

Representation of Diagnosis and Nursing Interventions in OpenEHR Archetypes

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Abstract

Keywords

- nursing informatics
- health information interoperability
- standardized nursing terminology
- nursing notes
- patient records

Objective The study aimed to represent the content of nursing diagnosis and interventions in the openEHR standard.

Methods This is a developmental study with the models developed according to ISO 18104: 2014. The Ocean Archetype Editor tool from the openEHR Foundation was used.

Results Two archetypes were created; one to represent the nursing diagnosis concept and the other the nursing intervention concept. Existing archetypes available in the Clinical Knowledge Manager were reused in modeling.

Conclusion The representation of nursing diagnosis and interventions based on the openEHR standard contributes to representing nursing care phenomena and needs in health information systems.

Background and Significance

The specifications of the openEHR standard are published by the openEHR Foundation, an entity responsible for developing the specifications and for the availability of specific tools that allow use of the standard, with one of the main objectives being to allow electronic health record (EHR) systems to communicate with each other without loss of meaning, achieving semantic interoperability.¹ To this end, the openEHR standard is based on two level modeling,¹ comprising the reference model and the knowledge model.^{2,3}

The reference model focuses on defining the structures and attributes necessary to express the instances of data in an EHR such as the data type and structure.^{2,3} The knowledge model comprises archetypes and templates. Archetypes are formal and semantic artifacts, which facilitate collecting, storing, retrieving, representing, and communicating clinical data, representing a maximum set of useful data from a

domain concept that must be shared and reused to contribute to interoperability, and they can be modeled by domain professionals and health informatics specialists. Templates restrict and group archetypes into larger structures,² corresponding to a dataset for an individual case usage. The number of archetypes used in a template reflects the detail level needed to meet the demands of specific contexts.⁴

The registered information is represented in openEHR by entry classes, which are the most important in the reference model in terms of content, as they determine the semantics of the information in the records and become the majority of the archetypes defined for the EHR.⁵

The openEHR foundation provides the Clinical Knowledge Manager (CKM) to enable reusing archetypes, which consists of a web-based repository containing archetypes and templates developed by an international group of experts.¹ These archetypes can be downloaded and reused directly or specialized to include specific elements and details for a given situation, such

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as the “weight” archetype, which can be specialized for “birthweight.”⁶

The application of the openEHR standard has been reported in several countries such as Sweden,⁷ China,⁸ Slovenia,⁹ and Brazil.^{10,11} It is a neutral approach to terminology, enabling the insertion of terminologies such as Systematized Nomenclature of Medicine-Clinical Terms (SNOMED-CT) and Logical Observation Identifiers Names and Codes. Using this approach, domain experts can participate in systems development, modeling archetypes and linking appropriate terminology.²

Terminologies in nursing name elements that represent professional practice (i.e., nursing diagnosis, results, and interventions), and there are already initiatives to represent concepts contained in nursing terminologies in the openEHR model.^{12,13} However, considering the principles of openEHR, there is the need for a generic archetype, which is reusable to represent any nursing diagnosis and intervention, regardless of the terminology to be used.

The components required for the construction of nursing diagnosis and interventions are proposed by ISO 18104:2014.¹⁴ Although the term “diagnosis” is used by several health professionals, nursing diagnosis has theoretical bases and specific elements which differentiate it from the medical diagnosis and which is intended to identify diseases, injuries, and health conditions by logic of the profession. The nursing diagnosis comprises an interpretation of the data collected in the nursing history and implies in the nurse’s decision about the responses of the person, family, or community at a given moment in the health-disease process, thus consisting of the basis for selecting interventions to achieve certain results.¹⁵

The representation of a generic archetype for nursing diagnosis and another for nursing interventions in the openEHR standard based on ISO 18104:2014 will favor reuse of these models in EHR, regardless of the context used.

Objective

The objective of this study, which originated this article, is to represent the content of nursing diagnosis and interventions in the openEHR standard.

Methods

This is a developmental study with its models being developed following ISO 18104:2014.¹⁴ The developmental study consists of using knowledge, in a systematic way, for the production of new materials, devices, or products, for the installation of new processes and systems, or for the improvement of those that already exist.¹⁶

Two new archetypes were elaborated: one to represent the nursing diagnosis concept and another for the nursing intervention concept based on the reuse of existing archetypes, available in the CKM. In addition, the Ocean Archetype Editor tool available on the openEHR Foundation website was adopted.

The metadata, which compose the title page of the archetypes, was initially described.

