Quality of Life through Quality of Information
J. Mantas et al. (Eds.)
IOS Press, 2012

doi:10.3233/978-1-61499-101-4-487

OpenEHR-Based Representation of Guideline Compliance Data through the Example of Stroke Clinical Practice Guidelines

Nadim ANANI[a,1], Rong CHEN[a,b], Tiago PRAZERES MOREIRA[c], Sabine KOCH[a]
[a] *Health Informatics Centre, LIME, Karolinska Institutet, Stockholm, Sweden*
[b] *Cambio Healthcare Systems, Stockholm, Sweden*
[c] *Karolinska Stroke Research Unit, Department of Neurology, Karolinska University Hospital-Solna, Stockholm, Sweden*

Abstract. In light of the lack of integration between electronic health records and decision support, this research explores how semantic electronic health record technology, particularly openEHR, can be used to represent clinical practice guidelines (CPGs). We used the tool Visual Understanding Environment (VUE) to build a graphical representation of the European ischaemic stroke clinical management guidelines. We used openEHR archetypes to conceptually support this process and also to represent clinical concepts in stroke treatment compliance criteria. Our results show that, as an intermediate step in authoring computer-interpretable guidelines, an openEHR-based representation of CPGs and their compliance criteria supports the process of identifying the relevant knowledge and data elements in the care process to be modelled. It further eases the separation of the CPGs into data and logic components and is useful as a communication means for guideline verification by clinicians. Additionally, we retrieved existing and authored new openEHR archetypes for the acute stroke clinical management process. We conclude that openEHR-based guideline and compliance data representations may be a promising first step in building future decision support applications that are well connected to the electronic health record, can be useful in locating discrepancies between different sets of guidelines within the same care context and provide a helpful tool for driving the archetype authoring and review process.

Keywords. openEHR, archetypes, practice guideline, guideline adherence, stroke

Introduction

The benefits of clinical practice guidelines (CPGs) in the practice of evidence-based medicine have been known for a long time [1]. CPGs may improve care by providing better clinical outcomes, ensuring patient safety, reducing costs and decreasing care variability. This has led to a great interest in creating CPGs that can provide patient-specific recommendations at the point of clinical decision making.

[1] Corresponding Author: Nadim Anani, Health Informatics Centre, LIME, Karolinska Institutet, Berzelius väg 3, SE 171 77 Stockholm, Sweden; nadim.anani@ki.se

Implementation of CPGs into routine clinical work is cumbersome and computerisation of CPGs facilitates their accessibility at the point of clinical decision making. However, existing guideline representation models do not usually allow for a shareable implementation of CPGs and are not integrated with electronic health records (EHRs), which is well recognised as the bottleneck of implementing guidelines for providing computerised decision support (CDS) [2,3].

Recently Chen et al. explored archetype-based semantic EHR design in combining openEHR, a semantic EHR technology [4], with rule logic to represent a CPG [5]. They also discussed the idea of using repositories to share and review guidelines, in the same way as clinical information models in the form of openEHR archetypes are shared and reviewed, e.g. via the platform in [6]. This could lead to possibilities such as modularising guidelines as well as increasing their shareability and maintainability. Since the guidelines would be built upon semantic EHR standards directly, the interoperability between guideline systems and EHRs would likely increase.

This study aims to extend the work by Chen et al. Aided by the example of stroke CPGs, we use openEHR in CPG modelling and compliance (i.e. adherence or conformance) checking.

1. Methods

We used the European Stroke Organisation's guidelines for the management of ischaemic stroke and transient ischaemic attack [7]. In a first step, we produced a graphical representation of the guidelines that cover acute stroke care, in which a chain of the involved activities is anticipated and a decision-tree-like approach is used in essence (Figure 1). Nodes represent clinical knowledge entities that would typically be captured in openEHR archetypes like OBSERVATION, ACTION, INSTRUCTION and EVALUATION archetypes. Arrows contain conditions between nodes. Nodes can also contain sub-nodes that represent 'part-whole' relationships. The representation is meant to provide a chronological order of activities from left to right and was used as a means to communicate about the stroke care process with a stroke physician.

We decided to use a 'general-purpose' graphical representation rather than a formal computer-interpretable guideline representation model at this stage because

- this approach provides a more flexible way of communicating our understanding of the guidelines to the stroke physician,
- it is difficult to choose a certain formal guideline representation model without such an intermediate representation, as different models have different features for representing various properties of CPGs. This way, different computer-interpretable models can be tested later based on a neutral graphical representation.

