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

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Design of a before-after study to improve quality of fall detection and management for elderly patients in general practice using decision support to increase adherence to ACOVE quality indicators - A study Protocol

“If you can not measure it, you can not improve it”
-Lord Kelvin

Adapted from: From assessment to improvement of elderly care in General Practice using decision support to increase adherence to ACOVE quality indicators: study protocol for randomized control trial.

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Abstract

**Background:** Falls in old ages form a serious concern for both elderly patients and health care systems. However, falls are under-detection and hence fall management is compromised. The set of 9 ACOVE (Assessing Care Of the Vulnerable Elders) quality indicators (QIs) pertaining to falls is a comprehensive instrument for measuring quality of fall-related care for elderly people. However, the indicators are still used to assess, rather than improve, care delivery. We introduce a clinical decision support system (CDSS) aimed at improving adherence to the ACOVE fall quality indicators and a protocol for investigating the system’s use and impact on adherence to the rules among general practitioners (GPs). The CDSS provides non-interruptive support and is based on clinical rules derived from a set of ACOVE fall quality indicators selected by the users.

**Hypothesis:** User-driven computerized decision support provided to general practitioners will improve their adherence to clinical rules pertaining to fall detection and management for elderly patients.

**Design:** We use a before after study among a group of Dutch general practitioners in Amsterdam, The Netherlands. To avoid workflow interruption caused by pop-ups, the CDSS displays a list in real-time with pending color-coded messages on the side of the computer screen. This is a dynamic floating list (DFL) because it is dynamically changed and can be moved on the GP’s screen. The clinical rule engine (CRE) is a remote server that monitors patient data and GP actions and verifies whether they adhere to a set of clinical rules (CRs). It then generates feedback accordingly, resulting in updating the DFL. The CRs are derived from the ACOVE fall set of quality indicators for elderly care. Specifically, we used our recently introduced Logical Elements Rule Method (LERM) to translate the quality indicators into clinical rules suitable for use in a CDSS. The CR set to be implemented was selected and modified by GP end-users using Delphi rounds. Their involvement is believed to obtain the most relevant CRs and increase acceptability of the system. GPs will receive support based on mobility problems and the number of falls that elderly patients sustained in the last 12 months. In addition all GPs will receive a form to document the history of falls, mobility and balance for their elderly patients.

**Outcomes:** Our main outcome measure is the degree of adherence to the clinical rules, before and after introducing the CDSS, in terms of mean and individual rule pass rates (the proportion of times the rule is followed when it is applicable). The adherence to the clinical rules in the
before-after in terms of higher fall-related documentations will be also measured by searching the electronic medical record system (EMR) using predefined fall-related words and manual text-based search.

Discussion: This paper describes a CDSS design to study the effects of applying the CDSS in managing falls for elderly patients. We rely 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 with pop-ups. These aspects are believed to increase CDSS acceptance and its impact on adherence to the selected CRs. The intervention is part of an effort to improve care for elderly patients. A general protocol of this trial, was published in the Journal Trials, in 2014.

9.1 Background

9.1.1 Falls and quality of fall prevention and management care in elderly patients based on ACOVE criteria

Falls and problems with balance and mobility in older seniors form a serious concern for elderly patients as well as the health care system. There is evidence for the effectiveness of interventions and follow-up assessment in reducing subsequent falls [1]. However, falls are under-detected [2]. Elderly patients that are at higher risk of falling, and vulnerable elderly in particular, are in need of continuous assessment, personalization and integration of the care offered to them [3].

The set of ACOVE (Assessing Care Of the Vulnerable Elders) quality indicators (QIs) is a comprehensive instrument for measuring quality of care for (vulnerable) elderly patients [4]. The ACOVE indicators are meant to capture minimal standards of care - standards that, if not met, almost ensure that the care is of poor quality [5]. These indicators were developed and judged by clinical experts to improve patient outcomes on the basis of clinical evidence and professional opinion [5].

