Thinking strategies

Paper I explored the variety and frequency of thinking strategies that RNs used during simulated care planning for PUs and malnutrition. All 17 thinking strategies presented in the work of Fonteyn (1998) were represented in the TA sessions, but there were substantial differences in how often the RNs used these strategies. The three most commonly used thinking strategies were 'making choices', 'forming relationships' and 'drawing conclusions'. There was variation in how the RNs assessed the residents presented in the four scenarios and none of the RNs included a structured PU or nutrition risk assessment. Half of the RNs did not refer to BMI when assessing the body weights and two thirds of the RNs did not connect nutritional status and skin condition to risk for PUs. All the RNs reasoned about the residents' well-being and many (n=12) of the RNs mentioned the limited ability of the residents to participate in the care planning process. The RNs did not verbalize or explicitly mention on what assessment and analysis they based their interventions. The importance of using pressure reducing mattresses to prevent PUs was proposed by two thirds of the RNs. No nursing diagnosis was explicitly mentioned by RNs, although the problems described in the scenarios could have been related to nursing diagnoses. Table 3 shows the 17 thinking strategies with definitions and percent of the total coded thinking strategies.

**Table 3.** Thinking strategies with definitions (Fonteyn, 1998) and percent of the total coded thinking strategies based on nurses assessment of resident scenarios.

Thinking strategy	Definition	Percent of (n = 3510)
Making choices	Selecting from a number of possible alternatives to decide on and pick out	24.4
Forming relationships	Connecting information to further understanding	18.2
Drawing conclusions	Reaching a decision or forming an opinion	12.5
Providing explanations	Offering reasons for actions, beliefs or remarks	8.9
Searching for information	Mentally looking for missing or concealed information	6.7
Asserting a practice rule	Asserting a truism that has consistently been shown to hold true in practice	6.2
Generating hypotheses	Asserting tentative explanations that account for a set of facts	4.3
Posing questions	Asking for answers without really expecting to receive them	3.6
Judging the value	Forming an opinion or evaluation about worth in terms of usefulness	3.0
Setting priorities	Ordering concepts in terms of importance or urgency	2.8
Stating a proposition	Stating a rule governed by IF-THEN proposition	2.0
Recognizing a pattern	Identifying characteristic pieces of data that fit together	1.9
Pondering	Mentally pausing to reflect on the meaning of a piece of information	1.7
Qualifying	Modifying, limiting or restricting, as by given exceptions	1.6
Making a generalization	Inferring from many particulars	0.9
Making assumptions	Taking for granted or supposing	0.9
Making predictions	Declaring in advance	0.4

## **Clinical reasoning**

During the TA sessions when RNs asked for more data about the resident, the strategy “collecting data” was used. Some examples of this strategy are: ‘Will these data say that the residents cannot do anything at all?’ ‘How much does she really eat?’ and ‘The resident has a low serum albumin. What does that mean for the resident?’ Half of the RNs moved directly to planning interventions after brief collection of data, without structured risk assessment or analysis of collected data from the scenarios. The RNs assessed data while reflecting over the information presented in the scenarios. The code was used when RNs, for example, stated: ‘His height and body weight show that he is in good shape’, ‘She is not eating enough’ and ‘He did not eat enough protein’. Planning was the most frequently used code when RNs proposed interventions for the residents’. Examples of this are: ‘He needs small meals in between’, ‘She needs pain killers three times a day’ and ‘I need to focus on prevention of obstipation’.

## **Effects of the computerized decision support system on pressure ulcers and malnutrition**

Differences between IG1, IG2 and CG on the RAPS scale and the MNA tool were compared between 2007 and 2009. Overall, the medians on the 10 items in the RAPS scale were scored between 3 and 4. Only the item friction and shear had median scores below 3 (scale score of 2) in 2007 and 2009. In the 2007 sample the prevalence rates of the PUs stage I-IV were 10 % in the IG1, 15 % in the IG2 and 11 % in the CG. The prevalence rates of the PUs stage I-IV in 2009 were 11% in the IG1, 17% in the IG2 and 9 % in the CG. In all, 58 PUs stage I-IV were identified in all three groups in 2007 and 60 PUs stage I-IV in all three groups in 2009. The prevalence of PUs before and after the intervention was compared using analysis of variance. The analysis revealed no statistically significant effects. Residents with no PUs stage I-IV and PUs by groups (IG1, IG2 and CG) and data collection periods (2007-2009) are presented in Figure 6.

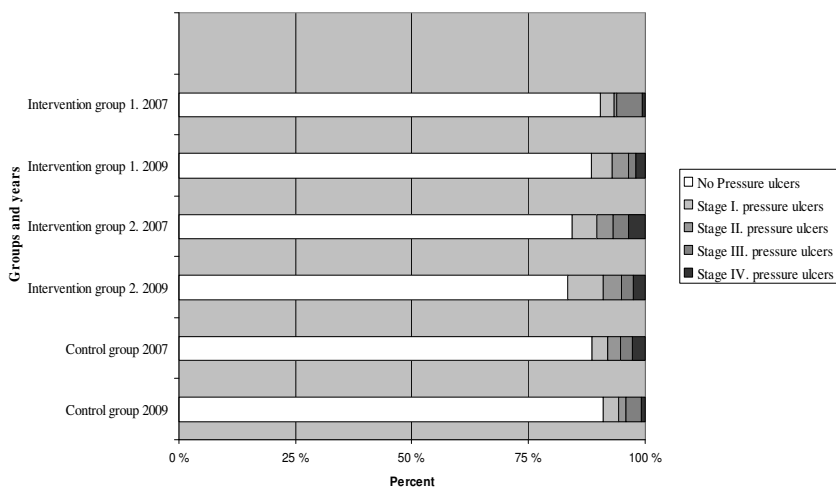


Figure 6. Residents with no pressure ulcers, stage I, II, III and IV and pressure ulcers by groups (IG1, IG2 and CG) and data collection periods (2007 and 2009).