Three research nurses worked on building the archetypal models. The developed models were discussed with other

nurses in a research group in the health technology area. The models were subsequently evaluated by five professors with expertise in health technology: three nurses and two health informaticians.

The workflow adopted in this study is shown in ►Fig. 1.

Representation in openEHR

The openEHR entry classes are observation, evaluation, instruction, and action.⁵ The observations comprise recording measurable or observed data such as blood pressure or body temperature; evaluations are the record of clinical assessments such as the assessment of health risk or adverse reaction risk; instructions consist of recording the start of a work process such as a service request or medication order; and actions comprise performed clinical activities such as procedures and medication management.¹⁷

The information in the input classes in openEHR can be structured in different ways such as (1) text that allows registering data in the form of a narrative; (2) date and time, which documents the date and time components in the EHR, may (for example) refer to the date and time of the evaluation or the beginning of the signs and symptoms; and (3) cluster, which is a format used to represent class logic and subclasses, in which broader content encompasses more specific content.

Another important concept used in the archetypes structured in this study is the slot, which defines a link point in an archetype in which other archetypes can be inserted; it is designed to be populated, meaning to have one of the allowed archetypes chosen for use.¹⁸

Empirical Basis: ISO 18104 Standard

The ISO 18104 standard was initially published in 2003 to provide a reference model for representing nursing diagnosis and actions and was updated in 2014. Its purpose is to facilitate the representation of the concepts of nursing diagnosis and actions and their relationships for computational processing.¹⁴

According to the model, a nursing diagnosis can be expressed by a focus, which comprises the activity area that is relevant to nursing (such as temperature), and a judgment which consists of the clinical opinion about the focus (i.e., increased), or by a clinical finding which contemplates situations in which judgment is implicit in the focus (such as pain). A location (i.e., right leg) can be added to the focus.¹⁴

Nursing diagnosis can also have potential, chance, or risk. The chance potential occurs when there is a possibility of positive diagnosis or opportunities such as a chance of effective self-care, while the potential risk occurs when there is a possibility of negative diagnosis such as a risk of low self-esteem.¹⁴ Still, the nursing diagnosis can be associated with an information subject (as a caregiver) and qualified by degree (such as severe), clinical course (such as acute), and time.

Regarding nursing interventions, the ISO 18104:2014 uses the term “nursing actions,” with the purpose of including assessment activities, data collection, and care coordination. The rule establishes that a nursing action must consist of a term for action (i.e., remove) and at least a term for the target (such as wound coverage). The latter refers to the entity, which is affected by the action.¹⁴