An early commitment to a particular computer-interpretable model would have therefore limited our abilities to visualise the CPGs. The tool we chose for the guidelines' graphical visualisation is Visual Understanding Environment (VUE), developed at Tufts University (http://vue.tufts.edu), as VUE is freely available, easy to use and the resulting visualisations can conveniently be communicated to physicians.

A stroke clinical research team at Karolinska Institutet and Karolinska University Hospital in Stockholm, Sweden provided us with a list of guideline compliance criteria (see Table 1 for selected examples). These criteria are tightly related to the European stroke guidelines we use here, not least because the head of that research team used to

chair the guideline authoring committee of the same guidelines. We used the list of compliance criteria to identify further clinical knowledge entities and explore the usefulness of openEHR archetypes for representing those criteria.

Searching for the needed archetypes in the international openEHR archetype repository[2] and the national repositories of Australia[3] and Sweden[4] in addition to composing non-existent ones, we gathered a collection of archetypes for acute stroke care.

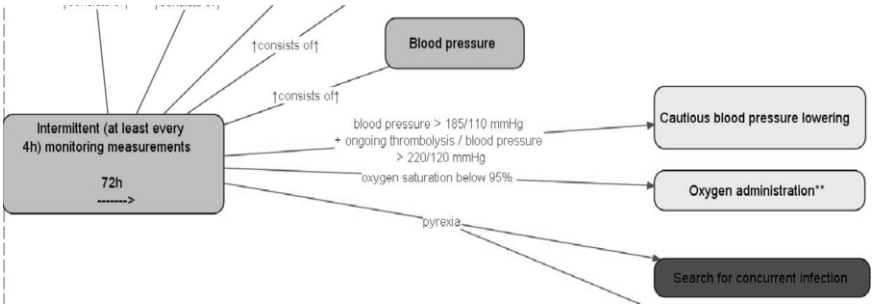

Figure 1. CPG graphical representation that is oriented towards archetypes.

Table 1. Contraindications against using thrombolytic treatment of acute stroke. These are typical examples of criteria that can be used for retrospective non-compliance checking.

Time since stroke onset greater than 4.5 hours
CT scan shows bleeding
NIH Stroke Scale score greater than 25
Diabetes and earlier stroke
One of the following in the last three months: stroke, head trauma, operation in the central nervous system, definite gastrointestinal bleeding

2. Results

The results we present here are intermediate results of a larger study, in which we aim to develop a prototype that tests automated execution of CPGs and automated retrospective checking of treatment compliance with CPGs.

Figure 1 shows an excerpt from our acute stroke CPG graphical representation, where 'Blood pressure' is an OBSERVATION archetype, 'Cautious blood pressure lowering' and 'Oxygen administration' are INSTRUCTION or subsequent ACTION archetypes, and 'Search for concurrent infection' is an EVALUATION archetype. 'Intermittent monitoring measurements' is an openEHR template as it consists of several different kinds of observations.

One of our findings is that when using such a graphical representation, there is an extra value (i.e. beside modelling CPGs in order to formalise and execute them in a CDS system [8]) of supporting the identification of all required knowledge components

[2] http://www.openehr.org/knowledge
[3] http://dcm.nehta.org.au/ckm
[4] http://sllocean.karolinska.se/ckm

in a certain care process that is represented by CPGs. Thus, identifying openEHR archetypes, including ones that do not exist in any recognised archetype repository, becomes easier. We also found that openEHR archetypes support the thinking process of converting textual guideline content to a graphical representation that would later be used to implement CPGs as computer-interpretable guidelines (CIGs) in health information systems; thinking in terms of archetype concepts separates the guideline text structurally into data and logic, in line with the findings from [5]. Furthermore, the graphical representation was a very useful means of communicating with the stroke physician for verification purposes as well as obtaining a better understanding of the stroke process and the knowledge content involved therein.

Another result is that we retrieved and composed a collection of archetypes for acute stroke care and retrospective compliance checking in this clinical context. A typical compliance checking archetype/template is one that captures the requirements for checking contraindications against a certain treatment. The new archetypes, which also include 'NIH Stroke Scale' (OBSERVATION) (Figure 2), 'Stroke' (EVALUATION) and 'Thrombolysis' (INSTRUCTION) are going to be provided to the openEHR community.

```
ELEMENT[at0076] occurrences matches {0..1} matches {   -- Dysarthria
   value matches {
      -1|[local::at0080],    -- -1 represents 'UN': Intubated or other physical barrier
      0|[local::at0077],    -- Normal
      1|[local::at0078],    -- Mild-to-moderate dysarthria
      2|[local::at0079]     -- Severe dysarthria
   }
}
ELEMENT[at0081] occurrences matches {0..1} matches {   -- Extinction and Inattention
   value matches {
      0|[local::at0082],    -- No abnormality
      1|[local::at0083],    -- Visual, tactile, auditory, spatial, or personal inattention
      2|[local::at0084]     -- Profound hemi-inattention or extinction to more than one modality
   }
}
ELEMENT[at0085] occurrences matches {0..1} matches {   -- Total Score
   value matches {
      DV_COUNT matches {
         magnitude matches {|0..42|}
      }
   }
}
ELEMENT[at0086] occurrences matches {0..1} matches {   -- Stroke Interval
   value matches {
      DV_CODED_TEXT matches {
```