In 2007, the prevalence of residents at risk for PUs was 26 % in the IG1, 38 % in the IG2 and 27 % the CG. The prevalence of residents at risk in 2009 was 27 % in the IG1, 36% in the IG2 and 28 % in the CG. Malnourished residents were 29 % in the IG1, 32 % in the IG2 and 21 % the CG in 2007. The prevalence of malnourished residents in 2009 was 20 % in the IG1, 25% in the IG2 and 25 % in the CG. The prevalence of adequate nutritional status versus malnutrition between groups and before and after the intervention was compared. The analysis of variance showed no statistically significant effects. The proportion of malnourished residents in IG1, however, decreased significantly from 2007 to 2009 ( $p=0.05$ ). Residents at adequate nutritional status, at risk for malnutrition and malnourished by groups (IG1, IG2 and CG) and data collection periods (2007 and 2009) are presented in Figure 7.

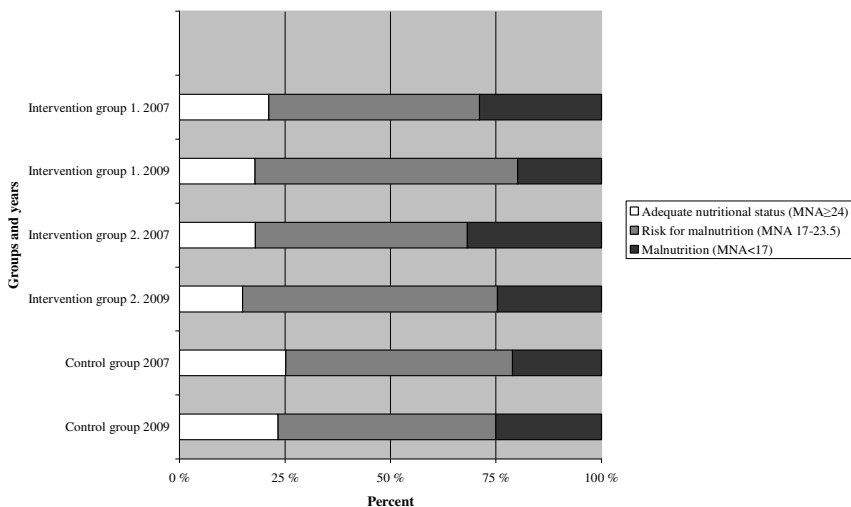


Figure 7. Residents at adequate nutritional status, at risk of malnutrition, and malnourished by groups (IG1, IG2 and CG) and data collection periods (2007 and 2009).

### Effects of the computerized decision support system on completeness and comprehensiveness in nursing documentation

Results from Paper III show that the CDSS resulted in a more complete and comprehensive documentation. Overall, nursing assessment of PUs, PU grade, size and nutritional status (e.g., body weight and daily food intake and fluid intake) improved after implementing the CDSS. The identified variables of interventions and prevention of PUs and malnutrition in the nursing documentation increased or were unchanged in the proportions of identified variables between 2007 and 2009.

When looking at the recorded assessment in the three groups in 2007, similar proportions of recording were identified in all three groups. The proportions of recorded PU variables in the IG1 before the intervention (e.g., physical activity, mobility, degree to which skin is exposed to moisture, food intake and fluid intake) ranged from 6 % to 100 % before and 96 % to 100 % after the intervention. In the IG2 the same recorded PU variables ranged from 9 % to 91 % before and 28 % to 100 % after the

intervention. Both groups (IG1 and IG2) demonstrated change, but the change was more pronounced in the IG1.

The proportions of recorded documentation of nursing assessment of body weight in the IG1 ranged from 20 % before the intervention to 100 % after the intervention. Recording of height in the IG1 ranged from 0 % before the intervention to 100 % after. In the IG2 the recording of body weight ranged from 31 % before to 21 % after and of height from 2 % before to 5 % after the intervention. In CG the recording of body weight ranged from 69 % before to 41 % after and of height from 4 % before to 14 % after the intervention. Risk assessment variables ranged from 18 % before to 97 % after the intervention in the IG1 while the corresponding variable in the IG2 ranged from 25 % before to 34 % after and in the CG from 15 % before to 38 % after the intervention. All three groups showed an increase over time, but the change was more pronounced in the IG1.

Residents' problems, interventions and outcomes should be present in the recording to serve as care plan for residents with PUs or malnourishment, or both. The IG1 had 37 problems related to PUs and malnutrition before and 63 such problems after the intervention. The IG2 had 62 problems related to PUs and malnutrition before and 60 problems after the intervention. The CG had 15 problems related to PUs and malnutrition before and 25 after the intervention. The mean number of notes per resident varied from 0.3 to 1.0 in 2007 and 0.4 to 1.4 in 2009. All three groups had an increase in the mean number of notes, but the change was more pronounced in the IG1. Before the intervention, the most frequently recorded resident problems in all three groups were 'the resident did not eat enough and 'the resident has a PU'. After the intervention, the RAPS scale or the MNA score was used to structure the recorded resident problems in IG1.

The differences in median scores in the nursing documentation for malnutrition between IG1 and IG2 and between IG1 and the CG were statistically significant ( $p < 0.0001$ ), as was the difference in scores between IG2 and the CG ( $p = 0.002$ ). The difference in median scores in the nursing documentation for PUs between IG1 and IG2 was statistically significant ( $p = 0.02$ ).

## **Facilitators and barriers in using a computerized decision support system**

The nurses' experiences of using the CDSS in the four nursing homes are summarized in Paper IV. The results indicate two facilitating factors: professional factors and software design factors. A professional factor was the increased focus on prevention of PUs, malnutrition and nursing documentation, which increases the motivation to use the CDSS. Software design factors were ease of use, usefulness and a supportive work environment with availability of 'super-users' to support the use of the CDSS. The participants recommended lectures and individual training in using the CDSS as supporting strategies in its implementation.

The present results revealed four groups of barriers: organizational barriers, individual barriers, task-fit barriers and design and software barriers. Lack of training, resistance to computer use and limited integration of the CDSS with the facility's EHR were identified barriers. An overview of the perceived barriers is presented in Table 4.

**Table 4.** Perceived barriers during implementation and use of the CDSS in nursing homes based on group interviews with 25 nursing personnel.