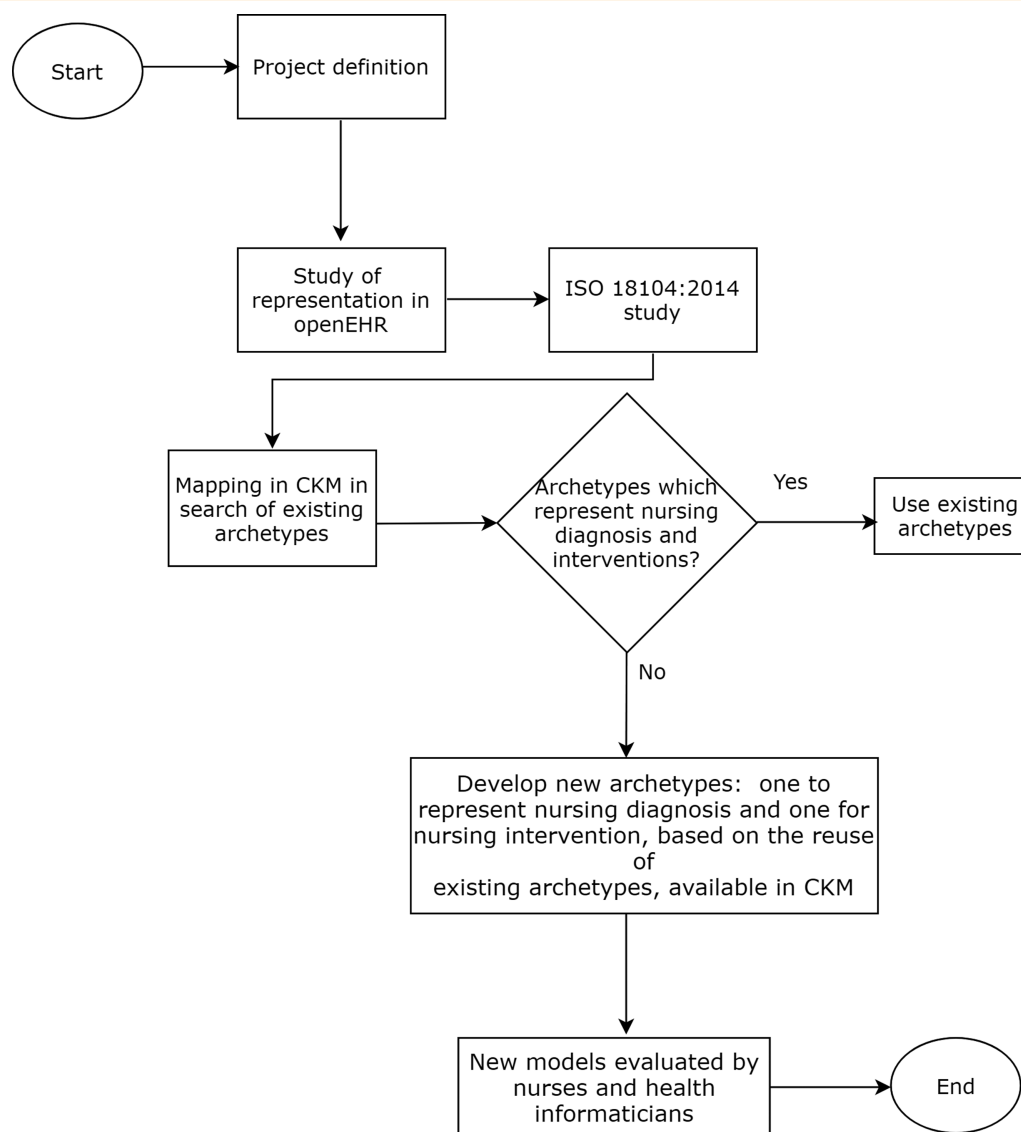


Fig. 1 Work flow adopted in this study.

The nursing action statements can also be specified with the inclusion of path, medium and time, while the location can be used to better specify the position of a target.¹⁴ It is noteworthy that the location in both structuring diagnosis and nursing interventions does not necessarily refer to an anatomical location and may be related to a location of space, such as a health care unit or home.

Nursing Diagnosis and Intervention Archetypes

The study by Abreu and Sousa was used as a basis¹⁹ for structuring the nursing diagnosis archetype, employing entry class evaluation. The nursing diagnosis title and the conditions related to it in this study were represented in text and the initiation and resolution dates in date format.

A cluster called the structural category of the nursing diagnosis was developed, within which it was possible to choose one of the three structures in which a nursing diagnosis can be represented: focus and judgment; clinical finding; or potential. The text format was chosen for registering these categories.

A cluster called additional descriptors was also created, in which the degree, clinical course, time, body structure or position, spatial location, and the information subject could be registered by means of text.

It is possible to make slots with two archetypes available in CKM, with the first using the “anatomical location” archetype and the second the “problem qualifier” archetype; in this work, they were renamed to “body structure or position” and “qualifier of the nursing diagnosis,” respectively. A terminological link was also made, linking the node name “nursing diagnosis” to code 86644006—Nursing diagnosis (finding)—from SNOMED-CT.

Next, the input class “instruction” was used for the nursing intervention archetype. The name of the nursing action was represented in text form, and a cluster was structured called the nursing action structure with the terms “action,” “target” and “subject of record” in the form of text.

Another cluster called additional terms was structured containing the items: path, medium, time, anatomical location, and spatial location. It is possible to develop slots with

two archetypes available in the CKM for the medium and anatomical location: the first with the “medical device” archetype, renamed “means,” and the second with the “anatomical location.”

The location in the two archetypes modeled in this study can be registered in a structured way through the slot when referring to the anatomical location or in free text when the record informs the space location. The same occurs for the registration of the “means” in the nursing intervention archetype, which can be done in detail in a structured way by using the slot or when referring to the means, which do not understand devices, in text form.

The relationship between ISO 18104:2014 and the representation of nursing diagnosis and intervention archetypes in the openEHR model is found in ►Fig. 2.

Results

The metadata which contains the set of items from the title page of the nursing diagnosis archetype is shown in ►Table 1. The

generic archetype for nursing diagnosis is shown in ►Fig. 3, whose registration can be performed by using the “nursing diagnosis” or “structural category of nursing diagnosis” field.

The example of terminological connection performed to link the name of the “nursing diagnosis” node to SNOMED-CT is shown in ►Fig. 4.

