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From ObsCare Software to an OpenEHR Platform: Modelling Obstetric Archetypes

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Abstract. Introduction and aims. Electronic health records (EHRs) are important tools to facilitate communication between care providers and to improve clinical research. In obstetrics they became essential. The ObsCare software was created to answer to the need for an EHR with specific obstetric features. The present study aimed to develop openEHR-archetypes capable of representing an ObsCare® EHR form and to create an openEHR-template using the developed archetypes. **Methods.** The study was performed in four phases: 1) selection and description of the ObsCare form; 2) Clinical Knowledge Manager (CKM) analysis; 3) modelling of the archetypes; 4) creation and testing of the template. **Results.** One openEHR-archetype — Newborn summary — was modelled to assemble the following three clinical concepts that were not represented in CKM: hours of life, "Examination of newborn movements" and "Examination of reflexes". Finally, an openEHR-template was built and automatically converted into an EHR by VCIntegrator. **Conclusions.** Considering the potential to improve clinical research, we believe that more obstetric-gynecologic clinical statements should be modelled into openEHR

Keywords. Electronic Health Record, Obstetrics, openEHR, Interfaces

1. Introduction

Electronic health record (EHR) can be defined as an electronic ecosystem that supports features beyond the core electronic medical record [1]. It presents some of the following functions: clinical documentation, test and imaging results, computerised provider order entry, and decision support [2].

The obstetrics field provides an excellent opportunity to demonstrate the potential for quality of care improvement with EHR implementation since the mothers are seen in a specific period, in multiple visits, with diverse evaluations, and by different health professionals [3]. However, general EHRs lack obstetric-gynaecologist specific functions and features and are inadequate for documenting and exchanging obstetric clinical information [4]. EHRs with specific obstetric features differ from those for other specialties to account for the specificities of this field, which is both a medical and

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surgical specialty, hospital- and office-based, and requires data fields and image displays [4]. The ObsCare software was created in 2003, to answer to these specific needs. Currently, it is used in nine Portuguese hospitals. The software was produced to serve as a clinical register for health professionals, collecting quality data and allowing easy and fast access to the current situation of several obstetric interventions.

Although ObsCare is a major development as an EHR with specific obstetric features, its data interoperability with other systems and the specifications of the included variables could be further improved to make it a future-proof EHR system [5]. openEHR, among others [6], has arisen as a standard specification aiming to provide a solution to these issues. openEHR has two framework levels known as reference and archetype models, that separate knowledge from information models and assure both a reliable clinical–meaning sharing and data interoperability [7]. The modelling of ObsCare variables into openEHR-archetypes is a relevant step in the path to make ObsCare a future-proof EHR.

This exploratory study aimed to develop openEHR-archetypes that represent an ObsCare EHR form and to create an openEHR-template using the developed archetypes.

2. Methods

This study was developed based on the steps described in Figure 1 and below.

2.1. Description of the selected ObsCare software form

The authors selected the newborn diary form to be modelled into openEHR-archetypes. In 2017, 14.034 newborns were registered in this form, which is filled daily by physicians and nurses. Its variables are described in Figure 1.

2.2. Search of clinical concepts in the openEHR clinical knowledge manager

The clinical concepts present in the selected ObsCare form were searched in the International CKM repository (https://www.openehr.org/ckm/). CKM is a system for collaborative development, management, and publishing of a wide range of clinical knowledge artefacts [8].

2.3. Archetype modelling in openEHR

Subsequently, the archetypes selected for further development were modelled in openEHR. To perform this step, we classified the archetype-concepts into entries. Each entry presents different structures and specific attributes to be used in different parts of the clinical recording and workflow process [9,10]. The Ocean Archetype Editor Software was used to model the archetype concepts [11]. The Archetype Editor provides graphical user interfaces that support openEHR-archetype creation and edition [10].

2.4. OpenEHR-template and EHR interface

The final step was the creation of the new openEHR-template, similar to the ObsCare form. We used archetypes that were created in the current study and some already

available in the CKM repository. To generate an openEHR template, we used the Ocean Template Design Software. It was subsequently tested in VCIntegrator, which allows, in an automated manner, the integration of relevant clinical information from various previously existing information systems. In this specific context, VCIntegrator allows the automatic conversion of openEHR templates into readily usable EHR.

