Improving quality of fall prevention and management in elderly patients using information technology: The impact of computerized decision support
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“A brief summary will be sufficient to recall to the reader’s mind the more salient points in this work. Many of the views which have been advanced are highly speculative, and some no doubt will prove erroneous; but I have in every case given the reasons which have led me to one view rather than to another [...]. False facts are highly injurious to the progress of science, for they often endure long; but false views, if supported by some evidence, do little harm, for every one takes a salutary pleasure in proving their falseness: and when this is done, one path towards error is closed and the road to truth is often at the same time opened”

- Charles Darwin

The Descent of Man, 1871
This thesis explores the role of information technology (IT) for prevention and management of falls both in general practice and hospital settings. Specifically, we address the question of how disease management concepts, process modeling, prognostic models and decision support can contribute to a better management of falls shared by general practices, an emergency department and a geriatrics outpatient clinic. The thesis is organized in three parts addressing three research topics.

The first topic is the assessment of the current quality of care, including fall-related care, for the (vulnerable) elderly population. The second topic is the analysis and improvement of the fall management process in an integrated care setting. This part relied on the concepts of disease-management and process modeling. The third topic is 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 systems. Below, we will summarize the results of each part and discuss the challenges of utilizing IT for quality improvement purposes for fall care processes. Recommendations for future studies will also be provided.

Part I - Quality of care, including fall-related care, for elderly population

Care of elderly patients is an increasingly important societal topic. The Assessing Care Of Vulnerable Elderly (ACOVE) quality indicators (QIs) were developed to assess and improve the care of elderly patients by the RAND group. In chapters 2 and 3, we reviewed the literature and summarized studies that assess the quality of care as assessed by ACOVE-based QIs, in order to evaluate the state of quality of care for the reported conditions. In addition, we aimed to identify and uniformly describe studies employing the ACOVE QIs within a comprehensive thematic model that reflects how the indicators were used.

Based on 41 included articles we showed that the studies using ACOVE QIs can be classified into the two general categories “Application of indicators” and “Analysis and Development of indicators”. The “Application of indicators” category included studies assessing quality of care; influencing behavior of health professionals; and examining the association of quality of care with other factors. The “Analysis and Development” category included studies developing new indicator sets; and those adapting and validating the original quality indicators to new settings. Our results showed that the indicators were used in a wide range of applications having two main foci: the assessment of quality of care for elderly patients; and investigating the feasibility of similar indicators and their adapta-
tion to new settings. Very few studies published to date have addressed the goal of care improvement; the vast majority of studies where hence confined to quality of care assessment. We discern therefore an important role for the proactive application of indicators to help health care professionals to adhere to the quality indicators, for example by resorting to clinical decision support systems.

From the 41 studies, seventeen studies assessed the quality of care of elderly patients using ACOVE QIs. The quality scores showed large variations between and within conditions. Only a few conditions showed a stable pass rate range over multiple studies. Overall, pass rates for dementia depression, osteoporosis and osteoarthritis were notably low. Medication management and use, hearing loss and continuity of care scored higher than other conditions. Out of the 278 QIs used in the studies, 50% of the QIs had mean pass rates below 50% and 16% scored below 25%. Twenty-three percent of the QIs scored above 75%. The quality of fall-related care ranged between 3% and 83% depending on the setting. Our study showed that the assessment of quality of care within the same condition varies markedly across studies. Although there has been much effort in improving the care for elderly patients in the last years, we concluded that the reported quality of care according to the ACOVE indicators is still relatively low.