The ACOVE quality indicators are in essence a list of IF-THEN statements, linking a logical condition to a conclusion. The indicator is adhered to if the conclusion (which is usually an action) is fulfilled when the indicator was eligible (that is, its logical condition is true). An example of such a QI is: “IF a vulnerable elder reports a history of 2 or more falls (or 1 fall for which the elder visits the general practitioner) in the past year and is taking a benzodiazepine, THEN the general
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practitioner should document a discussion of related risks and assistance offered to reduce/discontinue benzodiazepine use”.
ACOVE is emerging as an international standard for quality of care assessment for elderly patients. There are increasing numbers of studies that have translated the QIs to various settings [4]. In the Netherlands, the Trimbos Institute selected and translated rules relevant for the care of vulnerable elderly patients in Dutch general practice (GP), resulting in 81 QIs covering eight domains, including the fall domain containing 9 QIs [6]. As assessed by the ACOVE QIs, the quality of care is generally low [4].

9.1.2 From assessment to improvement

QIs are predominantly used for assessment of quality of care relatively long after it has been delivered rather than directly improving care. It remains unclear how and to what extent such quality assessment can contribute to actually improving the quality of care. There is one study that used the fall QIs in a paper-based proactive intervention for improvement of the fall-related care [7]. In our project we want to exploit QIs to proactively influence physicians behavior at the time of care provision. To accomplish this, we will represent QIs in computer interpretable clinical rules and incorporate them in a clinical decision support system (CDSS). By matching patient data and physicians behavior to the clinical rules, the CDSS can provide feedback to the physicians in the form of alerts and reminders. This feedback is meant to help GPs adhere to the clinical rules, and hence to the underlying QIs. Implementation of a CDSS at the point of care is likely to improve adherence to the clinical rules and thereby improve the overall quality of care. Currently, however, there are no computerized decision-support approaches to proactively support physicians for improving fall care for older patients on a comprehensive set of QIs aimed at managing and improving fall care.

9.1.3 CDSS and alert fatigue

The potential effectiveness of CDSSs has been demonstrated by various studies [8]. However, computer-generated feedback that is too often irrelevant or intrusive may result in alert fatigue and irritate clinicians. Alert fatigue is defined as the mental state that results from too many alerts and expenditure of mental energy, which can cause relevant alerts to be unjustifiably overridden along with clinically unimportant ones [9]. We designed a plugin which is not interruptive or intrusive and might therefore prevent alert fatigue.
9.1.4 The primary care practices GAZO

Gezondheidcentra Amsterdam Zuid-Oost (GAZO) is an organization comprised of six primary care practices in the southeast region of Amsterdam. A total of 36 general practitioners (GPs) work in the GAZO centers (full and part time). There is an average of 7,450 (range: 3,285 to 10,055) registered patients in each center. About 10% of the patients are 65 years or older and about 5% are 75 years or older (data originating from 2010).

9.1.5 Study aims

The general aim of this project is systematic improvement of the quality of fall prevention and management for older persons (defined as 65 years of age or older) by increasing adherence to the ACOVE-based clinical rules. The need for this intervention arose from a disease-management analysis of an integrated fall management process [10]. To attain this increase in adherence we intend to use a clinical decision support system (CDSS) that uses the respective clinical rules (CRs) in combination with patient and treatment data to proactively support health care professionals to make the right decisions at the right time. The primary aim of the study is assessing the impact of the system on the adherence to the clinical rules. The intervention is part of an effort for improving care for the elderly patients [11].

9.2 Methods

9.2.1 Preparation

Selecting the relevant CRs

We used a modified Delphi method to select the CRs corresponding to the most relevant QIs from the original set of 9 QIs that were translated to the Dutch general practice setting [6]. To assess the perceived need for a QI, we asked GPs whether they would personally switch decision support for the corresponding rule “on” or “off”. This is a more direct approach to understand their intention to comply than asking about importance and relevance of the rules. Table 9.1 shows the QIs that were chosen.

