Reviewer's report

Title: Leveraging workflow control patterns in the domain of clinical practice guidelines

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Reviewer: Dionisio Acosta

Reviewer's report:

This work represents a substantial effort towards understanding how to utilise workflow patterns to facilitate the computerisation of CPG using BPMN. The study provides a reasonable motivation into the problem, clearly defines the research questions, describes a sensible methodology to address those questions, describes and discusses a lengthy set of results, and finally anticipates limitations and future work.

The most valuable contribution of this work is the analysis of the expressiveness of workflow patterns for modelling frequently occurring constructs in CPG and the proposal of semi-automatic transformations of these workflow patterns specified in BPMN into Asbru and PROforma. Both contributions are important and timely, adding to the body of literature in the area.

On the other hand, the study has several shortcomings, some of them related to methodology, hence with significant implications in the interpretation of the results, others related to the balance of observations and arguments made and how they are supported by the data, which could diminish the usefulness of the work. These shortcomings are described in what follows.

Major Revisions:

The authors design a qualitative study aiming to assess the suitability of workflow patterns to model CPG. Two experts (the authors) review a set of CPG known to them and proceed to identify if a particular workflow pattern is present or not in this set of guidelines. Based on this experience, each workflow pattern was classified into suitable, unsuitable and unknown if the pattern was found to support the modelling, or if the pattern is not applicable to individualised treatment choices (multiple activations/instances and recursion patterns) or the pattern could not be found in the CPG sample set respectively. There are two main issues with the method described:

- There is a substantial selection and sampling bias. The authors acknowledge the small sample used, however they do not anticipate what would be the potential consequences. Nevertheless, judging by the number of workflow patterns discarded due to this factor, one could anticipate that the effect is negligible. The description of the CPG sample set is slight, and although the clinical area coverage seem to be reasonable, the CPG presentation style (free text, flowcharts, etc.), mainly determined by the CPG producing body, is not
discussed at any length. A thorough description of the CPG sample set is required together with a thoughtful discussion of the existence and implications of selection and sampling, and possible others, biases on the method and results of this study.

- The authors frame their suitability analysis on the premise that the only modelling application of computerisation of CPG is developing decision support system for individual patients. This assumption leads them to label as unsuitable multiple activation/instances and recursion workflow patterns. However, the interpretation of this assumption is disputable depending on the modelling intention. For instance, multiple instance patterns could model the same treatment applied to several different lesions caused by the same disease, while multiple execution threads patterns could model different concurrent treatments and the required synchronization control patterns for these two examples. The decision to employ these patterns or not will depend on the granularity level used for describing the particular clinical knowledge area. Methodologically, to prove unsuitability one should exhaust all modelling alternatives, and this clearly has not been done in this study. Given the method in this study, the conclusion that one could arrive is that these patterns have low prevalence in high level modelling of CPG, but not that they are not suitable. In the light of these comments, a comprehensive review of the method, results and discussion is required.

Minor Revisions/Comments:

Abstract

- Could have provided specific examples to motivate the problem.
- No attempt to cite other's works.
- No attempt to describe the CPG sample set and the selection criteria.
- No clear explanation on why the BPMN translation is not fully automatic.
- Slight conclusions.
- No attempt to anticipate implications of this work on guideline life-cycle and guideline interaction.

Background

- Slight review of the literature in the area. Critically, the assertion of “authoring of CPG models remains a complex, labour-intensive task, requiring both clinical and technical skills” is not grounded in the literature. That should be the starting point of this section.

- Cited works are not discussed at sufficient length as to motivate this study and facilitate understanding what this study adds. For instance, the section cites Grando, but it does not discuss the implications of that study. Doesn’t Grando already provide proof of which workflow patterns can be implemented in PROforma? Therefore, frame the contributions of this work in that context.
- Clear research questions. However: 1) is fair, but the definition and measure 'suitability' is subjective. 2) appears to have been addressed in other studies and is not clear what this study adds. 3) Other studies also give an explicit idea on how to achieve the same, for instance by using Petri nets, but it is fair to say that this study appears to use other transformations.

- 133 “kinds of “ # “types of”

- The discussion of the background goes through syntactic and semantic patterns, design patterns, and implementation patterns, without making an explicit distinction on what each one is addressing or whether there is an overlap between the aims of them. This section could be better described using a translation stack, specifying what is addressed in each level, to facilitate understanding where the contribution of this work lays.

- Reasonable discussion of GEM and MHB, although an example would have been helpful.

- It is not clear why the tools and methods proposed in other methods are not applicable to early stages, or why they cannot be semi-automatic.

