Modulation of Existent Obstetrics EHRs to the openEHR Specification

João Carlos Menezes de Magalhães[1] and Ricardo João Cruz Correia[2,3]
[1]*Mestrado Integrado em Medicina, Faculdade de Medicina da Universidade do Porto, Porto, Portugal*
[2]*CINTESIS, Faculdade de Medicina da Universidade do Porto, Porto, Portugal*
[3]*Department of Health Information and Decision Sciences, Faculdade de Medicina da Universidade do Porto,*

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Abstract: **Objective:** Create templates in OpenEHR through the modulation of existing electronic health records defined in OpenObsCare platform. **Materials and Methods**: Apply a 4 step process: select data fields already existent in OpenObscare; search both in openEHR and NEHTA clinical knowledge manager (CKM) for the archetypes that contain these data fields; create new archetypes when a data field doesn't have an existent one in both CKM's; develop templates from all the information gathered in the previous steps. **Results**: Development of 6 templates available online via http://joaomagalhaes.me/admission_templates and 1 archetype (openEHR-EHR-CLUSTER.exam-vagina.v1). **Discussion**: The process of modulation from existent EHR to the openEHR was possible since the standardization of clinical concepts allowed the re-utilization of a lot of already existent archetypes. This speeds up the development process by defining earlier the domain knowledge necessary for the HIS. Some hurdles faced in the process were due to the necessity of translation of all the archetypes to use at a national level and also due to the lack of national wide accepted terminologies. As this process is eased by the robustness of existent archetypes, the creation of default obstetric templates validated by a special commission, would probably be advantageous since the interoperability and semantics standardization would allow effective transmission of information between all the health care agents. **Conclusion**: The modulation of admission data existent in the HIS OpenObsCare to openEHR was easier than the "traditional" way of doing it which is by specifying requirements. This is due to the fact that a lot of the existent archetypes are already robust enough and the number of them is enough to represent several clinical concepts contained in the created templates.

1 INTRODUCTION

The widespread use of electronic health records demands the need of a electronic health record (EHR) that can resist during a patient entire lifetime. The quality of the EHR can enhance the health care quality(Delpierre et al., 2004) and can also facilitate the research for academic purposes contributing for a more evidence based medical practice(Zeng and Cimino, 1999). There is a consensus about the need of a system that is designed to allow maintainability and interoperability of this records(Hovenga, 2010)(Beale and Heard, 2007)(Xiao et al., 2011). The interoperability is the ability of different software systems to interpret clinical information in the same way. For this to be achieved the advantages of standardized clinical concepts and reference models comes as a need (Hovenga, 2010). This is the goal that OpenEHR foundation and others such as HL7(Dolin et al., 2001) proposed to reach.

The openEHR architecture is a two level modelling approach for EHRs. The first level is the reference model which is a relatively small set of classes used to support the medico-legal requirements and record management functions (Beale and Heard, 2007). The first level stands for functional interoperability. It provides the communication between different HIS (Health Informatic Systems).The second level represents the openEHR archetype methodology. Archetypes map clinical knowledge, therefore each archetype represents one clinical concept by constraining instances of the openEHR reference model. This dual approach allows a fundamental abstract concept which is the independence of the development of domain knowledge (clinical content) which is delegated to medical specialists and technical implementation which is a concern for the software development team. This has an enormous advantage since there is no need to transmit clinical requirements to non specialized people.

OpenEHR Templates(Leslie, 2008) are created by the clinicians and are used to create definitions of con-

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tent such as a particular document or message, required for specific use cases, such as specific screen forms, message types or reports. They contain different archetypes that have meaning all together (e.g. obstetrics hospitalization entrance note, obstetrics ultrasound report) and that can be assigned to the same template or to different templates several times making it re-usable.

In an effort to implement this change of paradigm in the Obstetrics department at Hospital de São João, Porto, we propose the creation of templates to be used by an experimental version of the OpenObsCare health information system (HIS) that is currently being used in this department. Since there are different ways of collecting data for an obstetrics EHR the analysis and comparison of this data between different institutions an countries is hard.

In this work we aim at creating openEHR templates for a pregnant woman hospitalization admission in an obstetrics department. We also want to document the process in order to evaluate its advantages and disadvantages compared to a more traditional way of creating HIS.