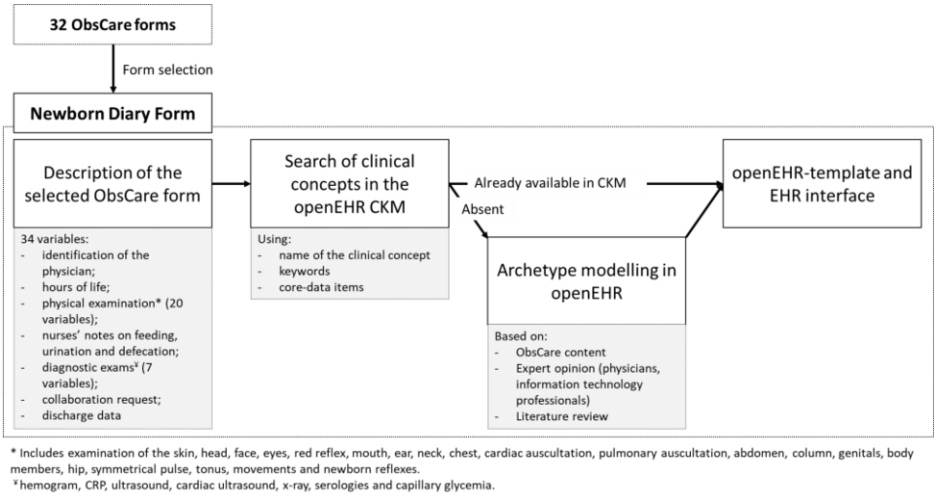

Figure 1. Summary of the study methodology

3. Results

Our team analyzed all clinical statements present in the ObsCare newborn diary form. Three out of the 34 identified clinical statements were not represented in the CKM - hours of life, movement, and reflexes - and were selected for further development. Therefore, three archetypes were created: "Hours of life", "Examination of newborn movements" and "Examination of reflexes" (Figure 1). The archetype "Hours of life" was categorized as an observation entry, while the other two were classified as clusters. These archetypes were created in English language and are available at https://github.com/NanoStima/openEHR_archetypes.

The CKM archetypes to represent the feeding content and faecal output need some changes to be a good representation of the content present in the ObsCare form. Therefore, the authors requested the CKM editors a review of these archetypes to add the following variables: 1) the identification of normality/abnormality of the feeding and the number of newborn feeds to the "Feeding" archetype; and 2) the identification of normality/abnormality of the faecal output to the "Faeces" archetype.

Finally, an openEHR-template representing the data from the ObsCare newborn diary form was created, assembling previously existing archetypes and the archetypes developed in our study. Subsequently, we used VCIntegrator to create an EHR interface. The VCIntegrator template can be accessed after filling the form available through the following link: https://docs.google.com/forms/d/e/1FAIpQLSdV-6n9-5PmjSRUv2kczyxY16I9kfacvIpG1vHGb0ZVDPG5nQ/viewform?usp=sf_link. This short form was created to allow the interested reader to get the VCIntegrator credentials to visualize the template as originally created in VCIntegrator.

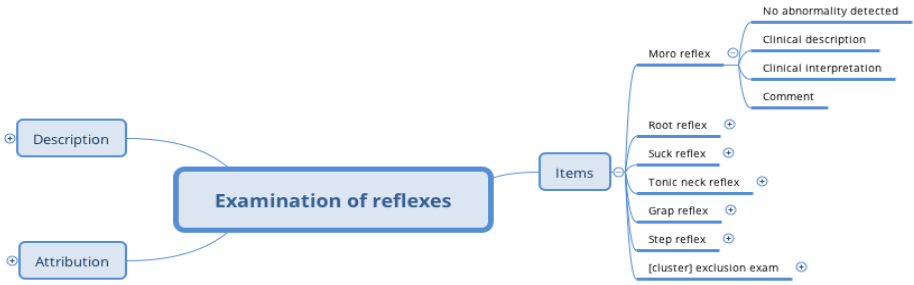

Figure 1. Mindmap of the Examination of reflexes

4. Discussion

In the current study we modeled openEHR-archetypes and an openEHR-template from clinical concepts present in the ObsCare software, an obstetric-specific EHR widely known and used in Portugal.

ObsCare has been in use for the last 15 years in one of biggest Portuguese tertiary hospitals and since 2015-2016 in eight additional hospitals. It was developed in the early 2000' based on the available literature, on paper forms used to collect obstetric data and on expert opinion. Its users (obstetricians, neonatologists, nurses, among others) have been validating and suggesting additional relevant variables, iteratively improving the content of the forms. Although ObsCare development was not based on a formal consensus process and no data on inter-clinician agreement regarding the included variables is available, we believe that its long-term use by hundreds of obstetric specialists with frequent, iterative, clinical practice-oriented updates gives ObsCare the strength needed to be the base for this study's variables selection. Thus, we believe that the archetype created in this study thoroughly represent part of the clinical practice in obstetrics and will be applied by health professionals to collect more complete obstetric-gynaecological data, with the potential to improve data quality and, consequently, research publications. In fact, Pereira et al. (2018) [12] have shown that hospitals with ObsCare software have research publications with a significantly higher sample size and study length when compared to hospitals without ObsCare informatization.