Method

- An example BPMN for the medical domain was cited, but no shortcoming of that work was discussed.

- The XSLT transformations between BPMN and Asbru and PROforma are of interest.

- “The suitability analysis has been carried out by the two authors of this article, who are computer scientists with a strong research record on CPG modelling “ # Rephrase: “The authors performed a qualitative suitability analysis ...”

- If an expert with a different background, for instance a clinician, with sufficient training in process modelling would attempt the same experience, would you expect the outcome of the suitability analysis to be similar, or would there be major differences?

- How to justify the choice of guidelines for the suitability study? The clinical areas are representative. Are the presentation styles of the chosen guidelines also representative? This is important since different guideline bodies present their guidelines following different formats and that has an obvious effect in how the clinical knowledge can be understood and harvested. The choice is of 'known guidelines' to the authors, with no attempt to discuss the potential biases. That the choice is an understandable factor for selection, but the type of guideline presentation (narrative, flowchart, etc.) should also be a defining factor. What kind of clinical guidelines have you chosen, what bodies, what style of clinical guidelines, do all of them follow different/similar styles?
- 2.3 is a noteworthy objective with a tangible, helpful result. However, the methodology is not described in a manner that allows the reader to reproduce the experience. The method should clearly explain why 1:1 are not always possible and how to address those situations, helping to identify when mappings are 1:1 and when they are not.

- The suitability “yes” means that the pattern was clearly found in the guideline, unknown that it was not found and no that “there are strong reasons to dismiss the applicability of the pattern in the CPG domain” based on that they are related to multiple instances or execution threads. It does not follow that the pattern is not suitable. For instance, if the decision support system intends to inform the understanding of the potential benefit of different treatments choices towards a particular goal, then such patterns could well be more expressive than alternatives, facilitating the work of the designer. The implicit premise of a particular type of guideline decision support system, could be very restrictive and not necessarily true. Nevertheless, this is a noteworthy result that certainly helps direct efforts for the next stages in this work.

- 302-321 “CPGs are developed to provide decision-support for a single patient rather than for describing the workflow for a care provider handling multiple patients.” This is a limited view. CPG-based decision support systems are also useful for policy analysis and decision-making, costing, etc.

- Findings in section 3 are already known, at least for PROforma, and it is not clear what this study adds, although the explicit implementation provided is a contribution.

- 436-445 how were they tested?

- 439 'Russel et al. publications' # delete word “publications”

- 441 'remarkable’?

- Section 3.3 Provides an interesting and useful result. What do the authors mean by semi-automatic? Aren’t these transformations manually specified? Could the authors provide a web resource for the XSLT transformations, specifying the BPMN pattern and what transformation to apply?

- 543-544 “We provided XSLT transformations for the implemented patterns and we showed that on the one hand BPMN 2.0 can represent the control flow of CPG” This is already know, isn't it?

547 “elements have to be filled in and how they must be filled” # filled in.

552-555 Do the authors mean that the XLST transformations might need to be parametrized or do they think that it is needed to extend the BPMN model.

558-559 This is already known, the authors have provided a reasonable survey of the level of support, prevalence of these patterns in CPG.
This is a narrow view and depends on the modelling intention. CPG could be used for automatic audit, costing, etc.

“On the other hand, particular kinds of CPG processes cannot be described in terms of existing workflow patterns and hence new patterns would be required.” This is the first time in this paper than this observation is stated and cites Table 3 for the first time. This should be moved to the results section. In lines 570-578 you identify these patterns as specialisations of existing ones. To an extent, this assertion contradicts the observations made in lines 293-302.

- It is apparent from the discussion that the translation of CPG using patterns is a positive step forward, however, there is no learning from this paper as to how to recognise these patterns to facilitate the implementation. There is a lack of lessons learnt in terms of how actually use the patterns. Admittedly, they have not tested this in a realistic setting and the CPG sample is small.

- The discussion does not contrast this approach with others.

- The semi-automatic conversion between BPMN 2.0 of CPG fragments into Asbru and PROforma is a valuable result.

Level of interest: An article whose findings are important to those with closely related research interests

Quality of written English: Needs some language corrections before being published

Statistical review: No, the manuscript does not need to be seen by a statistician.

Declaration of competing interests:

DA has the following non-financial interests that might be relevant to the submitted review: UCLB (a subsidiary of University College London) and ISIS innovation (a subsidiary of the University of Oxford) are actively seeking to commercialise aspects of MATE (a decision support system for breast cancer multidisciplinary meetings, based on PROforma) through a spin-out company.