2 MATERIALS AND METHODS

As data source for the templates' creation we used the current HIS implemented in the obstetrics department at Hospital de São João - OpenObscare. To create openEHR templates 4 stages were defined:

1. Select data fields already existent in OpenObscare
2. Search both in openEHR and NEHTA clinical knowledge manager (CKM) for the archetypes that contained those data fields
3. Create new archetypes for data that doesn't have a corresponding archetype in the openEHR and National E-Health Transition Authority (NEHTA) clinical knowledge managers (CKM).
4. Create Templates

This similar process has already been used by others (G.M. Bacelar-Silva, 2012).

2.1 Select Data Fields from OpenObsCare

OpenObsCare (Figure 1) is an opehEHR solution still in development that derives from the already existent ObsCare. Obscare is a software that was designed to be used by OB/GYN doctors, anesthesiologists, nurses and administrative staff and is used to register patient admission and discharge, as well as childbirth and newborn data. It is also used to register surgical and anesthetic procedures, nursing records, as well as gynecological interventions. It is currently in use at Hospital de S.João and will soon be installed in several other hospitals in northern Portugal. These fields were extracted from the hospitalization admission section of this HIS which is composed of several main tabs. We only included the Admission Note, General information and Ultrasound Exams for this modulation. The General Information contains 5 more sub-tabs which were each counted as main tabs. For each of these tabs a google spreadsheet was created to describe the different forms they contain. The spreadsheet information was gathered regarding the following parameters: Data fields, Description, OpenEHR archetype corresponding field, Archetype ID and Note.

2.2 Search for Archetypes

OpenEHR maps the clinical statements using specific types of Entries (Administrative, Observation, Evaluation, Instruction and Action) according to the nature of the statement. Archetypes were chosen according to the clinical concept the data field was part of. As an example, the pattern of uterine contraction data field present in OpenObsCare could be represented by the field Pattern of the archetype openEHR-EHR-Observation.uterine_contractions.v1. Preference was given to the openEHR CKM and only when a clinical concept wasn't found on it, the NEHTA repository was used. This archetypes were found in both the referred CKM's by submitting a "Complete search", which searches "inside" resources, including all metadata, and for archetypes, archetype definition, and the archetype ontologies. The last search was performed on August 27th.

2.3 Create New Archetypes for Data that doesn't have a Corresponding Archetype in the openEHR and NEHTA Clinical CKM's

If after searching on the referred repositories no available archetype could be found to represent a clinical statement, the creation of a new archetype would be considered. For this purpose the Ocean Archetype Editor, a tool to support the authoring of archetypes was used.

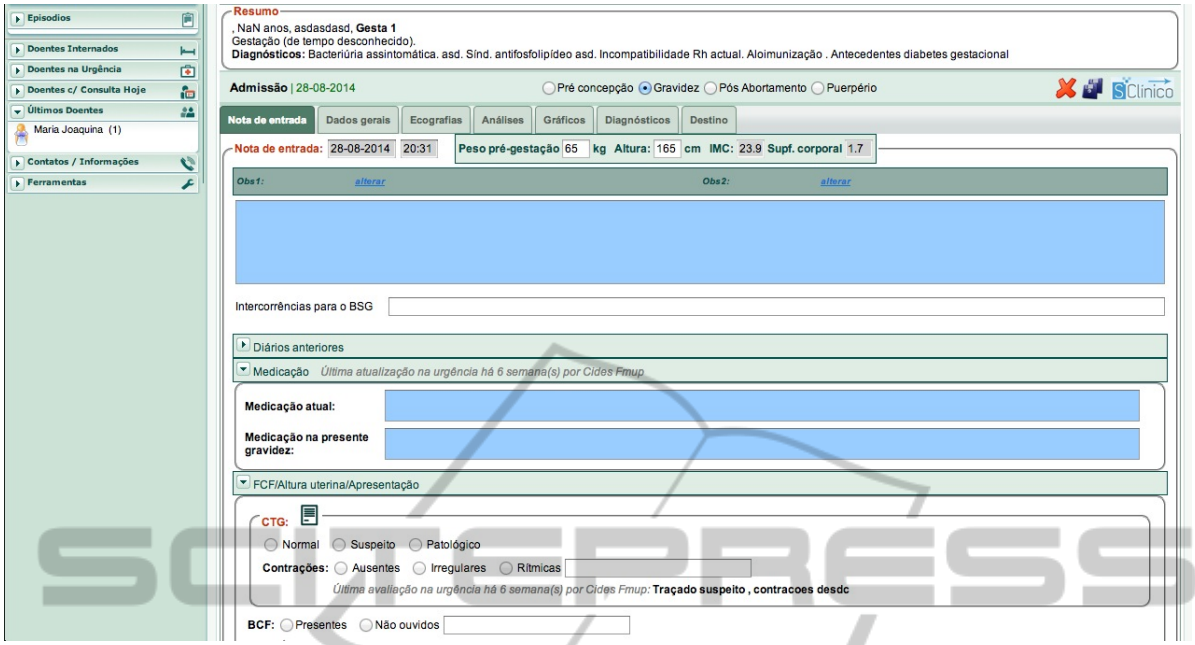

Figure 1: OpenObsCare platform.