The metadata that contains the set of items from the title page of the nursing intervention archetype is shown in ►Table 2. Finally, the nursing intervention archetype is shown in ►Fig. 5.

Discussion

Metadata are important when structuring archetypes, and it is essential that an evaluation is performed in the CKM before representing a new concept to identify existing concepts, which can be reused. The indications of use and nonuse collaborate to guide the professional in this step, which contributes to minimize inaccurate reuse, making interoperability difficult.

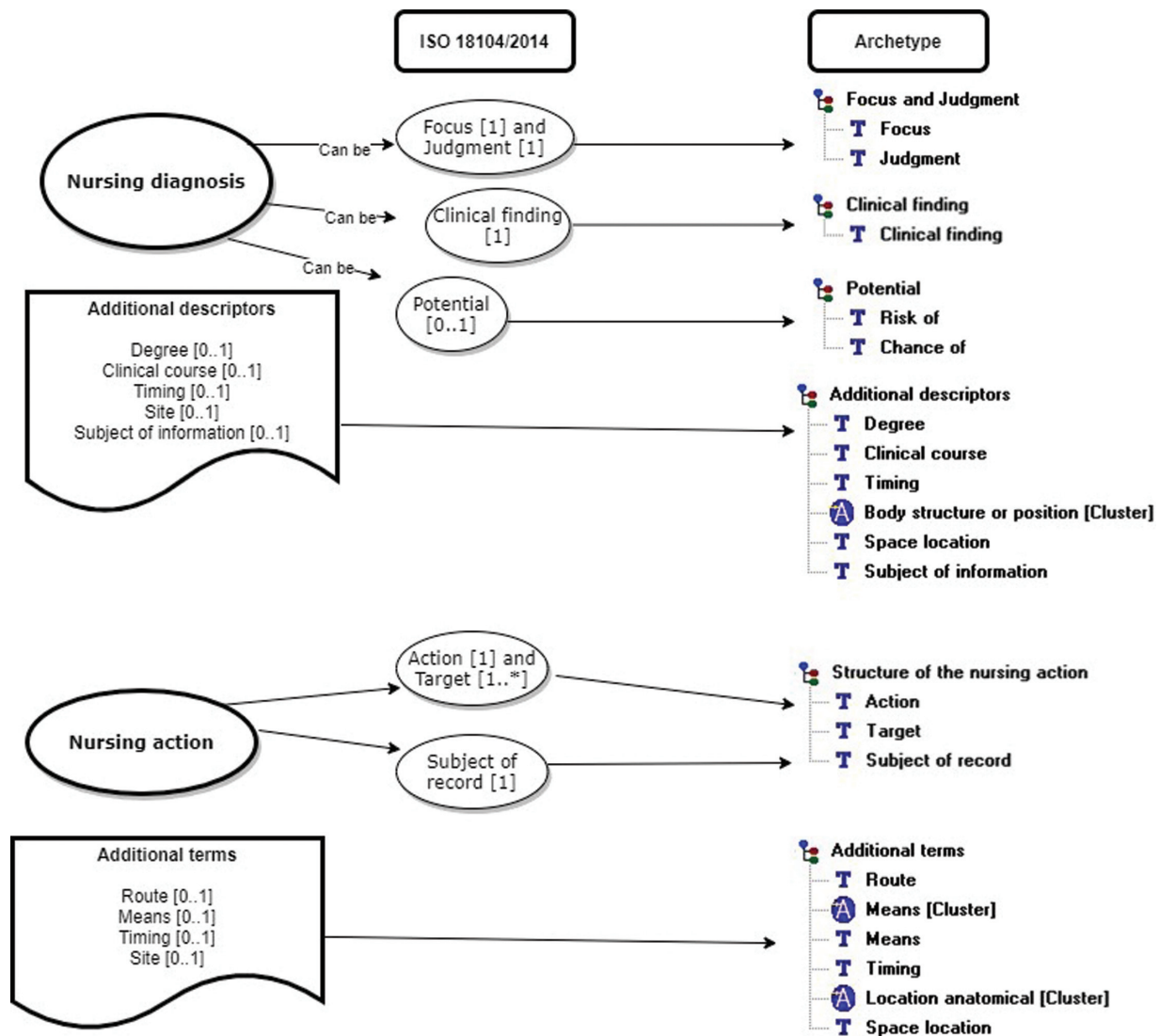


Fig. 2 Relationship between ISO 18104:2014 and the representation of nursing diagnosis and intervention archetypes.

