Feasibility of automatic evaluation of clinical rules in general practice

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ABSTRACT

Purpose: To assess the extent to which clinical rules (CRs) can be implemented for automatic evaluation of quality of care in general practice.
Methods: We assessed 81 clinical rules (CRs) adapted from a subset of Assessing Care of Vulnerable Elders (ACOVE) clinical rules, against Dutch College of General Practitioners (NHG) data model. Each CR was analyzed using the Logical Elements Rule
Method: (LERM). LERM is a stepwise method of assessing and formalizing clinical rules for decision support. Clinical rules that satisfied the criteria outlined in the LERM method were judged to be implementable in automatic evaluation in general practice.
Results: Thirty-three out of 81 (40.7%) Dutch-translated ACOVE clinical rules can be automatically evaluated in electronic medical record systems. Seven out of 7 CRs (100%) in the domain of diabetes can be automatically evaluated, 9/17 (52.9%) in medication use, 5/10 (50%) in depression care, 3/6 (50%) in nutrition care, 6/13 (46.1%) in dementia care, 1/6 (16.6%) in end of life care, 2/13 (15.3%) in continuity of care, and 0/9 (0%) in the fall-related care. Lack of documentation of care activities between primary and secondary health facilities and ambiguous formulation of clinical rules were the main reasons for the inability to automate the clinical rules.
Conclusion: Approximately two-fifths of the primary care Dutch ACOVE-based clinical rules can be automatically evaluated. Clear definition of clinical rules, improved GP database design and electronic linkage of primary and secondary healthcare facilities can improve prospects of automatic assessment of quality of care. These findings are relevant especially because the Netherlands has very high automation of primary care.

1. Introduction

Quantification of quality of care is critical for quality management in general practice. Specifically, measurement of quality of care allows general practitioners to appraise the current status of quality and to identify opportunities for improvement.

Evaluation of quality of care utilizes predefined sets of clinical rules against which data collected from electronic medical record (EMR) are evaluated [1]. These evaluation activities are often performed retrospectively. This approach is tedious, time consuming and presents performance results months after the target clinical process activities have occurred. Opportunities for timely intervention are thus lost. Increasing demand for adherence to several clinical guidelines and clinical rules make it even more difficult to perform quality of care assessment manually.

Moreover, large amounts of data that are generated in contemporary general practice make analysis of quality of care cumbersome and labor intensive. Automatic evaluation of care can be used to solve the problem of large data in general practices. Automation is important because it allows for applications such as quality assessment and real time decision support. Automation provides timely feedback to general practitioners that enable them to change their practice and thus improve quality of care.

Automatic evaluation of quality of care requires compatibility of clinical rules and clinical databases in terms of definition of concepts. Unfortunately, most clinical rules are formulated in natural language without considering that they can be represented in a computer interpretable format.

In this study, we investigated the extent to which the quality of care provided to elderly persons can be automatically evaluated using EMR data that is routinely recorded by general practices in

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the Netherlands. We use clinical rules adapted from the Assessing Care of Vulnerable Elders (ACOVE) clinical rules to evaluate the feasibility of automatic evaluation of quality of care of elderly persons at the general practice level [2].

2. Methods

2.1. ACOVE clinical rules

ACOVE clinical rules were developed by the RAND corporation in the USA to assess quality of care of elderly persons [2]. A subset containing 81 clinical rules (CRs) were translated for evaluating quality of care in general practice by a panel of Dutch geriatric care experts [3]. In this translation, the Dutch experts selected only ACOVE clinical rules relevant to general practice. The CRs are divided into eight domains of care namely: *organization of continuity of care, dementia care, depression care, diabetes care, end of life care, prevention and management of falls, appropriate medication use and, diagnosis and management of under nutrition.* The CRs are formulated as **IF . . ..THEN statements**. A given clinical condition or state in the **IF** segment of the CR prompts an action in the **THEN** segment of the CR. An example of the CRs reads as follows: *IF a vulnerable elder has diabetes,* **THEN** *glycated hemoglobin should be measured at least annually.*

2.2. Data source

General practitioners (GPs) in the Netherlands universally use electronic medical records (EMR) to document patient information.