2.4 Create Templates

The structured spreadsheets created helped in creating the framework for the development of the template, where the archetypes will be arranged. This was made using Ocean Template Designer – software that allows composing a set of archetypes into a template.

3 RESULTS

From the modulation of OpenObsCare IHS, spreadsheets with the specifications necessary for the development of templates were created (Fig.3). From this framework 6 templates were developed:

- Admission Note(Fig.3)
- Ultrasounds
- Current Pregnancy
- Obstetric history
- Family history
- Personal history

They are all available for download in the following url http://joaomagalhaes.me/admission_templates.

The archetypes used for creating the mentioned templates are presented in Table 1. Only 1 of the concepts used is taken from the NEHTA repository and also only 1 was created (Fig. 4). The reason for this has to do with the fact that no archetype could define with clinical rigor the concept of the pelvic examination.

4 DISCUSSION

The process of creating templates for an obstetrics pregnancy hospitalization admission was possible by mostly using archetypes already defined in OpenEHR and NEHTA CKM's. This is an advantage compared to the process of creating new ones from scratch since those already available to be shared have been validated by a group of specialists and so its robustness is inevitable. One archetype was created being derived from a pre-existent cluster - openEHR-EHR-CLUSTER.exam-vagina.v1. This was necessary since there wasn't an already available archetype to represent the findings of a speculum examination performed on a pregnant woman. This archetype can also be used in a more general context e.g. in a gynecology routine consult. However it still lacks the analysis of obstetrics specialists by being submitted to validation in openEHR CKM. Another limitation has to do with the fact that the archetypes and their fields were chosen according to the pre-existent specifications of ObsCare platform.

This migration from traditional HIS to a more standardized and consistent OpenEHR specification

Table 1: List of archetypes used - all taken from the openEHR CKM except for the Pregnancy Summary which was taken from NEHTA CKM and Examination of the vulva which was newly created.

Name	ID
Adhoc heading	openEHR-EHR-SECTION.adhoc.v1
Adverse Reaction	openEHR-EHR-EVALUATION.adverse_reaction.v1
Alcohol Use	openEHR-EHR-OBSERVATION.alcohol_use.v1
Blood Matching	openEHR-EHR-OBSERVATION.blood_match.v1
Blood Pressure	openEHR-EHR-OBSERVATION.blood_pressure.v1
Body Mass Index	openEHR-EHR-OBSERVATION.body_mass_index.v1
Body Surface Area	openEHR-EHR-OBSERVATION.body_surface_area.v1
Body Temperature	openEHR-EHR-OBSERVATION.body_temperature.v1
Body Weight	openEHR-EHR-OBSERVATION.body_weight.v1
Examination of the cervix	openEHR-EHR-CLUSTER.exam-uterine_cervix.v1
Examination of the fetus	openEHR-EHR-CLUSTER.exam-fetus.v1
Examination of the uterus	openEHR-EHR-CLUSTER.exam-uterus.v1
Examination of the vulva	openEHR-EHR-CLUSTER.exam-vagina.v1
Examination	openEHR-EHR-CLUSTER.exam.v1
Family History	openEHR-EHR-COMPOSITION.family_history.v1
Family History	openEHR-EHR-EVALUATION.family_history.v1
Fetal Heart Monitoring	openEHR-EHR-OBSERVATION.fetal_heart-monitoring.v1
Fetal Movement	openEHR-EHR-OBSERVATION.fetal_movement.v1
Free text	openEHR-EHR-CLUSTER.free_text.v1
Gestation	openEHR-EHR-OBSERVATION.gestation.v1
Height/Length	openEHR-EHR-OBSERVATION.height.v1
Imaging examination	openEHR-EHR-ACTION.imaging_exam.v1
Imaging examination result	openEHR-EHR-OBSERVATION.imaging_exam.v1
Medication Order List	openEHR-EHR-SECTION.medication_order_list.v1
Medication Order	openEHR-EHR-INSTRUCTION.medication_order.v1
Oedema	openEHR-EHR-CLUSTER.oedema.v1
Physical Examination	openEHR-EHR-OBSERVATION.exam.v1
Pregnancy Summary	openEHR-EHR-EVALUATION.pregnancy.v1
Problem/Diagnosis	openEHR-EHR-EVALUATION.problem_diagnosis.v1
Procedure Report	openEHR-EHR-COMPOSITION.report-procedure.v1
Procedure undertaken	openEHR-EHR-ACTION.procedure
.v1 Report	openEHR-EHR-COMPOSITION.report.v1
Review	openEHR-EHR-COMPOSITION.review.v1
Story/History	openEHR-EHR-OBSERVATION.story.v1
Substance Use	openEHR-EHR-OBSERVATION.substance_use.v1
Tobacco Use	openEHR-EHR-OBSERVATION.tobacco_use.v1
Urinalysis	openEHR-EHR-OBSERVATION.urinalysis.v1
Uterine contractions	openEHR-EHR-OBSERVATION.uterine_contractions.v1

