Improving quality of fall prevention and management in elderly patients using information technology: The impact of computerized decision support

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Aging is associated with an increase in the number of health challenges. When we grow older we face normal physiological changes, but also multiple chronic diseases and medications use that often contribute to a decline in activities of daily living, diminished physical function, and eventually deterioration of cognition. In addition, recovery from diseases takes longer and requires more efforts, and the need for professional care grows markedly, especially for existing geriatric conditions. One of these conditions, falling, might be an indication of progressive deterioration in physical functioning, and is therefore an important risk factor for recurrent falls.

Falls at older age form a major health concern since they might have serious short and long-term consequences for both elderly individuals and the health care system in terms of monetary, medical attention and psychological costs [1, 2, 3]. Annually, about 30% of the community-dwelling persons aged 65 years and older fall at least once; and about 10% fall two times or more [1, 2, 4, 5, 6]. Although not all falls lead to injuries, around 5 to 10% require medical attention [7]. In the Netherlands, a total healthcare cost of 474.4 million Euros is estimated due to falls, which represents 21% of the total healthcare expenses due to injuries [3].
In addition, the number of seniors is increasing in western countries, demanding new and feasible interventions for the prevention and management of geriatric conditions like physical and/or cognitive impairment. At the same time, seniors and especially vulnerable elderly patients often receive sub-optimal coordination and management of professional care within the present healthcare organization, especially for geriatric conditions [8]. Falling and other geriatric conditions affecting vulnerable seniors are known to be underdetected [9], partly due to the high number of risk factors, the complex and interdisciplinary nature of their care process, and lack of reliable instruments for continuous assessment of their care and prevention. Sub-optimal coordination and management of care for these patients could also be ascribed to factors related to inadequate case finding, deficient communication, and resource sharing between the stakeholders.
Seniors are therefore, in need of continuous assessment and proactive improvement of their care. In order to offer integrated care [4] there is a need to know where exactly deficits exist and which instruments and technologies are potentially useful for assessing and improving quality of their care. This foreseen improvement should include care with a preventive character, in order to reduce the medical and monetary costs.
A potentially beneficial technology is information technology (IT), which can play a role in measuring and maintaining quality, and providing proactive care through improving communication and collaboration. In particular, it can provide the right information at the right time through the right channel to the right caregiver, which opens the doors for offering tailored care. IT is however underutilized in fall management and we lack evidence about its effectiveness. The general aim of this thesis is to investigate the utilization of information technology to improve the quality of fall prevention and management processes for elderly patients, which are at increased risk of falling.
The thesis consists of three parts: The first part concerns assessing the quality of care, including fall-related care, for the (vulnerable) elderly population. The second part concerns analyzing and improving the process of fall management in a shared care setting. This part relies on the concepts of disease-management and process modeling. The third part addresses the quality of detection and management of falls in community dwelling elderly patients by general practitioners, and how to improve these by using computerized decision support.
Below, we will describe each part by providing the required preliminaries, the research questions, and the approach used. This description will also provide the chapter outline of this thesis.
Part I - Quality of care, including fall-related care, for (vulnerable) elderly population

Care for elderly patients is complex and it is not yet well understood. Due to multimorbidity and the complexity of their care processes, a multitude of possibly conflicting guidelines and quality indicators are applicable to them. Therefore, there is a need for evidence-based, comprehensive, simple and reliable instruments for measuring quality of care for the elders. Moreover, for generating better insight, elaborate studies are still needed to demonstrate the current quality of care offered to these patients. We aimed in this part of the thesis, to better understand the current quality of elderly’s care, including fall-related care.

The following research question is tackled in this part:

1) What is the quality of care of (vulnerable) elderly patients, and what is known about the quality of fall detection and management of (vulnerable) elderly patients?

Preliminaries:

1.0.1 Quality indicators for assessing the quality of elderly care

A quality indicator is defined as “measurable element of practice performance for which there is evidence or consensus that it can be used to assess the quality, and hence change in the quality, of care provided” [10]. More and more quality indicators are released, by different stakeholders in healthcare, including insurers, and scientific and governmental associations, and associations of care givers and patients. Quality indicators are mainly used for the purpose of assessment of the care processes. The quality indicators addressed in this thesis resemble guidelines, albeit very short ones. Guidelines are defined as “systematically developed statements to assist practitioner and patient decision about appropriate health care for specific clinical circumstance” [11]. Several benefits for clinical guidelines were reported [12]. They can improve patient care, reduce errors which can improve patient’s safety and reduce costs. One guideline for prevention of falls was released by the Dutch Institute of Health Care Improvement (CBO). This guideline recommends screening older persons and provides general evidence for it. Although there is sufficient evidence for the benefits of implementing clinical guidelines in daily practice, a number of difficulties exist related to their implementation. For example, interpretation of the content of the guidelines is difficult and updating the guidelines that have to do with state-of-the-art knowledge requires time and efforts [12]. In addition, previous studies
showed that factors pertaining to knowledge (not knowing or forgetting) and attitude of care providers (e.g. not agreeing with the guideline) are associated with lower adherence to the guidelines [13].