Implementability of relevant CRs

We recently introduced LERM (Logical Elements Rule Method) as a step-by-step method for assessing the amenability of clinical rules for decision support use,
Table 9.1: The fall QIs including those that will be implemented in the trial.

<table>
<thead>
<tr>
<th>Falls/mobility (Trimbos QIs)</th>
<th>Will be implemented</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) IF a vulnerable elder reports a history of ≥ 2 falls (or 1 fall for which the elder visits the general practitioner) in the past year, THEN the general practitioner should document a basic fall history (including type and circumstances of the falls, and possible contributing factors like medication, chronic conditions, alcohol intake) within 3 months of the reported history (or within 4 weeks, if the most recent fall occurred in the past 4 weeks).</td>
<td>X</td>
</tr>
<tr>
<td>2) IF a vulnerable elder reports a history of ≥ 2 falls (or 1 fall for which the elder visits the general practitioner) in the past year, THEN the general practitioner should document receipt of an eye exam in the past year, or evidence of visual acuity testing within 3 months of the reported history.</td>
<td></td>
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<tr>
<td>3) IF a vulnerable elder reports a history of ≥ 2 falls (or 1 fall for which the elder visits the general practitioner) in the past year, or has worsening difficulty with ambulation, balance, or mobility, THEN the general practitioner should document a basic gait, balance, and strength evaluation within 3 months of the reported history (or within 4 weeks, if the most recent fall occurred in the past 4 weeks).</td>
<td>X</td>
</tr>
<tr>
<td>4) IF a vulnerable elder reports a history of ≥ 2 falls (or 1 fall for which the elder visits the general practitioner) in the past year, THEN the general practitioner should document an assessment of cognitive status in the past 6 months or within 3 months of the reported history (or within 4 weeks, if the most recent fall occurred in the past 4 weeks).</td>
<td></td>
</tr>
<tr>
<td>5) IF a vulnerable elder reports a history of ≥ 2 falls (or 1 fall for which the elder visits the general practitioner) in the past year, THEN the general practitioner should document an assessment and modification of home hazards recommended in the past year or within 3 months of the reported history.</td>
<td></td>
</tr>
<tr>
<td>6) IF a vulnerable elder reports a history of ≥ 2 falls (or 1 fall for which the elder visits the general practitioner) in the past year and is taking a benzodiazepine, THEN the general practitioner should document a discussion of related risks and assistance offered to reduce/discontinue benzodiazepine use.</td>
<td>X</td>
</tr>
<tr>
<td>7) IF a vulnerable elder demonstrates decreased balance/proprionception or increased postural sway AND does not have an assistive device, THEN an evaluation/prescription for an assistive device should be offered within 3 months.</td>
<td></td>
</tr>
<tr>
<td>8) IF a vulnerable elder reports a history of ≥ 2 falls (or 1 fall for which the elder visits the general practitioner) in the past year AND has an assistive device, THEN there should be documentation of an assistive device review in the past 6 months or within 3 months of the reported history (or within 4 weeks, if the most recent fall occurred in the past 4 weeks).</td>
<td></td>
</tr>
<tr>
<td>9) IF a vulnerable elder is found to have a problem with gait, balance, strength, or endurance, THEN there should be documentation of a structured/supervised exercise program offered in the past 6 months or within 3 months of noting the problem.</td>
<td></td>
</tr>
</tbody>
</table>
and to formalize the rules in a computer-based form [12]. We use LERM in this project to translate implementable CRs to a form usable for a computer.

**Design and implementation of the CDSS**

Table 9.2 shows the different steps of the project. We have developed a software module, which is not an integral part of the GPs’ electronic medical records system (EMR). It forms a “plugin” that interfaces with a specific EMR type. The CDSS plugin can be classified as active (it does not wait to be promoted) and patient specific [13], and non-interruptive (does not interrupt the workflow and system provides advice automatically at the time of care) [14, 15]. For most of the fall-related rules it operates in the consulting mode (i.e., providing timely advice before a decision has been made). Several trigger points in the GPs’ EMR system have been designed. A trigger point is an event that occurs in the EMR that triggers an action. For instance, the event “opening a patient’s electronic medical record” will trigger the action “send data to the CDSS server”. These triggers are: opening a patient’s electronic medical record on the computer, changing medication (e.g. prescribing benzodiazepine).