Table 1 Title/header metadata for the nursing diagnosis archetype

Metadata	Description
Purpose	Register a single nursing diagnosis
Use	Record of a single nursing diagnosis, which can be composed of focus and judgment, a clinical or potential finding
Misuse	It should not be used to record symptoms described by the individual; use the “cluster symptom” archetype, usually within the “observation story” archetype.
References	Abreu N, Sousa P. Nursing diagnosis an essay of an archetype that expresses the clinical concept. Paper presented at: Conference ACENDIO - E-Health and Nursing – Knowledge for Patient Care; April, 2015; Bern, Switzerland. ¹⁹ International Organization for Standardization. ISO 18104:2014. Health informatics - Categorical structures for representation of nursing diagnoses and nursing actions in terminological systems ISO 18104:2014. 2 ed. Switzerland: ISO, 2014. ¹⁴ Conselho Internacional de Enfermeiros. Classificação Internacional para a Prática de Enfermagem – CIPE®: versão 2015. Tradução Telma Ribeiro Garcia. In: GARCIA, Telma Ribeiro (Org.). Classificação Internacional para a Prática de Enfermagem CIPE®: versão 2015. Porto Alegre: Artmed, 2016. 41–239. ²⁰

The “problem/diagnosis” archetype is available in the CKM openEHR, which can be reused in the EHR to represent diagnosis made by different health professionals.²¹ However, nursing diagnosis have a specific reference structure for its representation laid down by a rule,¹⁴ which includes items not addressed by the archetype in question. Furthermore, nursing diagnosis and actions are central concepts in professional practice, so it is important that they are represented by archetypes.²²

A similar situation occurs with the “service request” archetype available in the CKM, which could be specialized to represent nursing interventions. However, these also have a specific reference structure,¹⁴ which is not covered by the aforementioned archetype. In this case, the information “reason for the request” and “clinical indication for requesting an intervention” contained in the archetype can be used by linking the nursing diagnosis that supports them, despite being implicit when it comes to nursing interventions.

A contribution of the archetypes structured in this study is information retrieval. There are mapping initiatives for reestablishing numerical information contained in clinical narratives for archetypes, such as blood pressure data contained in unstructured clinical records.²³ This is interesting in the recovery of nursing diagnosis and interventions, which may have secondary use linked to identifying the phenomena that nurses are concerned with and the interventions performed, thus contributing to actions related to the quality of care, patient safety, and professional visibility.

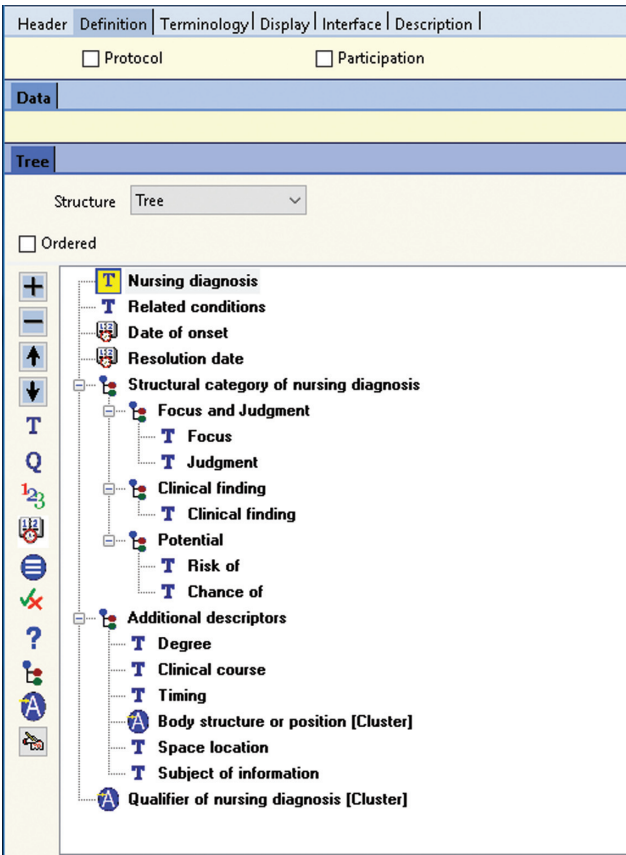


Fig. 3 Generic archetype for nursing diagnosis.