Organizational	Individual	Task-fit	Design/software
Lack of training	Lack of involvement in the implementation of the CDSS	Feels unnecessary to use guidelines	The nutrition plan was not fully integrated into the EHR
Lack of information for nursing personnel			Lack of good user interface in the EHR system
Challenging to organize the use into the daily workflow	Lack of computer skills for using the CDSS		The CDSS has lack of logic when navigating to choose interventions
Lack of equipment to measure body weight	Resistance to using computers		
Lack of work stations	Feel no need for care plans		The EHR system was difficult to use
Lack of routines for risk assessment personnel	Lack of basic knowledge in prevention of malnutrition and PUs among nursing personnel		
Too large a workload			
Preference for oral routines for inter-shift reports			

The high scores on the items in the usability questionnaire indicated that the participants were satisfied with the CDSS. The items with the lowest score were questions focusing on the function of the system, the ability of the system to find capabilities where expected and the flexibility of the system. Ease of use was reported from the five users included in the cognitive walkthrough observations and the GUI usability evaluations. The difficulty in using the CDSS within the EHR, flaws in the design of the GUI, and the two-click system to save input data in risk assessment were suggested to be improved.

## **DISCUSSION**

This chapter starts with a summary of the main findings from our studies and then in the following sections a more detailed account is presented. The chapter ends with methodological considerations, implications for practice, further research and some concluding thoughts.

### **Summary of main findings**

The overall aims of this thesis were to study the thinking strategies and clinical reasoning processes of nursing personnel who work in nursing homes and to implement and test a CDSS integrated into the EHR for preventing PUs and malnutrition among residents in nursing homes. The results show a variation in RNs' use of the 17 thinking strategies described by Fonteyn (1998). In the clinical reasoning process the RNs had a tendency to focus on collecting data and planning interventions; structured risk assessments, however, were not used (Paper I). The results further show that the proportion of malnourished residents in the IG1 decreased significantly (Paper II) after an intervention of a CDSS. The documentation of PUs and malnutrition was significantly more complete and comprehensive after implementing the CDSS (Paper III). The nurses' experiences using a CDSS showed that ease of use, usefulness and a supportive work environment are important facilitators in the implementation process. Barriers in implementing the CDSS were a lack of training of the CDSS, resistance to use computers and limited integration of the CDSS in the EHR (Paper IV).

### **Clinical reasoning in nursing home care**

Paper I revealed that RNs used a variety of thinking strategies, but there was variation in how often they used these strategies. This variation in thinking strategies is consistent with findings from previous studies in nursing (Fonteyn, 1998; Funkesson et al., 2007; McCarthy, 2003; Thompson et al., 2009; Twycross and Powls, 2006). Three thinking strategies (making choices, forming relationships and drawing conclusions) were used more frequently than the other 14 strategies, which confirms previous findings from hospital settings (Simmons et al., 2003). The identified lack of a systematic risk assessment and that the RNs did not refer to interventions based on research are a quality concern because identification of and prevention for residents at risk may be overlooked. The reason may be because RNs in nursing homes are not used to utiliz-

ing systematic evidence-based knowledge in their daily practice. Several international studies have, in fact, reported that there is a lack of evidence-based care in nursing homes (Boström et al., 2009; Boström et al., 2006; Hunter and Levett-Jones, 2010). Another reason for not using research could be the lack of support in the EHR to do structured nursing assessments and documentation. Unfortunately, new computer ISs still use local language (Maas and Delaney, 2004) and free-text notes for documentation of resident problems, interventions and outcomes (Voutilainen et al., 2004). International studies of nursing homes have also shown that nurses did not use structured risk assessment in daily practice (Meijers et al., 2009b; Persenius et al., 2008; Wipke-Tevis et al., 2004). Implementing clinical guidelines has shown to improve the amount of nutritional screening as well as the content and extent of assessment (Meijers et al., 2008). Despite this potential to support RNs with clinical guidelines, there is no international consensus regarding assessment of nutritional status (Gaskill et al., 2008; Green and Watson, 2006) and risk for PUs (Anthony et al., 2010; Anthony et al., 2008) in elderly care facilities, although these areas are described as important quality of care indicators.

In Paper I we used fictitious cases for the nurses' TA. It could be argued that the participants would have assessed the residents differently in a real-life situation. Nevertheless, studies from real-life (Simmons et al., 2003) and simulated sessions (Fonteyn, 1998) have shown similar results.

The present findings suggest that the RNs need support to perform systematic risk assessments of nursing home residents who might be at risk for PUs and malnutrition. Findings from the literature indicate that CIS support in nursing home settings may be an effective means of providing such support. The results from Paper I may contribute in developing CDSSs for RNs. Knowing more about how RNs can be supported in their reasoning process is important when designing CDSSs. However, ethical issues should be recognized and discussed continuously (Sävenstedt et al., 2006).

### **Effects of using a computerized decision support system on pressure ulcers and malnutrition in nursing home residents**

To our knowledge, there are no other studies that have measured resident outcomes after an intervention with a CDSS in these two specific areas of concern (PUs and malnutrition) in nursing home care. Evalua-

tions of using CDSSs in health care have mostly focused on the performance of physicians, with only a few studies on patient outcomes (Garg et al., 2005; Kaplan, 2001; Kawamoto et al., 2005).

Increased focus on recognizing and describing nursing sensitive outcomes may contribute to improve the quality of care (Du Moulin et al., 2010; Rantz et al., 2010). Papers II and III focus on the effects of a CDSS on two clinical problems, namely PUs and malnutrition. Previous research indicates that implementation of CDSSs to support EBP has the potential to improve nurses' knowledge and skills and may have a positive impact on resident outcomes (Anderson and Willson, 2008; Randell et al., 2007). One significant improvement in outcomes was found regarding the number of malnourished residents in the IG1 before and after the intervention study (Paper II). However, no significant differences in resident outcomes were found between the three groups (IG1, IG2 and CG) after the intervention. The results might be related to the fact that the intervention was conducted over a period of eight months, which might have been too short to affect resident outcomes. Implementation of CDSS in clinical practice is a complex process (Anderson and Willson, 2008; André et al., 2008; Randell et al., 2007) and implementation of CISs may require from 12-24 months (Rantz et al., 2011).

Another reason for the lack of significant effects between the groups could be that PUs and malnutrition in the elderly remain unidentified by the nurses. The challenges for nurses to identify residents' problems have been revealed in other studies in nursing (Florin et al., 2005; Suhonen et al., 2011). One study noted the risk of underreporting the number of PUs in that PUs are strongly related to poor quality of care (Gorecki et al., 2009).

Using a CDSS could be seen as an extra work load in nursing home settings, characterized by time pressure and lack of qualified physicians and few RNs (Ingstad, 2010; McHugh et al., 2011). This lack of resources could have hindered the use and integration of the CDSS into the daily workflow process.