Part II - Analyzing and improving an integrated fall management process

In chapter 4 we proposed a combined disease management and process modeling approach for evaluating and improving care processes, and demonstrate its usability and usefulness in a fall management case study. We showed that the process model of the fall management program was organized around the clinical tasks of case finding, risk profiling, decision making, coordination, and interventions. After developing a framework based on the disease management concepts and transforming the concepts to questions; we applied the resulting questions to the developed process models to expose weaknesses in the process. These weaknesses included: absence of program ownership, under-detection of falls in primary care, and lack of efficient communication among stakeholders due to missing awareness about other stakeholders’ workflow. The modelers perceived the application of the approach as usable and the attendees of the invitational conference found the analysis results to be valid. The proposed disease management view of process modeling was usable and useful for systematically identifying areas of improvement in a fall management program. Although specifically applied to fall management, we believe our case study is characteristic of various disease management settings, suggesting the wider applicability of the approach.
In chapter 5 we investigated which classes of medications are associated with recurrent falls in elderly patients visiting the Emergency Department (ED) after a fall. From a cohort of 2258 patients participating in our study, 39% (873) had sustained two or more falls within the previous year. After adjustment for potential confounders, the following variables remained statistically significantly associated with an ED visit due to a recurrent fall: drugs for acid related disorders, analgesics, anti-Parkinson drugs, antipsychotics, nasal preparations, ophthalmologicals, and antidepressants. Our results showed that known fall risk-increasing drugs, such as psychotropic drugs, also increase the risk of recurrent falls. However, we found four relatively new classes that showed significant association with recurrent falls. To our surprise, we found no association with some medication classes in this study that are known to have association with falling. In part, the new classes may act as markers of frailty and comorbidity, or they may reflect differences in the risk factors affecting the older, frailer population that tends to sustain recurrent falls. We studied the association between recurrent versus single falls. Due to the small differences between these two groups, the effect of medication on recurrent falling might be diluted in the analysis. Stronger study designs are necessary to confirm our findings. These replication studies should be done in large groups of elderly patients, differentiating between having no falls and recurrent falls, concentrating both on each individual medication class as well as studying the effect of simultaneous usage of the medication classes on recurrent falls, and finally adjusting for all possible confounders for which we were not able to adjust for.

The results of the above mentioned study together with other possible risk factors of falling were used in chapter 6 to develop a prognostic model in a cohort of 2259 patients visiting the emergency department due to a fall. Our final model included the variables: age, mobility problems (calculated score based on the Amsterdam and Rotterdam evaluation of falls (CAREFALL) triage instrument (CTI) questions), fear-of-falls, and precipitating symptoms. The discriminative performance of the model as measured by the AUC (Area Under the Receiver operating characteristic Curve) was 0.75 (95% CI: 0.70-0.79) for internal, 0.74 (CI: 0.64-0.84) for temporal, and 0.70 (CI: 0.65-0.76) for external validation. The Brier skill score for the internal and external validation was 0.17 and 0.08, respectively. The identified predictors of recurrent falls are easily obtained and yield a model with fair discrimination and acceptable calibration. Such a model has the potential to be used in the clinic or in a self-assessment tool designed to support elderly patients in making decisions pertaining to fall prevention.
11.0.1 Patient empowerment using IT

An important concept of disease management is self-management in which the patient could gain control over his/her care. Information technology plays an important role for empowering patients in terms of improving the involvement of the patient in their own care. The Internet is a promising platform for empowering seniors, and helps minimizing the gap between the supply and demand of care by facilitating cheaper solutions [1] in particular in societies with an aging population requiring increasingly more care. However, their information-seeking behavior about falls and their information needs are not well understood. We therefore investigated the information-seeking behavior about falls among elderly Internet users in chapter 7. 32% of the respondents reported they sustained a fall in the last 12 months, and 86% reported using the Internet to find health-related information. 64% of the respondents were willing to search for fall-related information on the Internet. In general, there was much stated interest in receiving information about conditions and medications that increase the risk of falls and information on safety at home. Around half of these respondents did not feel that they are well-informed about falls. Our study showed that the majority of elderly in our cohort expressed higher interest in receiving fall-related information than undertaking a self-assessment test. In addition, only a small proportion had searched for this information already. Future study is needed to investigate why seniors express less interest in participating in online assessment tests, as seniors are health information-seekers and could be at a considerable risk of falling. Due to the diversity, the physical restrictions and the seniors’ aptitude with the fast growing technology, employing IT as an instrument for empowering elderly individuals is a challenge [2]. More studies are therefore needed to investigate the information needs of elderly, taking into account their physical restrictions and limitations, such as cognitive impairments, communication problems, the level of health literacy, and demographic diversity (such as level of education and cultural background). In addition, a substantial research deficit exists in the area of elderly-computer-interaction and the seeking behaviour of this group with multimorbidity, on which research needs to focus. It can be expected that changes in the nature of care delivery will occur when the patients would attend to his/her health care processes no longer as a naive patient but as an informed patient or coordinator of his/her care. Future studies are therefore needed to investigate the impact of this shift, in particular on the patient vs. health care professional relation, improving clinical outcomes, reducing adverse outcomes and on the quality of the patient’s life.
Part III - Quality of detection and management of falls by general practitioners and improving it by a decision support system