The example of the terminological connection made in the nursing diagnosis archetype stands out for information retrieval (→ Fig. 4). The use of SNOMED-CT in conjunction with openEHR contributes to interoperability,⁹ with semantic interoperability being essential regarding nursing care to facilitate sharing information produced by nurses, ensuring their understanding by information systems in health care and its users.²⁴

A reflection on the optional and mandatory items is necessary when structuring openEHR archetypes. Some items do not need to be completed in the case of nursing diagnosis when it is related to psychological processes; for example, it is not necessary to register the body’s location, laterality, and position for the diagnosis “anxiety” and “anguish.” The “body location” item becomes mandatory when the “anatomical location” archetype slot is performed; thus, it can be documented during registration as an item which does not apply to certain diagnostic statements, for which (if pertinent) it is possible to insert the space location in text form.

Similarly, the “device name” item becomes mandatory in the nursing intervention archetype when making a slot with the “medical device” archetype. This is an interesting question in interventions that can be qualified by terms of the “means” axis, such as pulse oximeter, cardiac monitor, and nebulizer. It was also decided to structure this information in text form because nursing practice involves several types of intervention, understanding that a medium does not only refer to the devices and materials used in nursing practice,

The screenshot shows a web-based terminology interface. At the top, there are tabs: Header, Definition, Terminology (selected), Display, Interface, and Description. Below the tabs, there are sub-tabs: Terms, Bindings (selected), Constraints, and Languages_Terminologies. A dropdown menu for 'Terminology' is set to 'SNOMED International Clinical Terms, 2002'. Below this, there is a 'Node' section with a dropdown set to 'Complex'. A table below shows a list of nodes with columns for 'Node', 'Code', and 'Release'. The first row shows 'Nursing diagnosis' with code '86644006'.

Node	Code	Release
Nursing diagnosis	86644006	

Fig. 4 Terminological connection linking the “nursing diagnosis” node to systematized nomenclature of medicine-clinical terms.

Table 2 Title/header metadata of the nursing intervention archetype

Metadata	Description
Purpose	Record all data of a nursing action
Use	Registration of a single nursing action. The term “action” was used to include data collection and evaluation actions considered relevant in nursing practice and also included in the nursing records.
Misuse	It should not be used to record nursing interventions performed; use the “action” subclass archetype for this purpose.
References	International Organization for Standardization. ISO 18104:2014. Health informatics - Categorical structures for representation of nursing diagnoses and nursing actions in terminological systems ISO 18104:2014. 2 ed. Switzerland: ISO, 2014. ¹⁴ Conselho Internacional de Enfermeiros. Classificação Internacional para a Prática de Enfermagem – CIPE®: versão 2015. Tradução Telma Ribeiro Garcia. In: GARCIA, Telma Ribeiro (Org.). Classificação Internacional para a Prática de Enfermagem CIPE®: versão 2015. Porto Alegre: Artmed, 2016. 41–239. ²⁰

but can also inform a care provider or a therapy (for example).

The most generic nursing interventions would have a smaller amount of information to be filled in the EHR, such as “remove dressing,” in which only the fields related to the action and the target would be filled in; in this case, “remove” represents the term “action,” while “bandage/dressing,” despite being a mean, represents the target of this intervention. On the other hand, more specific nursing interventions, such as “removing the left leg bandage in the morning,” would have a greater number of fields filled in.

A challenge in developing archetypes is the decision on the depth of data to be recorded. This can influence the way in which the records accurately represent the phenomena of patients, interfering in the decisions of health professionals.²⁵ The maximum representation of a concept in an archetype enables choosing what information will be kept when it is restricted at the template level. This collaborates so that the structured models correspond to the needs of each service, considering specific contexts.

The results of this study also contribute to extracting and retrieving information. The use of the openEHR archetypes