How a CDSS is integrated into the EHR and the daily workflow is described as important for successful CDSSs implementation (Bates et al., 2003; Osheroff et al., 2005). Nursing personnel in our study (Paper IV) reported a lack of sufficient integration of the CDSS in the EHR, which, in turn, could have affected the use of the CDSS. Both EHRs and CDSSs are complex systems that can be used and integrated in different ways. From studies we know that nurses tend to use CDSSs in different ways based on their experiences of CISs and ability to adopt CISs (Dowding et al., 2009a). Our results show that overall the nursing personnel per-

ceived the CDSS as easy to use (Paper IV). However, contextual variables such as management system, supportive resources, work environment and the nursing personnel's opinion about use of EBP are unknown, but should be kept in mind when comparing the present results with those from previous research.

### **Effects of using a computerized decision support system on nursing documentation of pressure ulcers and malnutrition**

CISs have been recognized to have the potential to improve content and completeness of nursing documentation by providing rapid access to structured and critical information for PU care (Gunningberg et al., 2009). They also have potential with respect to the development of structured care plans (Thoroddsen et al., 2011). In our study (Paper III) the audit of nursing records showed improvement both in content and comprehensiveness in the IG1 after the intervention. The CDSS provided the nurses with a structured assessment and choices of nursing interventions. The CDSS improved the assessment of PUs and malnutrition and the total number of nursing interventions in the IG1. The increase in documented nursing interventions can be partially explained by the nurses increased knowledge on PUs and malnutrition. The increased knowledge from the education program could have given them an opportunity to better document nursing assessments and interventions in the records. However, the differences in the proportions between recorded assessments and interventions in the IG2 (education) and the CG did not show the same increases as between the IG1 and the two other groups, indicating that the CDSS in itself led to improved completeness in the nursing documentation.

A Norwegian law (The Ministry of Health and Care Services, 2000) stipulates that the documentation should include essential information about the reasons for care, the residents' diagnosis, planned and implemented interventions and outcomes of care. Nursing documentations in the IG1 after the intervention met the legal demands to a higher degree than before the intervention and comprehensiveness was improved. Implementation of CDSSs might be of great value to provide support for nurses in nursing homes to meet the legal demands, increase the quality of documentation and increase use of EBP. On the other hand, there is concern about providing nurses automatically with interventions in the EHRs. It requires a CDSS that is continuously updated based on available evidence-based knowledge. The interventions should always be as-

sessed by the nurses against the residents' individual needs of and preferences for care, as well as nurses' clinical experience.

Despite these promising effects of implementing the CDSS, there was concern about the overall small number of resident problems documented in the residents' care plans. The included care plans were based on the fact that the residents' had already been identified as being at risk for having PUs or malnutrition. It could have been expected that there should have been more problems documented. Nevertheless, these findings are in accord with those from other studies (Ehrenberg and Ehnfors, 1999a; Voutilainen et al., 2004).

### **Implementation of a computerized decision support system in nursing homes**

The TAM model (Dishaw and Strong, 1999) has been helpful in interpreting the results. According to TAM, 'perceived usefulness' and 'ease of' use will lead to behavioral intention and ultimately to the actual use of technology (Davis, 1989). The increased focus on PUs, malnutrition and improved documentation indicates that 'perceived usefulness' could have been even more focused in the planning and during the implementation to increase the acceptance of the CDSS. Some participants in our study (Paper IV) described the CDSS as 'easy to use' and some described it as challenging. The contrasting findings may support an increased focus on the individual users in future implementation of CDSSs. Some participants felt it was unnecessary to use guidelines because they thought they could just look at the residents' physical appearance and then have enough information to consider if the residents were at risk for PUs and malnutrition. On the other hand, some participants described a lack of basic knowledge in prevention of PUs and malnutrition among other nurses in the staff. The nursing personnel (Paper IV) reported that it was difficult for nursing assistants to use the CDSS as well as for those nurses who were resistant to use computers. Studies have shown that even though the amount of evidence-based knowledge has increased, there is still a challenge to get nurses to actually practice according to evidence-based knowledge (Thompson et al., 2007).

The innovation, like a CDSS, needs to show relevance to clinical practice (Rogers, 1995). The five attributes (Relative advantage, Compatibility, Complexity, Trialability and Observability) found by Rogers (1995, p. 207) to be important in explaining why an innovation like a CDSS is taken up by users may be fundamental. Relative advantage is whether

the adopters see an advantage over existing practice; for instance, did the nurses perceive the evidence-based interventions in the CDSS as easy to discern and interpret, or did the implementation, especially in the beginning, just cause them more work? Our results show that some nurses perceived the CDSS as a support system in their daily work, but the results from Paper IV, especially that the nurses reported that the data in the CDSS were incomplete, may give reason to question whether the CDSS was fully integrated in the daily work process in the nursing homes. Compatibility is whether the CDSS has compatibility with existing practices and values. Using the CDSS was a new way of performing assessments and none of the nursing homes had used clinical practice guidelines before in assessing risk for PUs and malnutrition. Complexity is the degree to which the innovation is perceived as difficult to understand and use. For some of the nurses, using a computer for documentation was reported as a barrier that requires new knowledge and skills (Paper IV) and as a factor that may have had an impact on the results. Rogers (1995) also describes that users need to be able to identify 'observable results' of new technology. An important question for the nurses' adoption of the new technology is whether the implementation of CDSSs improves resident outcomes. Older people in nursing homes are often frail and suffer from several diseases (Huber et al., 2009). These facts might present difficulties to observe the immediate benefit of the extra work that the CDSS gave the nurses. However, Paper IV shows that the nurses felt that the CDSS had facilitated the identification of residents in need of nutritional interventions. Trialability is whenever the innovation gives the intended users an opportunity to experiment with it on a limited basis (such an innovation will be more easily adopted). In our study the nurses could use the CDSS in a test-module in the EHR system as much as they needed and their feedback could be submitted to the IS specialist. Nevertheless, none of these five attributes (Rogers, 1995) alone guarantees adoption and a systematic review suggests to increase focus on improving the absorptive capacity of the health care organization for new knowledge, managers should prepare the health care organizations to support and enable change in general and explore processes leading to long-term daily use (Greenhalgh et al., 2004). There is limited evidence on effective interventions promoting adoptions of CDSs to support health care professionals (Gagnon et al., 2009). In the PARIHS framework evidence, context and facilitation are presented as central elements for successful implementation in health care (Kitson et al., 1998; Rycroft-Malone et al., 2002b). Our results suggest that more

focus on organisational context and facilitation is needed when implementing CDSS in nursing homes.

