Information Modelling in Evidence-Based Health Care

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Information Modelling Methods in EBHC

Agenda

I. **Introduction & Motivation**
   - Evidence-Based Health Care
   - Formal Models in Informatics

II. **Example – Modelling Febrile Seizures**

III. **Conclusions, Challenges, Future Work**

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Evidence-Based Health Care

"***...an ability to assess the validity and importance of evidence before applying it to day-to-day clinical problems***" [*]

"...the concept of evidence-based medicine should be broadened to evidence-based practice to reflect the benefits of entire health care teams and organizations adopting a shared evidence-based approach" [**]

Process of Evidence-Based Practice:

- Translation of uncertainty to an answerable question.
- Systematic retrieval of best evidence available.
- Critical appraisal of evidence for validity, clinical relevance, and applicability.
- Application of results in practice.
- Evaluation of performance.

Currently, EBHC methods are mainly based on collecting the information about "best practices" in the given field, evaluating, generalizing and sharing it.
Our aim is to ***enrich the EBHC practices with the power of modelling techniques from informatics***, particularly the conceptual modelling with "object life cycles"

[*] Oxman AD, Sackett DL, Guyatt GH: Users' guides to the medical literature. I. How to get started. The Evidence-Based Medicine Working Group. JAMA 1993, ISBN: 270:2093-2095.
[**] Dawes, M. et al.: Sicily statement on evidence-based practice, BMC Medical Education 5 / 2005.

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Formal Models in Informatics

Conceptual Modelling (mid-70ties)
the description of the modality of the Real World by identifying the essential real world objects, expressed with concepts, and their essential relationships.

- Entity Relationships Diagram (original diagram by Peter Chen).
- UML Class Diagram (current widely accepted standard since mid-nineties).

Particular object classes in the conceptual model represent concepts which identify possible real world objects from the given domain. Relationships among object classes then identify possible links among real objects in the domain.

Ontology Engineering (late 90ties)
a successor of conceptual modelling focused on the identity of real world objects and the ways of ensuring it across different models with use of Internet technologies known as linked data approach. Reduced mainly to essential classification of concepts - just a part of the needed description of the modality of the real world domain.

- Various languages and graphical tools for ontology description.

OntoUML (2005)
reintegration of ontology engineering with its natural predecessor conceptual modelling.

- Extension of UML Class Diagram with special stereotypes and additional rules for the purpose of modelling ontologies.

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Motivation

Currently, EBHC methods are mainly based on collecting the information about “best practices” in the given field, evaluating, generalizing and sharing it.
Our aim is to ***enrich the EBHC practices with the power of modelling techniques from informatics***, particularly the *conceptual modelling* with “*object life cycles*”.

Conceptual model brings to the basic EBHC facts an additional information about general logical relationships among objects which increases the knowledge about them with basic options of their possible combinations (i.e. modality of the domain).

Life cycle model captures the basic logic of object’s dynamics, possible time sequences of events related to the given object (i.e. casusality of the domain).

Ontology modelling has a long tradition in the field of medicine. Some medical standards are even directly based on ontological models (SNOMED), which gives them a great power for development. Nevertheless, existing medical ontologies use standard ontological languages, i.e. are focused on the classification of concepts and usually marginalize relationships among them.

Existing methods for *modelling dynamics* in medicine are usually mathematical and focused mainly on epidemiology and modelling the dynamics of infectious diseases. There are also some publications about modelling the disease development with algorithmic-like models, but none of them in connection with the contextual conceptual model.

There are also potential additional contributions to the EBHC practice as well as its background theory, following from the use of modal and causal informatics-based models.

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Febrile Seizures

Febrile seizures are defined as **seizures occurring in association with a febrile illness in children between the ages of six months and five years.**
It is important to differentiate febrile seizures with fever from complex febrile seizures secondary to central nervous system infections. Febrile seizures are relatively benign as compared to complex febrile seizures that have serious sequale, longer duration, and require further medical follow-up [*].

The motivation for practical guidelines in this field underlines also the fact that simple febrile seizures are relatively prevalent conditions that often causing **avoidable anxiety to the children and their parents** [**].