Whenever a trigger is activated, the GP system sends information from the medical record that is currently opened on the GP’s screen to a remote server via a secure Internet connection. This information consists of: the data-buffer that holds the information entered or selected by the GP that is shown on the screen (such as selection of a medication) but is not yet saved permanently to the EMR’s database, as well as active medications, a list of the patient’s diagnoses codes, number of falls, and mobility and balance problems. On the remote server a clinical rule engine (CRE) evaluates the information originating from the EMR by the computerized decision rules. Evaluation of a decision rule may lead to a response in the form of a message. This message is formatted as an XML file (a file format designed to exchange data) and sent to the CDSS plugin that has been installed on the GP’s computer. The plugin reads the XML file and evaluates the content. It extracts the message’s title and displays a shortened form of the title in a thin sidebar that is attached to the right side of the GP’s screen (see Figure 9.1). We refer to this sidebar as the dynamic floating list (DFL). The GP can move the mouse cursor over the DFL to display the full message title as shown in Figure 9.1. He or she can then choose to open the message in another window by clicking anywhere on the message title. When open, this window shows the message, which usually includes an advice and relevant findings supporting the advice. In addition, if the GP wishes to overrule the advice, he or she also has the possibility to indicate on this window the reason they do not adhere to the rule. Upon first appearance, the message’s title is displayed with a red background in the DFL, indicating that the message is new. If the GP does not open the message or does
not behave according to its advice, the background will become orange the next time the GP opens the electronic medical record, indicating the message has been shown before but not dealt with yet. When the GP changes the treatment plan according to the guideline, the message will disappear. This can happen without opening the message, for example the GP might already know that he or she needs to change the treatment plan and doing so will also result in the message disappearing, without having to interact with the CDSS plugin.

**Fall history gathering**

The QIs imply an appropriate assessment and delivery of fall-related care, including adequate documentation in the EMR. Therefore, the system is designed to gather fall history and balance and gait problems. For all patients aged 65 years and older, their respective GPs receive a form to document the history of falls, and mobility and balance problems of these patients. This form contains two questions, one related to fall history (number of falls) and the second one is related to balance and mobility problems. The fall history form gathers the number of falls in the past 12 months. Based on the number of falls and the availability of fall or mobility problems, the GPs will receive support for three CRs.

If the CR related to the documentation of the basic fall history is triggered (i.e., when the condition “IF a (vulnerable) elder reports a history of 2 or more falls” is fulfilled), a message title will appear in the DFL. If the GP opens the message, a form will appear containing background information, number of falls and mobility problems and advice on documenting actions that are performed for fall management. The GP can then indicate if he/she performed the actions himself, the actions were addressed by referring the patient to another caregiver or it was not applicable for this patient. The actions include review of medication use; review of chronic and geriatric comorbidities; eye exam; memory test; balance, power and gait test; alcohol intake; walking aid evaluation or advice; and advice about safety at home. Once the form is completely answered the message will be suppressed from appearing again for six months. Completing the fall prevention form was obligatory otherwise the form appeared on DFL in the subsequent visit as an empty form.

After the first 3 months of the start of the trial and upon a subsequent appearance of the fall-history taking form, the question on the number of falls will change to “number of falls since the previous visit”.

A recorded history of more than 2 falls and prescribing a benzodiazepine will trigger the CR related to benzodiazepines. Likewise, if the answer to the decreasing balance or gait question was positive, the CR related to mobility problems will result in adding a message title in the DFL. CRs related to benzodiazepines and balance or gait problems will result in advice to perform balance, gait, or
muscle strength tests, to discuss the risks related to using benzodiazepines with the patient, and to offer assistance with reducing/discontinuing benzodiazepine use. The GP can then “accept” or “ignore” the message. Once the mobility question was answered, this question will be suppressed from appearing again for six months.