To improve communication and information sharing about the implementation of the CDSS a multidisciplinary method has been successfully applied when developing CISs for elderly home care in Sweden (Scandurra et al., 2008). Organizing multidisciplinary teams for developing CISs and increasing the focus on usability evaluations have been suggested to improve the design of clinical technology (Alexander and Stagers, 2009). Our results show that the usability evaluations gave important suggestions to improve the interface.

Continuous evaluation is central in improving design and efficiency of clinical CISs in nursing homes (Alexander, 2008b; Alexander and Wakefield, 2009). Resistance toward changes in general may occur when nurses try to protect themselves against demands for changes in clinical practice (Lorenzi and Riley, 2000). From the literature, it is known that implementation of CDSSs can lead to both unexpected and negative consequences (Han et al., 2005; Koppel et al., 2005; Maslove et al., 2011; Tschannen et al., 2011). Although nurses in Paper IV reported that overall they were satisfied with the CDSS, it is critical to explore facilitators and barriers from their experiences of using a CDSS. Studies have shown that implementations of CDSS do not often undergo systematic evaluations and there is a general lack of reports about the effectiveness of CDSSs (Kaplan, 2001; Randell et al., 2007).

The combination of the nurses' characteristics and the CDSS and the representation of knowledge in the CDSS may explain the success or failure of implementing CDSSs. Nurses in the four nursing homes in our study (Paper IV) that used the CDSS described a variety of facilitators and barriers. Barriers such as lack of CDSS training, lack of information about the implementation of the CDSS, lack of computer skills, resistance to using computers and lack of computer work stations were reported, similar to what has been reported in other studies evaluating the implementation of CISs in health care settings (André et al., 2008; Randell and Dowding, 2010; Whittaker et al., 2009).

To address these issues the nursing home managers in the IG1 had signed a contract with information about the importance of providing nurses with opportunities to participate in the educational program before the intervention. However, because of time pressure and a high workload, it was often difficult for the nurses to participate in the educational program. The managers' role was not targeted in this study; however, leadership is known to be closely related to successful implementa-

tion (Kitson et al., 1998; Perry et al., 2011; Rycroft-Malone et al., 2004a).

Preferences for oral information were also described by the nurses in our study (Paper IV). The finding was similar to findings in a recent observational study in nursing homes (Munyisia et al., 2011). A CDSS could be seen as a threat by the nurses because of the time and effort they have to use in browsing the CDSS. The time they used browsing the CDSS could be seen as time that could have been used more productively in direct care of residents. Emotional feelings have been reported in a study of computerized physician order entry (CPOE) systems that have a lot of similarities to CDSSs (Sittig et al., 2005). Positive and neutral and negative emotional responses by physicians were reported. Negative emotional responses were most frequently reported (e.g., shame, sadness, pain, anxiety, fear, anger, hostility and disgust) toward the CPOE (Sittig et al., 2005).

A factor depicted as important in the implementation of CDSS is nurses' engagement (Randell and Dowding, 2010). In our study nursing personnel were involved in the planning, implementation and evaluation of the CDSS to increase their engagement. Access to IS specialists to facilitate an appropriate environment for implementing CDSSs is critical for using the system to its full potential (Dowding et al., 2009b; Randell and Dowding, 2010). Not surprisingly, this was reported as a facilitator for using the CDSS in our study (Paper IV). These findings are supported by the PARIHS framework that describes the facilitators as critical for success (Kitson et al., 1998; Rycroft-Malone, 2008; Rycroft-Malone et al., 2004a).

The analysis of the data from the cognitive walkthrough observations and the GUI usability evaluations resulted in four main issues in the design of the interface of the CDSS. These issues could have been overcome if a systematic usability evaluation had been conducted before the implementation (Kushniruk, 2002; Scandurra et al., 2008). However, the interface was continuously updated based on feedback from the 'super users'. Kawamoto and coworkers (2005) note four central features of clinical decision support associated with the ability to improve clinical practice. In our study two of the four features were included: actionable recommendations provided and that the decision support was computer-based. The two higher level features ("decision support provided automatically as a part of the clinicians workflow and decision support delivered at the time and location of decision-making") (Kawamoto et al., 2005, p. 7) were not fully addressed.

The nurses suggested pursuing an approach of reminder functions and preformulated care plans in the CDSS. These recommendations are in line with results from a systematic review on trials to identify features critical to the success of CDSSs (Kawamoto et al., 2005). The EHR system used for this study did not have reminder functions and preformulated care plans.

The design and development of CDSSs have undergone discussions during the past 30 years; however, vendors have incorporated these principles to support health care professionals only to a limited extent in software design (Ball et al., 2010).

Continuously updating knowledge and information so the nurses feel that they can trust the CDSS is another issue. In situations where there is a lack of updating, unexpected and critical events can occur (Han et al., 2005). Another issue referred to in the literature is that much more work must be done to increase the quality of the underlying evidence-base to ensure that reliable knowledge and information on relevant aspects of health care necessary to support resident care are available. Although considerable work has been done over the past years, much work remains to be done to realize the promises of EBP (Lemieux-Charles and Champagne, 2004).

### **Ethical issues**

Ethical issues are important to discuss, such as concerns that the CDSS may serve as a 'cook book', which increases a lack of assessment of the individual resident's perspective and preferences. It is important that the nurses continuously appraise information and suggested interventions in light of the resident's unique situation, beliefs and wishes. Experienced nurses in our study could have felt that the information and knowledge they were provided with in the CDSS should have been or were already known to them. The experienced nurses could have felt that the CDSS decreased their autonomy as professional health care workers. A study conducted in telenursing found that if nurses felt that they were familiar with the decision task, they were more likely to 'over-ride' the recommendation from the CDSS (Holmström, 2007). We did not choose to study the difference between experienced and novice nurses in using the CDSS in our group interviews. However, it has previously been pointed out as a challenge to design CDSSs to fit the requirements for both groups (Greenes, 2007).