The main motivation to apply openEHR is to create an open alternative to the closed/proprietary solutions currently offered by EHR vendors. Additionally, it allows the creation of EHR platforms based on open standards and good design practices, searching for a generic, reusable, scalable, extensible, web-based, knowledge-driven, and future-proof solution [13]. Moreover, openEHR aims to stimulate health professionals to be more active and understand that modelling of openEHR archetypes can be performed by them. In fact, the involvement of health professionals in openEHR archetype development enables the creation of breadth, depth, and complexity of the health record to better suit their needs in clinical practice [13]. In this study, we could further improve the details of each variable by putting the health professional perspective into practice. An example is the concept of "reflexes" that in the original form should be globally stated as normal or abnormal, and that, in this archetype, can be specifically stated for each type of reflexes, including clinical description, clinical interpretation, and comment. This doesn't mean that all reflexes must be included in every form, but it

allows the template creator to select those that will be available for the user to complete, allowing a fast change when necessary. In addition, we observed that the representation of the "feeding" content present in the ObsCare form could be improved. For this reason, the archetypes "feeding" and "faeces" available in the CKM repository were used in their total formats to add relevant variables to the software. For all archetypes modelled in the present study, we performed a comprehensive literature review that, although not extensive, allowed us to improve and complete the data presented in the archetypes.

The current study has some limitations that must be considered. Firstly, the archetype created to represent newborn data was not yet submitted to CKM. However, this is an exploratory study and, before submission, we will comprehensively evaluate other variables that are present in the ObsCare forms and that might be included in the present archetype. Meanwhile, the archetypes are available in GitHub. Secondly, we would like to submit a full set of obstetric-gynecologic archetypes to the International CKM repository. Finally, our future perspective is to model all ObsCare forms into openEHR-archetypes, targeting an improved data quality and a direct interoperability among systems.

5. Conclusion

This is the first study to develop a specific openEHR-archetype representation for the obstetric-gynecological field. Considering the potential to improve data quality, system interoperability and, consequently, clinical research, we believe that more obstetric-gynecologic clinical statements should be modelled into openEHR and that health professionals should be drivers of those developments.

References

[1] S.G. Peters, M.A. Khan, Electronic health records: current and future use, *Journal of comparative effectiveness research* **3** (2014),515-522.
[2] K. Hayrinen, K. Saranto., P. Nykanen. Definition, structure, content, use and impacts of electronic health records: a review of the research literature, *Int J Med Inform* **2008** (2008), 291-304.
[3] J. George, P.S. Bernstein, Using electronic medical records to reduce errors and risks in a prenatal network, *Current opinion in obstetrics & gynecology* **21** (2009), 527-53.
[4] M. J. Coy, A.M. Diamond, A.L. Strunk., Special requirements of electronic medical record systems in obstetrics and gynecology, *Obstetrics and gynecology* **116** (2010),140–143.
[5] L. Wang, L. Min, X. Lu, H. Duan, Archetype Relational Mapping Based on openEHR, *Chin J Biomed Eng* **33** (2014), 856–890.
[6] openEHR Foundation, openEHR. An open domain-driven platform for developing flexible e-health systems. Welcome to openEHR, Homepage. http://www.openehr.org.
[7] L. Wang, L. Min, R. Wang, X, Lu, Archetype relational mapping - a practical openEHR persistence solution, *BMC Med Inform Decis Mak* **15** (2015), 2–18.
[8] openEHR Foundation, Clinical knowledge Manager: http://www.openehr.org/ckm.
[9] G. Bacelar-Silva, Cruz-Correia, R. Manual de introdução à norma openEHR, Porto, 2015.
[10] M. Braun, A.U Brandt, S. Schulz, M. Boeker, Validating archetypes for the Multiple Sclerosis Functional Composite, *BMC Med Inform Decis Mak* **14** (2014), 14-64.
[11] openEHR Foundation, Archetype Object Model: openEHR release 1.0.2, London, 2008.
[12] A. M. Pereira, P. A Maranhão, T. Silva-Costa, R.J. Cruz-Correia. Impacto da informatização dos registros clínicos obstétricos na produção científica, *Congresso Brasileiro de Informática em Saúde* (2018).
[13] H. Leslie, The openEHR approach, (2015). https://openehr.atlassian.net/wiki/spaces/healthmod/pages/2949213/The+openEHR+Approach