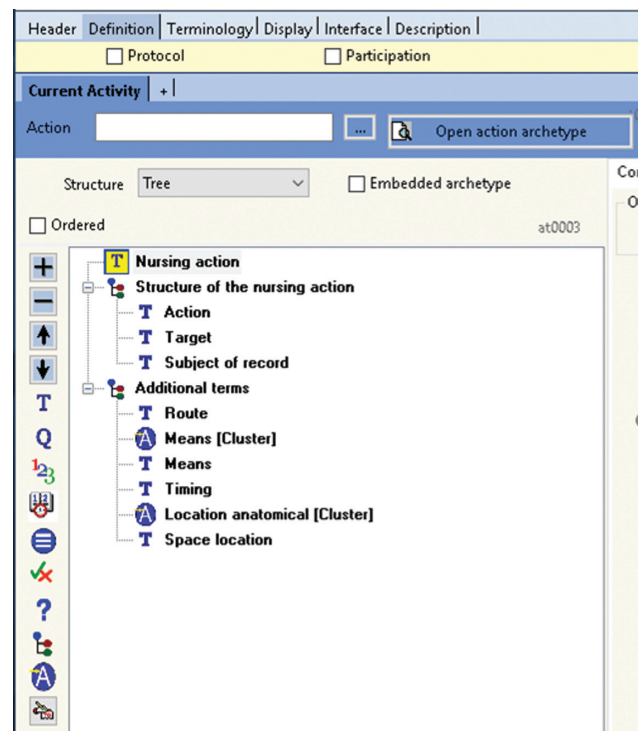


Fig. 5 Generic archetype for nursing intervention.

and Natural Language Processing (NLP) is a viable approach for extracting and representing EHR information. NLP techniques can be used in conjunction with openEHR for reusing and exchanging unstructured data,²⁶ thus enabling more detailed secondary analysis.

Conclusion

The represented models can be reused in EHR to document nursing diagnosis and interventions in different contexts of action, ranging from generic to more specific statements.

The representation of nursing diagnosis and interventions based on the openEHR standard contributes to representing specific nursing care phenomena and needs in health care information systems.

We intend to submit these archetypes to the openEHR foundation as future work for analysis and review.

Clinical Relevance Statement

The implications of this study are related to representing nursing phenomena in information systems, contributing to

documenting the nursing process and to teaching related to the nursing process and nursing informatics.

Information systems which already use archetypes can benefit from the concepts defined in this study by incorporating these archetypes in their base. With this, they will implement the definitions of nursing diagnoses and interventions, maintaining all the benefits of using the openEHR standard to achieve the semantic level of interoperability.

Multiple Choice Questions

- How should a nursing diagnosis be expressed?
 - A focus and a location
 - A focus and a judgment, or by a clinical finding
 - A subject of information and a clinical course
 - Only by a clinical finding

Correct Answer: The correct answer is option b. According to the model ISO 18104, a nursing diagnosis can be expressed by a focus, which comprises the activity area that is relevant to nursing (such as temperature), and a judgment that consists of the clinical opinion about the focus (i.e., increased), or by a clinical finding which contemplates situations in which judgment is implicit in the focus (such as pain). A location (i.e., right leg) can be added to the focus.

- How should a nursing action be represented?
 - A term for focus
 - A term for action and a term for location
 - A term for action and at least a term for the target
 - A term for the target and a term for the information subject

Correct Answer: The correct answer is option c. According to the model ISO 18104, a nursing action must consist of a term for action (i.e., remove), and at least a term for the target (such as wound coverage). The latter refers to the entity, which is affected by the action.

- In which openEHR entry classes should nursing diagnosis and interventions be represented?
 - Observation and evaluation
 - Instruction and action
 - Evaluation and instruction
 - All entry class

Correct Answer: The correct answer is option c. The openEHR entry classes are observation, evaluation, instruction, and action. The observations comprise recording measurable or observed data, such as blood pressure or body temperature; evaluations are the record of clinical assessments, such as the assessment of health risk or adverse reaction risk; instructions consist of recording the start of a work process such as a service request or medication order; and actions comprise performed clinical activities, such as procedures and medication management.

Protection of Human and Animal Subjects
None.

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Conflict of Interest

None declared.