The use of CDSSs in health care practice is likely to expand; however, today there is still a lack of robust evidence to support the full scale use

of CDSSs in nursing practice (Anderson and Willson, 2008; Randell et al., 2007). Studies have shown that the CDSSs are used in different ways than originally intended by the system designers, although the designers have involved users as recommended and the implementation process has followed recommended guidelines (de Veer et al., 2011; Dowding et al., 2009a; Greatbatch et al., 2005). If nurses ‘over-ride’ the CDSS, it could lead to an increase rather than a decrease in variation or errors in clinical practice.

## **Methodological considerations**

In this thesis there are strengths as well as limitations regarding the validity and reliability of the studies that may have influenced the results. When considering the quality of the research, reliability and validity must be addressed (and for the qualitative studies issues of trustworthiness).

### **Reliability and validity**

Fifteen nursing homes from seven municipalities in four counties in Southern Norway were recruited to the project. The 46 units varied in size and how extensively EHRs were used for care planning. The number of nursing homes and the variations may strengthen the validity of our studies.

Quasi-experimental designs are used when it is not feasible and/or ethical to conduct a randomized controlled trial, which is often the case in health informatics studies (Harris et al., 2006). In this case we needed a vendor that was willing to develop the CDSS. The vendor had a limited number of municipalities that used the EHR and thus only a limited population was available to test the CDSS. When implementing a CDSS, it is also difficult to randomize the intervention to individual residents or to individual CDSS users. Because of these constraints, a design with the highest rated category of the quasi-experimental designs was chosen, a quasi-experimental design with one control group and a pre-test (Harris et al., 2006). In the design of the intervention study two intervention groups and one control group were chosen to compensate for the methodological limitation. The design should facilitate drawing conclusions about the specific effects of the CDSS.

In the intervention study (Paper II and III) the number of participants did not meet the expected sample size as determined by the power analy-

sis, although the number of residents asked to participate was more than enough to ensure good statistical power. Conducting research in nursing homes is a challenge because many residents have some form of dementia and therefore are unable to provide informed consent. The intervention included risk assessments and interventions that were expected to be a part of the ordinary clinical practice in nursing homes. Still, it was necessary to ask the residents for consent and if the residents could not provide consent, we referred to their proxies. Several of their proxies did not return the consent form or declined to participate, however. Researchers have to be aware of the ethical and validity issues that arise, which is especially problematic in research with older people (Maas et al., 2002). Based on our results, it can be assumed that the ordinary clinical practice provided was a greater threat to the residents' health than the care provided during the intervention.

In 2007, 21 residents died and two had missing information from incomplete data collection (e.g., nurses failed to take body weight or had only filled out a few items when the resident was moved to another unit). In 2009, 20 residents died and 13 had incomplete information. However, the group of residents who participated in the intervention study (Paper II and III) did not differ significantly in age, gender and length of stay compared with residents that declined to participate.

Paired comparisons could not be done because all personal information was removed to protect the identity of the residents. Hence, it was only possible to make comparisons at the nursing home level. Because of this, caution should be observed in interpreting the results and generalizing to other settings, conditions and persons.

The data collection instruments used for the record audit in Paper III could have undergone psychometric testing. Such a testing would have strengthened the validity of the results. However, both the EPUAP guidelines modified for audit by Gunningberg and Ehrenberg (2009) and the CIND developed by Ehnfors and Smedby (1993) have been used in previous studies. Further, the CIND has undergone tests of interrater reliability and has produced Cohen's kappa values between 0.57 and 1.0 (Ehnfors and Smedby, 1993; Ehrenberg and Ehnfors, 1999a; Ehrenberg and Ehnfors, 1999b; Gjevjon and Hellesø, 2010; Gunningberg and Ehrenberg, 2004; Gunningberg et al., 2006).

Important strengths in this thesis are the combinations of research methods used (Patton, 2002) and that the CDSS was tested in a natural setting. Evaluation studies of CISs in health care settings are scarce (Kaplan, 2001; Koch and Hagglund, 2009). External threats to validity are common in non-randomized studies in that other factors than the

intervention could have caused the effect in the intervention group. The main outcome variables were the proportions of nursing home residents at risk of PUs or with PUs and the proportions of residents at risk of malnutrition or malnourished residents. The outcome variables were chosen based on the relevance and severity of these problems in nursing home residents and that RNs play a key role to prevent and treat these problems.

The cognitive walkthrough observations and the GUI usability evaluations were conducted after the intervention. These methods can detect design flaws early in the development of a CIS (Ball et al., 2010) and could ideally have been used before the intervention study. However, the users in the intervention study were actively involved in all phases of planning, implementing and evaluating the CDSS.

### **Trustworthiness**

The sample for Paper I was recruited by the managers at the nursing homes, which could have resulted in that they gave varying instructions when presenting the study to the participants. The managers were given written instructions to limit this risk.

The written scenarios used in the TA sessions were based on fictitious resident cases, each presented to the participants in three sequences. The participants could have felt that they did not have enough information about the residents in the cases (e.g. contextual information, information about test results and historical data about the resident). Such lack of information could have had an impact on the RNs' reasoning process (Fonteyn et al., 1993), although results have been similar between sessions conducted in real life settings (Simmons et al., 2003) and those conducted in simulated sessions (Fonteyn, 1998).

The richness of data from the TA sessions shows that RNs easily expressed their thoughts, similar to what has been reported from other scenario-based studies (Fonteyn, 1998; Grobe et al., 1991; Simmons et al., 2003). Deductive coding was chosen in accordance with the aim of the study (Paper I). An inductive coding could have given another result, although all 17 thinking strategies were identified in the data from the first interview, which gave support to pursue the structured deductive coding method. In all phases of the coding process we were open for data that could add new thinking strategies to those presented by Fonteyn (1998). Paper I examined thinking strategies and clinical reasoning concerning two clinical issues, PUs and malnutrition. Thus, generalization to other areas in nursing care cannot be done. The study (Paper I) did not

examine the quality of the clinical reasoning. Such analysis could have shown whether there were differences in the clinical reasoning based on, for example, the participants' experience from working in a nursing home setting.

The sample for Paper IV was recruited by the managers at the four nursing homes, which may have imposed bias. In addition, both sample selections and personal characteristics of the nursing personnel imply that transfer of the findings (Paper IV) needs to be done with caution. The principal investigator (MF) was involved in all phases of the intervention study (Paper II and III) and that may have affected the participants in the group interviews and the usability evaluations, although the participants expressed both positive and negative experiences from using the CDSS. Despite this possible bias we believe that our study adds to an understanding of facilitators and barriers of using a CDSS for nursing personnel in nursing homes.