Figure 9.1: The collapsed and expanded Dynamic Floating List (DFL)

Baseline measurements
Baseline adherence to the CRs was measured prior to the intervention using a questionnaire distributed to community-dwelling elderly persons, 70 years or older, registered in some of the participating GAZO centers.
Validation and bias control

We will also measure the fall documentation based on data elements residing in the central EMR database of the primary care centers in GAZO (maintained by an external central server). In particular for all the patients 65 years and older who visit the GPs during the first 3 months of the trial, the EMR data concerning the 12 months prior to the date of visit will be manually checked in order to perform a baseline analysis using free text search on the documentation and the action performed for fall management. The text will first automatically be selected using fall related words. Next manual check will be performed to study whether the GP documented basic fall history and the circumstances of those falls.

To reduce bias, randomization as design is the best choice. However, due to lack of documentation about falls, mobility and balance history, and a lack of ICPC code or a proxy for detecting documentation for falls in the current EMR, we cannot apply a randomized trial.

To check for possible seasonal effects we will assess records of the patients from the same time period of the year before, see figure 9.2.

Verifiable CRs and unverifiable CRs

This study is based on a prospectively planned intervention with a before-after design. We make a distinction between two types of CRs: verifiable CRs and unverifiable CRs. Verifiable CRs are ones for which the CRE is able to verify whether the GP adheres to them or not. All of the fall QIs are not verifiable.

Consider the CR, “If a (vulnerable) elder reports a history of 2 or more falls (or 1 fall for which the elder visits the general practitioner) in the past year, THEN the general practitioner should document a basic fall history”. This CR is unverifiable by the CRE because there is no structured form for documenting fall history in the EMR.

9.2.2 Participants

Patients

Although the ACOVE QIs were meant for vulnerable elders, most of these rules (and certainly the ones that are selected by the users) are relevant to all elderly patients, whether they are vulnerable or not. Our study will include all patients who are 65 years and older in six GP practices.
Figure 9.2: Study time-line demonstrating the baseline, intervention and validation periods.

Extracted records of all patients who visited GPs during Oct 2012 - Dec 2012

All elderly patients who visited GPs during the first 3 months of the trial (A)

All elderly patients who visited GPs (B)

Extracted records of all patients who visited GPs during Oct 2013 - Dec 2013

Validation: percent new cases of fall documentation: we looked for fall documentation in the 12 months prior to the date that the patient visited the GP during the first 3 months of the trial

Validation and seasonal effect analysis: Percent new cases of fall documentation: we looked for fall documentation in the 12 months prior to the date that the patient visited the GP during Oct 2012 - Dec 2012
Physicians

All GPs in the GAZO practices will be included in the study. All GPs use the same GP information system in their practice.

9.2.3 Outcome measure

Measures pertaining to improvement of fall management will be investigated. The main outcome measure is the (difference in the) degree of adherence to the fall-related clinical rules associated with the introduction of the intervention. The main outcome measure (adherence) will be calculated in terms of the mean and individual rule pass rates. The pass rate of a rule is the proportion of times that a rule was followed when it was eligible.

9.2.4 Statistical unit

The number of times the CR is eligible in the study population

Some studies have evaluated the level of adherence to one individual ACOVE QI in the outpatient setting. To our knowledge, no studies have yet been performed that measure the level of adherence to the fall set of ACOVE QIs in the Netherlands in primary care. Wenger et al. [16] showed that a paper-based intervention in the primary care setting for fall management and detection targeting patients at risk of falls had a mean absolute increase of pass rates 21% (from 23 to 44%) for the fall related ACOVE QIs.