References

- Gonçalves-Ferreira D, Sousa M, Bacelar-Silva GM, et al. OpenEHR and general data protection regulation: evaluation of principles and requirements. *JMIR Med Inform* 2019;7(01):e9845
- Min L, Tian Q, Lu X, Duan H. Modeling EHR with the openEHR approach: an exploratory study in China. *BMC Med Inform Decis Mak* 2018;18(01):75
- OpenEHR. Architecture overview. 2020. Accessed September 2, 2020 at: https://specifications.openehr.org/releases/BASE/latest/architecture_overview.html#Beale2002
- Leslie H. openEHR archetype use and reuse within multilingual clinical data sets: case study. *J Med Internet Res* 2020;22(11):e23361
- Beale T, Heard S. OpenEHR architecture overview. OpenEHR Foundation, 2008. Accessed September 2, 2020 at: <http://www.openehr.org/releases/1.0.2/architecture/overview.pdf>
- Bacelar G, Correia R. As bases do openEHR. Versão 1.0. 1 ed. 2015Porto, Portugal. Accessed September 10, 2020 at: <https://www.medicina.ufmg.br/cins/wp-content/uploads/sites/4/2015/10/ebook-openEHR-UFGM-v1.2.pdf>
- Sundvall E, Nyström M, Karlsson D, Eneling M, Chen R, Öрман H. Applying representational state transfer (REST) architecture to archetype-based electronic health record systems. *BMC Med Inform Decis Mak* 2013;13(01):57
- Wang L, Min L, Wang R, Lu X, Duan H. Archetype relational mapping - a practical openEHR persistence solution. *BMC Med Inform Decis Mak* 2015;15(01):88
- Beštek M, Stanimirović D. Special topic interoperability and EHR: combining openEHR, SNOMED, IHE, and Continua as approaches to interoperability on national eHealth. *Appl Clin Inform* 2017;8(03):810–825
- S Rubí JN, L Gondim PR. IoMT platform for pervasive healthcare data aggregation, processing, and sharing based on OneM2M and OpenEHR. *Sensors (Basel)* 2019;19(19):4283
- Santos MR, Bax MP, Kalra D. Dealing with the archetypes development process for a regional EHR system. *Appl Clin Inform* 2012;3(03):258–275
- Spigolon DN, Moro CMC. [Essential data set's archetypes for nursing care of endometriosis patients]. *Rev Gaúcha Enferm* 2012;33(04):22–32
- Nogueira JRM, Cook TW, Cavallini LT. Mapping a nursing terminology subset to openEHR archetypes. A case study of the international classification for nursing practice. *Methods Inf Med* 2015;54(03):271–275
- International Organization for Standardization. ISO 18104:2014. Health informatics - Categorial structures for representation of nursing diagnoses and nursing actions in terminological systems ISO 18104:2014 2nd ed. Switzerland: ISO; 2014
- Conselho Federal de Enfermagem. Resolução nº 358/2009. Dispõe sobre a Sistematização da Assistência de Enfermagem e a implementação do Processo de Enfermagem. 2009. Accessed September 4, 2020 at: http://www.cofen.gov.br/resolucao-cofen-3582009_4384.html
- Organisation for Economic Co-operation and Development. Basic definitions and conventions. In: Organisation for Economic Co-operation and Development. *Frascati Manual: The Measurement of Scientific and Technical Activities*. France1980:25–37

- 17 Cardoso de Moraes JL, de Souza WL, Pires LF, do Prado AF. A methodology based on openEHR archetypes and software agents for developing e-health applications reusing legacy systems. *Comput Methods Programs Biomed* 2016;134:267–287
- 18 OpenEHR. Archetype definition language 2 (ADL2). Archetype slots Accessed September 18, 2020 at: https://specifications.openehr.org/releases/AM/latest/ADL2.html#latest_issue
- 19 Abreu N, Sousa P. Nursing diagnosis an essay of an archetype that expresses the clinical concept. Paper presented at: Conference ACENDIO - E-Health and Nursing – Knowledge for Patient Care; April, 2015. Accessed 2015 at: https://www.researchgate.net/publication/276179629_Nursing_diagnosis_an_essay_of_na_archetype_that_expresses_the_clinical_conceptBern, Switzerland
- 20 Internacional de Enfermeiros C. Classificação Internacional para a Prática de Enfermagem – CIPE®: versão 2015. In: Garcia TR (org.) Classificação Internacional para a Prática de Enfermagem CIPE®: versão 2015. Porto Alegre: Artmed; 2016:41–239
- 21 OpenEHR. OpenEHR. Clinical Knowledge Manager. 2019. Accessed September 4, 2020 at: <http://www.openehr.org/ckm/>
- 22 Hovenga E, Garde S, Heard S. Nursing constraint models for electronic health records: a vision for domain knowledge governance. *Int J Med Inform* 2005;74(11-12):886–898
- 23 Zubke M, Bott OJ, Marschollek M. Using openEHR archetypes for automated extraction of numerical information from clinical narratives. *Stud Health Technol Inform* 2019;267(267):156–163
- 24 Sousa P. [Information Systems in Nursing: new challenges, new opportunities...]. *Rev Esc Enferm USP* 2012;46(05):1035–1040
- 25 Wei PC, Atalag K, Day K. An openEHR approach to detailed clinical model development: tobacco smoking summary archetype as a case study. *Appl Clin Inform* 2019;10(02):219–228
- 26 Wulff A, Mast M, Hassler M, Montag S, Marschollek M, Jack T. Designing an openEHR-based pipeline for extracting and standardizing unstructured clinical data using natural language processing. *Methods Inf Med* 2020;59(S 02):e64–e78