There are different types of quality indicators, including process and outcome indicators [14]. A process indicator pertains to the way care is provided. Outcome indicators pertain to the effect of given care on the health care status of the patients. One class of process indicators that resemble guidelines is the Assessing Care of Vulnerable Elders (ACOVE) quality indicator (QI) set. The ACOVE QI set was developed by the RAND corporation in the year 2000 [15]. It is a comprehensive method for assessing the quality of care of vulnerable elderly patients. Review of the relevant evidence and iterative expert meetings were used to generate this set of indicators to assess the quality of the process of care, rather than its outcomes. RAND researchers assume that these sets represent minimal care rather than optimal care, and are meant to assess and ultimately improve the quality of care [15, 16]. These indicators are intended to evaluate, by means of measuring adherence to the indicators, the extent to which the care being delivered meets minimal standards of quality. The set consists of multiple medical and geriatric sub-sets, including a subset for falls, expressed in natural language statements in the form of condition-action (IF-THEN) rules. The inherit ambiguity existing in the natural language is a prominent problem for automatically computing the health care quality indicators. Formalization methods are therefore required for this purpose. In this part of the thesis we reviewed the quality of care of elderly persons as measured (mainly manually) by these QI sets and will demonstrate the measured quality of fall management in different settings. Later, we introduce a design for proactively employing the fall-related formalized set in a clinical decision support system in primary care.

Part II - Analyzing and improving an integrated fall management process

Recently, prevention of preventable falls has been a major focus of research, resulting from a growing awareness of the resulting morbidity and mortality [17] and the need for effective interventions in aging populations. Due to this awareness, many interventions, guidelines and prediction models for the prevention and identification of patients at higher risk of (recurrent) falling have been developed [15, 18, 19, 20, 21, 22, 23]. However, they have shown a varied degree of success [20, 24]. This part of the thesis tackled the following research questions:
Chapter 1

2. How can fall-related care processes be evaluated and improved?

3. To which extent can one predict risk of recurrent falls, and how are medication groups associated with recurrent falling?

4. What are determinants of fall-related health information seeking behavior of elderly Internet users?

Preliminaries:

1.0.2 Disease management: a new strategy

Disease management (DM) is a strategy aimed at providing efficient and effective care for patients, especially to those patients suffering from chronic conditions [25]. The main goal of disease management can be realized by, among other things, improving the involvement of the patient and case finding, redistributing tasks of (collaborative) work, the use of scientific evidence and guidelines in clinical practice and, patient empowerment and education [26]. Information technology can support realizing these concepts. It is also a promising solution for identification of patients at higher risk of falling for prevention of (recurrent) falls. However, the effectiveness of utilizing information technology has not yet been tested in practice for this purpose.

DM consists of desiderata that the provided care should meet. A problem is that not much is known on how to assess the extent to which a process meets these desiderata and how to improve it. We therefore first develop a process modeling-disease management approach to evaluate the fall prevention processes. We investigate later in this part of the thesis how disease management aspects of fall management could be supported by information technology.

1.0.3 Clinical prognostics models

Great efforts have been made to develop risk profiles and prognostic models to identify elderly persons at risk of falling [18, 23, 27, 28, 29]. Despite the current efforts and their many benefits, the current existing disadvantages, including not being validated, hinder their applicability. There is a need to develop specific, validated and easy-to-apply risk profiling tools with the potential to identify individuals at higher risk of falling. A validated tool to predict risk of falling can be embedded within a computerized decision support system to alert clinicians...
when their patient may be at higher risk of a fall. In addition, they have the potential to be used in patient self-management or for other empowerment goals.

1.0.4 Patient empowerment

Patient empowerment is a process to help patients gain control, take the initiative, and make informed decisions and manage their health [30]. Information technology and the Internet have an important and promising role in patient empowerment. The Internet forms a promising instrument for the coordination and self-management of diseases and education of patients. The Internet forms a potentially cost-effective instrument, allowing providing the patient with tailored information and preventive measures [31, 32]. The number of elderly patients using the Internet is increasing [33] and they are becoming more active health information seekers on the Internet. A national survey in 2012 showed that 81% of elders aged between 65-75 use the internet. If they rely more on online sources of information, then the health information communicators need to understand the nuances and needs in health information seeking of different groups of patients. The health information communicator therefore needs to develop interventions and education programs appropriate for their elderly-target group to reach effective empowerment. In addition, the group of seniors might be more diverse than younger people [34]. Beside psychological and medical factors, aptitude, inherent or acquired ability (e.g. having expertise and experience) is more diverse in this group, as seniors might not have aptitude with newly developing trends. Therefore it is important to not consider the elderly as one homogeneous group when attempting to understand their individual needs. There is a lack of understanding of the fall-related health information seeking behavior of different elderly adults on the internet.