2.3. Description of standard reference model of EMRs in dutch general practice

The Dutch College of General Practitioners publishes a reference model which describes a minimum dataset that all EMRs in Dutch general practice must collect. EMRs databases are derived from the same reference model to facilitate data exchange and aggregation. In this study, we used the NHG database model to establish the data variables that are collected from the EMR databases.

Patient contacts are classified as consultations, home visits or drug prescriptions. General practitioners link each contact to specific clinical episodes of care. An episode is defined as a medical problem for which a patient seeks medical assistance, for example *hypertension or diabetes.* Patient diagnosis (es) in each contact is coded using the International Classification for Primary Care (ICPC) [4].

Patient characteristics in the EMR databases include age and gender.

Data collected about the general practices include; type of practice, geographical location and urbanization level of the locality of the practice. The brand of EMR used in each practice is also documented. Findings of diagnostic procedures such as physical examination, specific elements of history, functional tests, imaging examinations and laboratory tests are coded and documented using a terminology developed by the Dutch College of General Practitioners (NHG).

The EMR databases also contain prescription data. Each prescription is a single record. Details about each prescription include date and time, code name of drug, amount and frequency. The anatomical and therapeutic chemical (ATC) classification system is used for the coding the name of the medication [5].

2.4. LERM analysis

We analyzed 81 clinical rules using the Logical Elements Rule Method (see supplementary table for a list of the CRs). LERM ana-

lyzes a clinical rule to establish if the terms and concepts that constitute it can be represented in a computer interpretable form [6,7]. Each CR was analyzed separately. Fig. 1 illustrates the steps in the analysis of the CR.

The first step involved analyzing whether the CR could be proactively operationalized. A proactively stated CR is one which can be used to make a decision for a clinical intervention when its condition is fulfilled. A non-proactive CR is one whose condition and recommendation is temporally invalid. Non proactive CR do not give the physician any opportunity to change practice because it is aimed at foregone events. For example: *IF a vulnerable elder who had dyspnea in the last 7 days of life died an expected death,* **THEN** *the general practitioners record should document a dyspnea management plan.* In this clinical rule, no intervention can be implemented because the patient has already died. Non-proactive CRs are thus limited to assessing past performance. The sample CR about diabetes is proactive, because the GP has an opportunity to test the patient when the condition is met.

Secondly, each CR was formulated into a logical statement. During this process phrases containing concepts were extracted from the statement of the indicator. In the illustration, the following concepts phrases were extracted from the logical statement: *Vulnerable elder, diabetes mellitus, glycated hemoglobin(HBA1c) and date of last laboratory test.*

Thirdly, concepts extracted from the clinical rule are converted to data variables, as they would be represented in EMR databases. We then assess if all data variables that constitute each clinical rule are documented in the EMR databases in a sufficient detail to allow for development of electronic feedback to the general practitioners. Clinical rules whose data variables are captured in the EMR database were considered to be amenable for automatic evaluation at the point of care.

These steps were repeated for each of the 81 clinical rules.

3. Results

Table 1 shows clinical rules which can be used for automatic assessment of quality of care. Overall 33 out of 81 clinical rules were found to be evaluable with the current data available in the EMR databases. The following paragraphs explain the results of the analysis for each domain of care.

3.1. Continuity of care

Two of thirteen clinical rules associated with continuity of care were found to be amenable for automation. The two clinical rules involve the follow up of diagnostic laboratory results and scheduled preventive care such as vaccinations. Three CRs were found to be ambiguous in their definitions. These CRs would be evaluable if they were redefined. Four CRs that involve documentation of information that is generated at hospital discharge and two CRs that involve information sharing between the nursing home and GP practice could not be automated since there was no electronic data linkage between nursing homes and GP practices. Two CRs regarding information sharing when a patient migrates from one GP practice to another or when a patient receives medication from another GP practice to was not automatable. There existed no electronic linkage between GP practices at the time of this analysis.

3.2. Depression care

Five out of ten CRs in the domain of depression care could be automated. Three of the six CRs involve documentation of co morbidities at the time of diagnosis of dementia. Two deal with prescription of treatment for depressed patients. On the contrary,