## **Implications for practice**

The overall results from this thesis may provide nursing personnel, nursing home managers and vendors with knowledge about facilitators and barriers in implementing CDSSs to support EBP in nursing homes. A CDSS should include high level features that include actionable recommendations provided automatically as a part of the clinicians' workflow, whenever feasible and appropriate. Implementing CISs like CDSSs have potential to improve the quality and safety of care. CDSSs have the potential to support nurses to perform nursing documentation that meets the legal demands and increases their use of EBP. Nursing home managers must be aware that implementation of advanced CISs requires time before the expected effects can be reached. It is important to be aware that the change will take many months of planning and support after implementation before the expected benefits can be realized. A detailed implementation strategy should include how these issues can be addressed.

## **Further research**

Increased development of EBP and implementation of CDSSs to support EBP are crucial, both for the residents and for the healthcare services. Future research should focus on integrating CDSSs in a more advanced way into EHRs, focusing on automation of the data collection process,

retrieval and analysis. Another important research question with respect to improvement in the quality of resident outcomes is how CDSSs can be used to support multidisciplinary documentation. In the future resident data from multiple sources may be linked to the EHRs. The increased amount of data will give opportunity to create more advanced algorithms to further develop CDSS to support health care professionals in their daily work. The human-computer interaction, such as the interface, is a critical component in further research. In this respect nurses will expect to access information fast with little or no learning efforts. The addition of features that will easily match the workflow for the health care professionals in the CDSS is fundamental in the further design, development and implementation of CDSSs.

In addition, contextual factors such as lack of nurses, time pressure and organizational challenges may hamper the implementation of CDSSs. Such factors need further investigation.

# CONCLUSIONS

The main conclusions of the thesis are as follows:

- The use of thinking strategies varied among RNs in nursing homes and the clinical reasoning did not include systematic risk assessments of PUs and malnutrition. Mostly, the nurses went straight to planning interventions after a brief assessment of the residents' problems and needs.
- Residents' nutritional status improved within the intervention group (IG1), before compared with after implementing a computerized decision support system for preventing PUs and malnutrition, but there were no significant improvements between the intervention and control groups.
- The content and comprehensiveness of nursing documentation improved in the intervention group (IG1) after implementing a CDSS to prevent PUs and malnutrition.
- Implementation of a CDSS requires adequate training of nurses, as well as support from managers and facilitators.
- Both 'ease of use' and 'usefulness' of the system are important when implementing a CDSS. Usefulness of the system seems to be the most challenging issue.
- Organizational factors, individual resistance to use computers and design and software factors seem to be important for successful implementation and are therefore important to focus on when designing, developing and implementing CDSSs in healthcare practice.

## SUMMARY IN NORWEGIAN

Å utøve pleie og omsorg av høy kvalitet er det overordnede målet for helsetjenesten. Bruk av teknologi er blitt en stadig større og viktigere del av helsearbeidernes hverdag. Det er forventet omfattende positive effekter ved innføring av ny teknologi i helsetjenesten. Innføring av elektronisk pasientjournal (EPJ) og bruk av andre typer informasjonssystemer, slik som elektroniske beslutningsstøttesystemer integrert i EPJ, forventes å spille en nøkkelrolle ved innføring av kunnskapsbasert praksis i helsetjenesten. Elektroniske beslutningsstøttesystemer er dataprogrammer som inneholder informasjon og helseopplysninger til å hjelpe sykepleiere og andre helsearbeidere i kliniske beslutningsprosesser. Innføring av elektroniske beslutningsstøttesystemer påvirker helsearbeiderens ansvar, deres måte å samarbeide på og selve arbeidsprosessen. Helsearbeiderne produserer en omfattende mengde informasjon, og det kan karakteriseres som krevende å gjenfinne tilstrekkelig og nødvendig informasjon som grunnlag for å iverksette relevante tiltak. Elektroniske beslutningsstøttesystemer kan hjelpe helsearbeiderne i å organisere aktuell kunnskap, forskningsresultater og risikofaktorer på en måte som kan støtte pleien.

EPJ med integrerte elektroniske beslutningsstøttesystemer vil kunne bidra til å oppnå forventet kvalitet og kontinuitet i helsetjenesten. Til tross for potensialet har det vært gjennomført få studier nasjonalt og internasjonalt på sykepleiernes og andre helsearbeideres erfaringer med elektroniske beslutningsstøttesystemer. De fleste studiene er gjort på legers erfaringer og få studier har sett på effekter på pasientresultater etter implementering av elektroniske beslutningsstøttesystemer i helsetjenesten. I avhandlingen brukes begrepet helsearbeidere om gruppen offentlig godkjente sykepleiere og hjelpepleiere/omsorgsarbeidere.

Forskningsarbeidet ble gjennomført i sykehjem blant annet med bakgrunn i en uttrykt bekymring for kvaliteten på den pleien som utøves i den konteksten og fordi helsearbeiderne arbeider svært selvstendig i denne delen av helsetjenesten. Den overordnede hensikten med forskningsarbeidet var å utvikle, implementere og å frembringe erfaringer med bruk av elektroniske beslutningsstøttesystemer. Arbeidet omfatter derfor flere aspekter ved helsearbeidernes kliniske vurderinger og hvilke effekter en elektronisk beslutningsstøtte integrert i et EPJ system har på to utvalgte kliniske områder: utvikling av trykksår og underernæring samt evaluering av helsearbeidernes erfaring med bruk av det elektroniske beslutningsstøttesystemet. Det ble også undersøkt hvordan den elektroniske beslutningsstøtten påvirker dokumentasjonens innhold og sammenheng for å kunne innfri kravene til dokumentasjon i helsetjenesten, beskrevet i

den nasjonale journalforskriften. Avhandlingen består av tre studier og fire artikler (I-IV).