has already been performed by others (Bernstein et al., 2009)(Tapuria et al., 2013). As in the current paper the advantages of using pre-existent archetypes was valued and the biggest disadvantage resides in the translation of the concepts when creating templates. Other common problem noticed was the difference between terminologies (Bernstein et al., 2009) (e.g. degree and extent of oedema and fetal contractions) which can indicate the need for a national or international level standardization.

As the modulation of an existent EHR was possible and bearing in mind the advantages of using openEHR to achieve national interoperability we can see the enormous advantages of creating a national level comission to create obstetrics templates. They would have the minimal acceptable content. The advantages of this approach would be a common language spoken by all HIS in the country, a consensus on what is essential for an obstetrics EHR and the flexibility to allow different regions or locals to add more archetypes since the database schema doesn't have to suffer big changes thus also being very well supported economically. The local archetype addition could be useful in cases where a specific detail of the obstetric history that isn't contained in one the national accepted templates is necessary for academic purposes.

Since the templates were created but not translated to HTML and implemented in the OpenObscare version that was built with a database schema that adapts to OpenEHR specification, there is no information about the possible easiness or difficulty in performing this process.

Data fields	Description	OpenEHR archetype corresponding field	Archetype ID	Note
Previous to gestation weight		Weight	openEHR-EHR-OBSERVATION.body_weight.v1	
Height		Height/Length	openEHR-EHR-OBSERVATION.height.v1	
BMI	Body mass index	Body Mass Index	openEHR-EHR-OBSERVATION.body_mass_index.v1	
Body surface area		Body Surface Area	openEHR-EHR-OBSERVATION.body_surface_area.v1	
Doctor's name	Name of the doctor who performs the observation	Name -> Unstructured Name	openEHR-EHR-CLUSTER.individual_professional.v1 -> openEHR-EHR-CLUSTER.person_name.v1	
Doctor's team		Professional Details -> Team	openEHR-EHR-CLUSTER.individual_professional.v1	
Story		Story	openEHR-EHR-OBSERVATION.story.v1	
Complications for the pregnancy book	National pregnancy book implemented in Portugal	Free text	openEHR-EHR-CLUSTER.free_text.v1	
Medication				
Current medication	Free data field to identify all medication	Order -> Medicine	openEHR-EHR-INSTRUCTION.medication_order.v1	
Medication prescribed in the current pregnancy		Order -> Medicine	openEHR-EHR-INSTRUCTION.medication_order.v1	
FCF/ Fundal Height / Presentation				
CTG	Cardiotocography			
Contractions	Type of uterine contractions	Pattern	openEHR-EHR-OBSERVATION.uterine_contractions.v1	Archetype describes one more
Fetal Heartbeat		Variability Category	openEHR-EHR-OBSERVATION.fetal_heart-monitoring.v1	Data field only refers 2 states h - Minimal [Heart rate variability - Moderate [Heart rate variabilit - Marked [Heart rate variability
Presentation	Fetus presentation	Abdominal findings -> Presentation	openEHR-EHR-CLUSTER.exam-fetus.v1	
Fundal Height		Findings -> Size -> Fundal height	openEHR-EHR-CLUSTER.exam-uterus.v1	
Pelvic exam				
Speculum exam	Vaginal exam using a speculum	Clinical description	openEHR-EHR-CLUSTER.exam-vagina.v1	Create new cluster archetype

Figure 2: OpenObsCare form modulation spreadsheet for the Admission note.