Prevention of geriatric conditions is rooted in primary care. It was hence useful to focus on investigating the quality of detection and management of falls in the elderly population by general practitioners. We used the ACOVE QIs and designed a questionnaire to determine General practitioners (GP)’s adherence to nine fall-related QIs validated for the Dutch setting in chapter 8. We investigated the association between adherence to the QIs and vulnerability - as quantified by the Identification of Seniors At Risk for Primary care (ISAR-PC). We then cross-validated the self-reported falls with medical records. Of the 950 elders responding to our questionnaire, only 11% reported that their GP proactively asked them about falls. Of the 160 patients who reported two or more falls, or one fall for which they visited the GP, only 23% had fall-documentation in their records. Adherence to the fall rules ranged between 14% and 49%, and was positively associated with the ISAR-PC score. The history of fall circumstances and risk factors of falls were documented in only 37% of the fallers. Based on the ACOVE fall-related rules, one can conclude that the quality of fall management needs more attention in primary care in the Netherlands. Although there was a positive association between adherence to the QIs and vulnerability, awareness for fall prevention opportunities should still be increased, especially for the assessment of cognitive status, assessment and modification of home hazards, and recommendation of a structured/supervised exercise program. We hypothesized that computerized clinical decision support systems (CDSSs) can play an important role in improving adherence to the QIs.

In chapter 9, we introduced a CDSS aimed at improving adherence to the ACOVE fall QIs and a protocol for investigating the impact on QI adherence among general practitioners (GPs). The CDSS systematically gathered fall history, and mobility and balance problems for all patients who were 65 years and older and visited the GPs. It was designed to give non-interruptive support in the form of a small sidebar on the left side of the GP’s screen, providing access to a message containing patient specific fall related background information and advice based on clinical rules derived from the ACOVE fall quality indicators selected by the users. In this design, we relied on active end-user involvement in selecting what to support and on a model for providing support based on a dynamic feedback list that displays color-coded real-time messages concerning the patient visiting the GP at that time, without interrupting the GP’s workflow, like pop-ups do. These aspects could increase CDSS acceptance and its impact on adherence to the selected CRs. The primary outcome measure was the degree of adherence to the
rules, in terms of the changes in the pass rates after the introduction of the system. We also analyzed the system’s usage during the intervention. The intervention introduced a structured means of documentation for falls, fall history, and balance/mobility problems. Our results in chapter 10 showed that the non-intrusive CDSS that provided timely, patient-specific and proactive computerized feedback is effective, at least in the short term, in better management of falls in primary care in terms of adherence to the QIs.

Addressing the challenge of improving quality of fall processes using IT

11.0.2 IT as a sine qua non for improvement of care processes

The results of our studies in chapter 2, 3 and 4 showed that care for elderly individuals is complex and there is still a gap between the quality of care delivered to elderly patients, in particular for geriatric conditions such as falls, and what they actually need to be delivered. In the last decades, new models and strategies such as the chronic care model or disease management are therefore introduced to close this gap [3, 4]. The improvement models and strategies, however consist of components that demand a readiness to accept new ways of delivery of health care services where patients plays an active role in his/her care process [5, 6]. Moreover, proactive assessment and improvement of the quality of care formed an essential role. IT is seen as an indispensable and essential instrument, to act as a foundation of these models to bridge the current gap [7]. Standardization of health care processes is highly required to achieve this goal.

In part three of this thesis we designed and deployed a system based on DM components to improve the adherence to current quality indicators and introducing a structured way of fall identification and management. In the next section we will explain briefly our effort based on DM components for standardizing the fall management and improving the adherence to QIs. We will then discuss the current existing challenges to improve the fall management processes utilizing IT.

11.0.3 Redesigning fall management processes based on DM components

Our intervention was based on the components of disease management, which were customized into electronic medical-record structured forms. We employed
four components of DM:

- Case finding: For this purpose we extended the electronic medical record by introducing our CDSS which proactively collected fall history. For all 65-year-old and older patients who visited the participating GPs, a structured form appeared, non-interruptively and small on the left side of the screen, related to the fall, balance and mobility history taking. This structured fall-history taking form was introduced due to the non-availability of fall-terminology or classification in the systems.

- Evidence-based quality indicators: We used ACOVE-QIs, which are evidence-based standard for improving the care.

- Decision support: The structured fall history-taking and prevention form helped health care professionals to systematically identify the patients at higher risk of falling and offered advice based on patients’ fall history and mobility/balance problem.

- Patient education: The advice included a brief recommendation for the GP to provide patient education, such as modifications of home hazards and reduction of falls by discontinuation of medication.