Figure 2. Extract from the NIH Stroke Scale archetype as represented in the openEHR Archetype Definition Language (ADL)

Interestingly, there was some clinical content that we found in the compliance criteria but had not encountered in the guideline document, which was clear when comparing the compliance criteria template with the graphical representation of the acute stroke care process. This content includes thrombolysis contraindication checks concerning postictal paresis, septic shock, infectious endocarditis, pericarditis, pancreatitis, severe liver damage, operations in the central nervous system, pregnancy and childbirth.

3. Discussion

Clinical information models represented in openEHR archetypes could be used as building blocks in capturing guideline-specific knowledge, including compliance criteria. At the same time, graphical representations of guidelines seem to be useful in identifying existing archetypes and noticing new ones that need to be authored. A

further potential benefit of an openEHR-based approach is the ability to more easily identify differences between guidelines and compliance criteria or between different sets of guidelines.

We suggest that modelling CPGs based on openEHR archetypes for implementation in EHR-based CDS scenarios should undergo an iterative process that includes graphically representing guideline archetypes and logic, verifying the graphical representation by clinicians and identifying archetypes in compliance criteria. The latter consolidates the CPG representation and improves archetype clinical content.

Panzarasa et al., amongst others, have worked with modelling and computerising stroke CPGs [9]. Here we present the first attempt to do so with a focus on openEHR concepts.

However, this study provides intermediate results of a larger study. It is therefore limited in that we have not yet implemented a prototype in order to test openEHR-based CPG compliance checking and we do not yet know how effective the transition is from an openEHR archetype-based graphical representation of CPG content to a representation based on a computer-interpretable guideline representation model. Our next step is to implement such a prototype through computer-interpretable stroke guidelines and fine-grained data queries through openEHR archetype technology.

Nevertheless, the new archetypes herefrom are going to enrich the collection of archetypes that are available to the openEHR community and may initiate fruitful discussions as well as archetype reviews.

References

[1] Latoszek-Berendsen A, Tange H, van den Herik HJ, Hasman A. From clinical practice guidelines to computer-interpretable guidelines: a literature overview. Methods Inf Med. 2010;49(6):550-70

[2] Gooch P, Rousdari A. Computerization of workflows, guidelines, and care pathways: a review of implementation challenges for process-oriented health information systems. J Am Med Infom Assoc. 2011;18(6):738-48

[3] Sim I, Gorman P, Greenes RA, Haynes RB, Kaplan B, Lehman H, Tang PC. Clinical decision support systems for the practice of evidence-based medicine. J Am Med Inform Assoc. 2001;8(6):527-34

[4] Beale T, Heard S, editors. Architecture overview [document online]. The openEHR Foundation; 2008 Nov 13 [last accessed 2012 Apr 6]. Available from: http://www.openehr.org/releases/1.0.2/architecture/overview.pdf

[5] Chen R, Georgii-Hemming P, Åhlfeldt H. Representing a chemotherapy guideline using openEHR and rules. Stud Health Technol Inform. 2009;150:653-7

[6] The openEHR Clinical Knowledge Manager [electronic tool on the Internet]. The openEHR Foundation, 2012 [last accessed 2012 Apr 6]. Available from: http://www.openehr.org/knowledge

[7] The European Stroke Organisation (ESO) Executive Committee and the ESO Writing Committee. Guidelines for management of ischaemic stroke and transient ischaemic attack [document online]. Scientific report; 2008 [last accessed 2012 Apr 6]. Available from: http://www.eso-stroke.org/pdf/ESO08_Guidelines_Original_english.pdf

[8] Isern D, Moreno A. Computer-based execution of clinical guidelines: a review. Int J Med Inform. 2008;77(12):787-808

[9] Panzarasa S, Maddè S, Quaglini S, Pistarini C, Stefanelli M. Evidence-based careflow management systems: the case of post-stroke rehabilitation. J Biomed Inform. 2002;35(2):123-39