Hypothesis about the efficacy of the intervention

A power calculation was performed to determine the number of cases in which a CR should be eligible to detect at least a minimally clinically relevant effect of the CDSS. Based on the Wenger study for patients aged 75 years and older we can estimate an absolute increase of 20% in the pass rates of the supported set of CRs. In that case we would move from a mean pass-rate of an estimated 30% before the intervention, based on a questionnaire that we administered, to 50% after providing support to the 3 QIs that were chosen by the end-user. Based on this effect size, for a power of 0.80 and two-sided testing at the 0.05 significance level, and an estimated number of 7.5% of elderly patients aged 70 years and older in the practices, a total of 102 cases in each of the before and after periods are required. This corresponded to a duration of seven months to prospectively include these patients.
9.2.5 Statistical analyses

Standard statistical tests will be used to compare the baseline characteristics of the practices and patients. The unit of analysis is eligibility of a CR. Statistical analyses will be performed with the R statistical software (R Foundation for Statistical Computing, Vienna, Austria).

9.2.6 Time line

Table 9.1 shows the sequence of steps in the project. The trial started in October 2013, and will continue for at least 7 months. We plan to report the result in the second quarter of 2014.

9.2.7 Regulatory aspects

The medical ethics committee of the Academic Medical Center confirmed that the Medical Research Involving Human Subjects Act (WMO) does not apply to this study and that an official approval of this study by the committee is not required. The interventions are simply different means of giving valid information to physicians. The trial is supported by two grants from the Netherlands Organisation for Health Research and Development (ZonMW). The funder and the software companies involved have no role in study design, data collection and analysis, or decision to publish on this study. The trial has been registered within the Dutch Trial Register (www.trialregister.nl) under identifier NTR4107 since August 5, 2013.

9.3 Discussion

This study presented an innovative clinical decision support system and described the protocol to study the effects on level of adherence to a selected set of ACOVE-based fall-related clinical rules in an outpatient setting. The system is characterized by a non-interruptive presentation and real-time color-coded messages that are promptly updated based on the GP’s actions. The CDSS is novel in the sense that it combines all of the following for the management of falls: it is not interruptive; provides color-coded messages in real time; allows for understanding why a GP does not choose to follow a rule; and is based on clinical rules specifically chosen by the end-users (the GPs) after Delphi-like rounds. We expect that these aspects will result in increased acceptance and thereby improve adherence to fall CRs. Specifically, real-time feedback has been correlated with success in decision support implementations [15, 17]. However,
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Providing real-time feedback has traditionally been based on pop-up messages which interrupt the clinicians’ workflow and contribute to alert fatigue [18] and the perception of “too many alerts” is already prevalent among the clinicians in this study. We designed the DFL as a way to provide automated alerts at the time of care, but without demanding that the clinician interrupt what they are doing to respond (such as dismissing a pop-up). We expect that this innovation will result in higher acceptance and therefore improve adherence to CRs.

Table 9.2: Project’s plan

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prioritization</td>
<td>1. Distribute brief questionnaires among 10 GPs to select relevant fall QIs</td>
</tr>
<tr>
<td></td>
<td>2. Discuss result of phase 1 and disagreements in a focus group.</td>
</tr>
<tr>
<td></td>
<td>3. Distribute detailed questionnaires among end-users to select CRs from those in phase 1.</td>
</tr>
<tr>
<td>Design and implementation of CDSS</td>
<td>4. Design triggering points in The GP’s EMR.</td>
</tr>
<tr>
<td></td>
<td>5. Design CDSS for selected CRs in CR Engine.</td>
</tr>
<tr>
<td></td>
<td>6. Implement and test CDSS in EMR.</td>
</tr>
<tr>
<td>Measuring Baseline</td>
<td>7. Measure baseline before activating the CDSS.</td>
</tr>
<tr>
<td>Starting the trial</td>
<td>8. Start the study.</td>
</tr>
<tr>
<td>Gathering and analyzing the data</td>
<td>9. Start gathering and analyzing the data.</td>
</tr>
<tr>
<td>Writing and reporting results</td>
<td>10. Start writing and reporting the result.</td>
</tr>
</tbody>
</table>

Acknowledgements

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Bibliography


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