Den første studien hadde til hensikt å beskrive sykepleiernes vurderingsstrategier. Totalt 30 offentlig godkjente sykepleiere ble rekruttert til «think-aloud» intervjuer der det ble brukt konstruerte bruker case presentert i tre sekvenser. Sykepleierne tenkte høyt om casene. Intervjuene ble tatt opp på lydbånd og transkribert. Datamaterialet ble analysert med deduktiv innholdsanalyse. Modellen til Fonteyn og medforfattere som beskriver totalt 17 vurderingsstrategier ble brukt som struktur for analysen. Det ble også gjort en analyse av prosessen i de kliniske vurderingene sykepleierne gjennomførte. Alle 17 vurderingsstrategiene ble avdekket i datamaterialet, men det var store forskjeller mellom informantene, og også store variasjoner i hvor hyppig de ulike vurderingsstrategiene ble brukt. De tre mest brukte vurderingsstrategiene var 'å ta avgjørelser', 'forme sammenhenger' og 'å trekke konklusjoner'. Hovedfokuset i sykepleiernes vurderinger var å gå direkte på planlegging av intervensjoner.

Den andre studien består av en intervensjon som ble gjennomført i perioden 2007-2009, og omfattet totalt 15 sykehjem fra fire fylker i Sør-Norge. Hensikten med studien var å evaluere effekter av bruken av et elektronisk beslutningsstøttesystem integrert i EPJ systemet; Prosys. Effekten på brukerresultater var hovedfokus for artikkel II og dokumentasjonens innhold og kvalitet var hovedfokus i artikkel III. Intervensjonsstudien har et kvasi-eksperimentelt design. Sykehjemmene ble rekruttert til tre grupper, to intervensjonsgrupper og en kontrollgruppe. Intervensjonsgruppe 1 (IG1) fikk både en utdanningsintervensjon og implementering og bruk av den elektroniske beslutningsstøtten. Intervensjonsgruppe 2 (IG2) fikk utdanningsintervensjonen. Utdanningsintervensjonen inneholdt en gjennomgang av forebygging av trykksår og underernæring. Helsearbeidere i hver enkelt avdeling, totalt 46 avdelinger, rekruttert til studiegruppene, gjennomførte en kartlegging av alle brukerne med Mini Nutritional Assessment (MNA®), et kartleggingsverktøy for vurdering av ernæringsstatus og Risk Assessment Pressure Scores (RAPS), et kartleggingsverktøy for vurdering av risiko for utvikling av trykksår. I tillegg ble alle brukerne kartlagt i forhold til om de hadde trykksår og eventuelt stadie (I-IV) for trykksåret eller trykksårene. Det ble også gjennomført en innsamling av all dokumentasjonen tilhørende hver enkelt bruker som ble rekruttert til studien i en periode på tre måneder fra datasamlings-tidspunktet. Det var totalt inkludert 491 brukere i 2007 og 480 brukere i 2009. Dataene ble analysert med statistiske metoder og i den andre studien (Artikkel II) viste analysene en signifikant reduksjon i antall underernærte brukere i IG1, i forhold til MNA skårene mellom 2007 og 2009.

Resultatene fra kartleggingen med MNA og RAPS ble brukt som utvalgsriterier for den tredje artikkelen. Hensikten med studien var å evaluere effekter med bruken av det elektroniske beslutningsstøttesystemet integrert i EPJ systemet; Prosys, på dokumentasjonens innhold og kvalitet (Artikkel III). De brukerne som hadde trykksår og/eller var underernærte ble inkludert. Det ble gjennomført journalgranskning på totalt 150 brukerjournaler fra 2007 og 141 brukerjournaler fra 2009. Alle sykehjemmene hadde tatt i bruk EPJ, men helsearbeiderne brukte en blanding av elektroniske dokumenter og papirsystemer for å dokumentere helsehjelpen både i 2007 og 2009. Det ble brukt tre instrumenter i journalgranskningen. Et instrument vurderte dokumentasjonen av ernæringsstatus, laget spesielt for studien ut fra spørsmålene i MNA. Et annet instrument, 'Comprehensiveness in Nursing Documentation' (CIND), undersøkte sammenhengen i sykepleiedokumentasjonen på en skala fra 1-5. Det tredje instrumentet vurderte dokumentasjonen av forebygging av trykksår og dokumentasjon av faktorer relatert til trykksår. Resultatene av analysene viste at IG1 hadde en signifikant forbedring i både innhold og sammenheng på den dokumentasjonen som ble vurdert på de to utvalgte områdene forebygging av trykksår og underernæring.

Hensikten med den fjerde studien var å beskrive suksessfaktorer og barrierer som har en innvirkning på helsearbeidere ved implementering av et elektronisk beslutningsstøttesystem for forebygging av trykksår og underernæring hos brukerne i sykehjem. Totalt 25 helsearbeidere i de fire sykehjemmene som hadde vært i IG1 ble intervjuet i fire grupper. Det ble brukt en intervjuguide og intervjuene ble tatt opp på bånd og datamaterialet ble analysert med manifest innholdsanalyse. Det ble også gjennomført en brukervennlighetstest med fem helsearbeidere som hadde brukt den elektroniske beslutningsstøtten i intervensjonsperioden på åtte måneder. Resultatet viser at informantene beskrev den elektroniske beslutningsstøtten som lett å bruke, anvendbar og at det var viktig at arbeidsmiljøet støttet opp om innføringen. Det hadde vært variasjoner i hvor mye de ansatte hadde brukt den elektroniske beslutningsstøtten. Barrierene ved innføringen ble beskrevet som mangel på muligheter til å trene på å bruke den elektroniske beslutningsstøtten, motstand blant andre ansatte i å bruke datamaskiner som arbeidsverktøy og svakheter ved integreringen av den elektroniske beslutningsstøtten inn i EPJ systemet som sykehjemmene anvendte.

Den elektroniske beslutningsstøtten brukt i studie to, presentert i artikkel II og III, gav helsearbeiderne mulighet til å øke bruken av kunnskapsbasert praksis ved at aktuell kunnskap, forskningsresultater og kliniske erfaringer ble integrert ved utviklingen av den elektroniske be-

slutningsstøtten. Etter intervensjonen inneholdt dokumentasjonen i større grad tilstrekkelige og nødvendig opplysninger om brukerne i IG1 sammenlignet med før intervensjonen. Resultatene viser at den elektroniske beslutningsstøtten bidro til en kvalitetsforbedring av dokumentasjonen av helsehjelpen for brukerne i sykehjemmene i IG1. Forskningsarbeidet i sin helhet viser at det er et potensiale for å utvikle elektroniske beslutningsstøttesystemer for integrering i EPJ systemene, men det stiller omfattende krav til utviklerne, helsearbeiderne og helsetjenesten ved utvikling og ved implementering av elektroniske beslutningsstøttesystem.

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