Part III - Quality of detection and management of falls by general practitioners and improving it by a decision support system

In the Netherlands the general practitioner (GP) plays the role of a gatekeeper and is the first echelon that the patient faces. Increasing amount of healthcare data are routinely recorded in Electronic Medical Records (EMR). Virtually all GPs in the Netherlands use an EMR thus facilitating the integration of computerized decision support based on the (fall-related) ACOVE QIs in the primary care setting. No studies have been conducted to investigate the effect of automatic
computing of clinical indicators embedded in a CDSS, for the identification and management of community dwelling patients with risk of falling.

The main research questions to be answered in this part were:

5. What is the quality, based on the ACOVE-QIs, of fall-related care delivered by general practitioners?

6. How to design, deploy and test a CDSS in order to improve fall prevention and management processes in GP-practices?

7. What is the effect of a CDSS on adherence to fall-related QIs?

Preliminaries:

1.0.5 Computerized decision support systems (CDSSs)

Computerized decision support systems (CDSS) are computer programs intended to support care providers in making decisions [35]. They were shown to be generally effective in improving the care process, for example by providing knowledge or feedback in the form of alerts and reminders based on guidelines, they can help the user (e.g. a physician) to make the right decision at the right time or by providing the right information [36]. A CDSS is characterized by its consultation mode (passive vs. active mode), the level of support (general vs. specific) and the style of communication (critiquing vs. non-critiquing style). Different combinations of these characteristics may have different effects on the outcome. Automatic computing of health care quality indicators embedded in a CDSS can help set the proactive assessment in motion, and to identify patients at higher risk of falling. In this thesis we describe the design of a CDSS and investigate its effect on the adherence of the fall QIs.

Outline of this thesis

The studies in this thesis explore several aspects of fall detection and management, with a focus on information technology. The objectives are addressed in 3 parts.

Part I contains two chapters that discuss the results of two systematic reviews based on the Assessing Care Of Vulnerable Elders (ACOVE) QIs and give answers to question 1 (What is the quality of care of (vulnerable) elderly patients,
and what is known about the quality of fall detection and management of (vulnerable) elderly patients?). **Chapter 2** reviews the state of the art regarding studies pertaining to the ACOVE instrument. **Chapter 3** reviews the assessment of care for (vulnerable) elders.

**Part II** consists of chapter 4 through chapter 8, which are related to analyzing and improving the process of fall management in an integrated care setting. **Chapter 4** addresses research question 2 (How can fall-related care processes be evaluated and improved?). It investigates a combined process modeling and disease management approach to study fall-related processes. **Chapters 5 and 6** address research question 3 (To which extent can one predict risk of recurrent falls, and how are medication groups associated with recurrent falling?). They study the association between medication and the increased risk of falls in frequent fallers and present the development and validation of a prognostic model that predicts the risk of recurrent falling. Research question 4 (What are determinants of fall-related health information seeking behavior of elderly Internet users?) is addressed in **Chapter 7**. This chapter describes a pilot study on understanding fall-related health information-seeking behavior of elderly patients using the Internet.

**Part III** consists of chapter 8 through chapter 10, which pertain to the assessment of the quality of detection and management of community dwelling elderly patients by general practitioners. **Chapter 8** addresses research question 5 (What is the quality, based on the ACOVE-QIs, of fall-related care delivered by general practitioners?). It describes the results of the ACOVE-based assessment of quality of fall management. The design of a before-after study of implementing a CDSS for improving the fall-related care processes is described in **chapter 9**, which addresses research question 6 (How to design, deploy and test a CDSS in order to improve fall prevention and management processes in GP-practices?). **Chapter 10** addresses research question 7 (What is the effect of a CDSS on adherence to fall-related QIs?). It presents the results of the implementation of this CDSS in primary care.

**Chapter 11** provides a general discussion and summary, which states the main findings of the studies presented in this thesis, describes the implications in practice, and recommends future studies.

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1Not all the supplementary materials and appendixes are included in this thesis. For the complete list of supplementary material please visit the website of the journal where the article is published.
Chapter 1

Bibliography


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