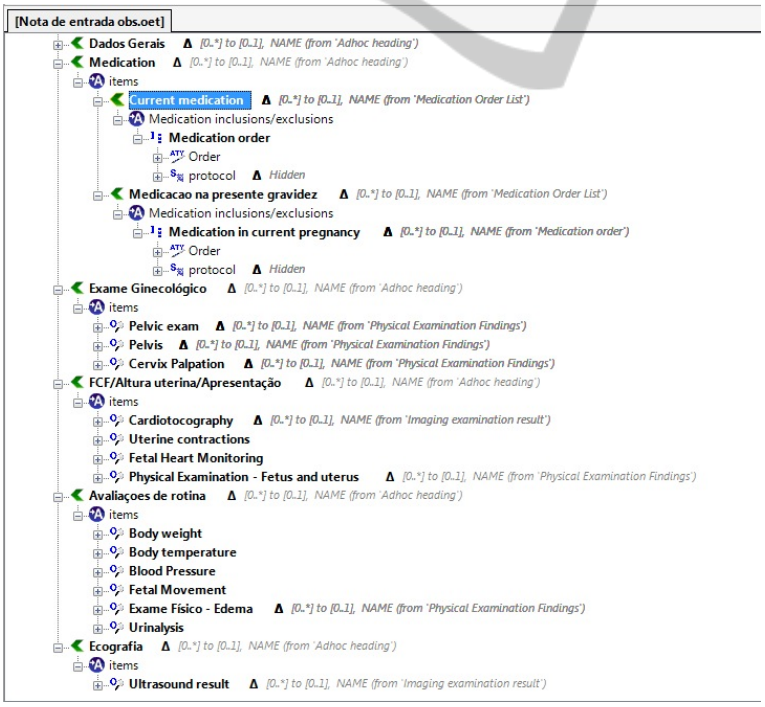

Figure 3: Admission Template.

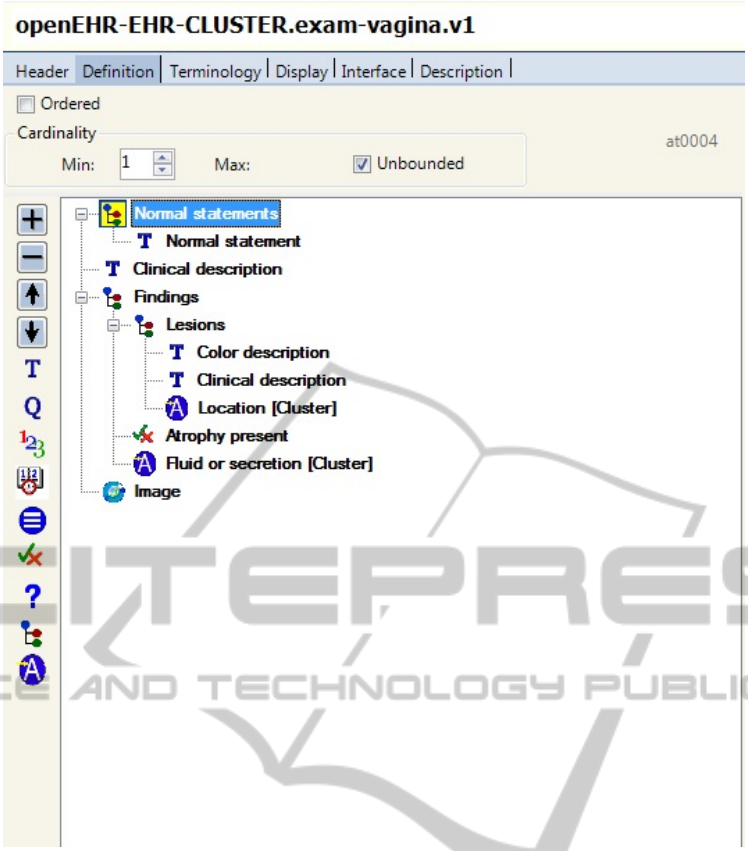

Figure 4: Vulva examination archetype.

5 CONCLUSION

In the current paper the modulation of clinical hospitalization data existent in an obstetrics HIS to the OpenEHR specification was performed. The process was easier than the ”classic” one by which medical specialists transmit the requirements of the system and then these data models are created from scratch since it can be easily achieved by reusing existent validated archetypes. Both OpenEHR and NEHTA CKM’s contain good solid archetypes with a community of medical specialists reviewing them in an iterative process that aims to achieve an EHR standardization that allows interoperability between different systems. There was only the need to create 1 new archetype and to edit other. Using the method described here in this paper the transition process to an interoperable and semantics standardized EHR can start. However there are still more steps ahead and the process of application and maintainability of this type of EHR must be ascertained. Furthermore this is an effort that we would expect to be more effective if there were nationwide standard templates defined by a special comission of specialists.

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