Our results showed that it took the GPs an average of 1 minute and 24 seconds to fill in the fall prevention forms, regardless of the time they spent to perform the fall prevention activities (no exact results were available on the latter point). Time limitation could be an explanation for why many GPs did not document falls because other health problems might take priority. Therefore, It is important to carefully unravel all the care processes and activities and if needed, redistribute or redesign the tasks over the different professionals, if it leads to more success or improvement [7] by for example delegating this task to the practice assistant.

11.0.4 Future steps in the fall management in primary and secondary care

In this thesis, we developed and validated a prognostic model in a cohort of elderly persons who visited the emergency department due to a fall. The model
yields easy to assess variables based on a validated questionnaire. As mentioned above, such a model has the potential to be used in a self-assessment tool designed to support elderly patients in making decisions pertaining to recurrent fall prevention by facilitating the provision of personalized fall risks to these patients, amongst other things. This might help to improve the senior’s awareness, and potentially also his/her willingness to attend fall prevention programs and/or the adherence to the therapy. However, future studies are needed to investigate the actual effect of the awareness of the fall risk on individual patient’s decisions. The impact of psychological factors such as identity, intention, subjective norms and perceived behavioral norm in relation to the elderly’s falls perception needs to be studied for better understanding the reasons of denials or patient’s decisions.

To our knowledge, no studies have investigated the perception of GPs about fall prevention and management in primary care. In addition, our results showed that some GPs never documented fall history and balance/mobility problems using the system. Therefore, future studies should explore why some GPs did not document falls in such a system based on their perception of fall prevention, technology acceptance theories and findings on alert-overriding. Future efforts should also measure the clinical outcomes of such interventions and the reasons of GPs for using or ignoring the system.

Finally, other strategies or instruments for more specific identification of patient at higher risk of falling should be implemented in the EMR and needs to be tested in the CDSS to investigate whether a higher adherence can be reached. A potential use of our model is for identifying individuals at a higher risk of falling. Such a model has the potential to be implemented in the EMR, especially in the EMR of general practitioners or embedded in decision support systems to alert clinicians when their patient may be at higher risk of an injurious fall. Future studies should investigate the impact of utilizing such a model in the EMR of GPs for identification of patients at higher risk of falling.

In addition, the model can also be embedded into the EMR of the emergency department for improving the follow-up fall-care processes and reducing costs. Future studies should focus on how and to which extent this ideal could come true, due to the complex nature and highly demanding care in this department.

11.0.5 Automatic measurement and quality improvement for geriatric conditions in primary care

Automatic measurement and quality improvement are considered as means for improving routine measurement of quality of health care. However, up until now, the capabilities of automatically gathering the data about geriatric conditions,
which helps continuous measurement of quality, remained limited [8]. Prior to our study, no structured way of fall documentation and management existed in primary care, both in paper-based systems as well as in the EMR.

In addition, recent studies showed that only a small number of the quality indicators’ data elements related to geriatric conditions could possibly be extracted from the EMR of the general practitioners, which hinders automatic measurement of quality indicators [9]. In the field of geriatrics, many quality measures focus on documentation, management and history taking and circumstances described [10], and can be mostly found as free text rather than coded data. However, for full measurement of geriatric condition we need to be able to rely on data that are gathered structurally or coded properly.

The International Classification of Primary Care (ICPC) coding system, generated by the Wonca International Classification Committee, allows the classification of the patient’s reasons for problems, diagnosis managed, and primary or general health care intervention. ICPC is widely used among GPs. ICPC, however, does not have any classification available for falls or fall history. As a result, searching for information for many geriatric conditions in EMRs of GPs using ICPC is only possible through free text search (e.g. exploring SOAP-journals). Although there is a component in the biaxial structure of ICPC-2 called “injuries”, documentation of fall history is unlikely to be complete as not all falls lead to injuries. The lack of appropriate coding possibilities impedes fully commissioning IT solutions, unless this classification is expanded or mapped to other terminology classifications which can automatically be classified if needed.

The detailed coded information can then be available for a variety of purposes, such as investigating falls or other geriatric conditions. Future studies need to investigate the quality of data coded based on different terminology classification methods and/or find improved application of natural language processing.

Although standardized recording of data and documentation may have been proven to be useful, it is not an easy task [7]. Our results showed that physicians just write some catchwords down in the EMR related to fall management, rather than documenting the risk factors, prevention measures and plans in a structured way. Lack of documentation does not necessarily mean they did not perform the tasks, however convincing the busy care professionals adequately documenting and thereby using the provided IT-facilities for better management of care is still a challenge.
Bibliography