* Sadleir, L., Scheffer, I.: Febrile seizures.in British Medical Journal, 334, 2007, pp. 307-311.
** Joanna Briggs Institute: Management of the child with fever. Best Practice, Evidence-Based Practice Information Sheets for Health Professionals, Volume 5, Issue 5, 2001.

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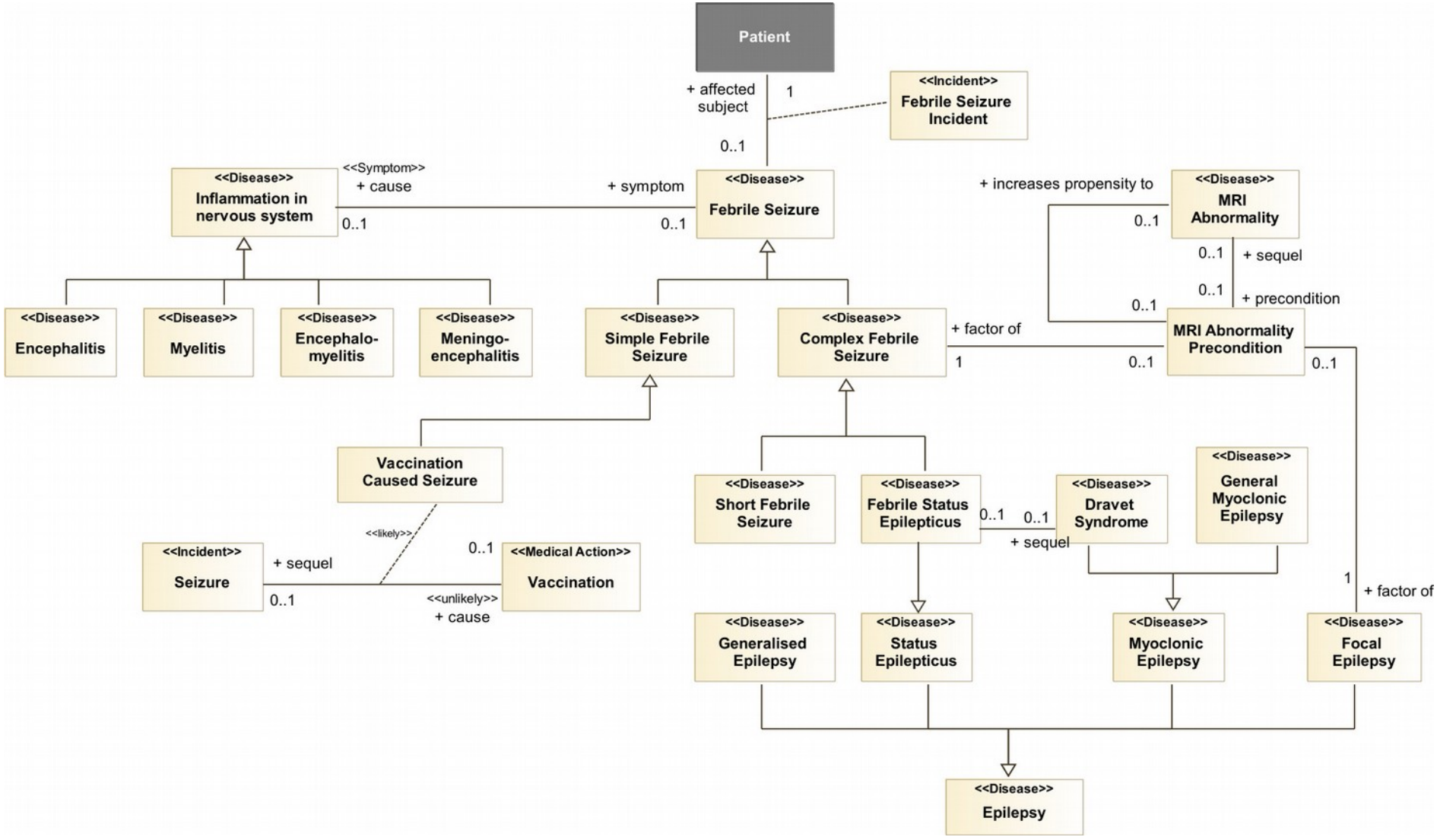
Febrile Seizures Conceptual Model – a fragment



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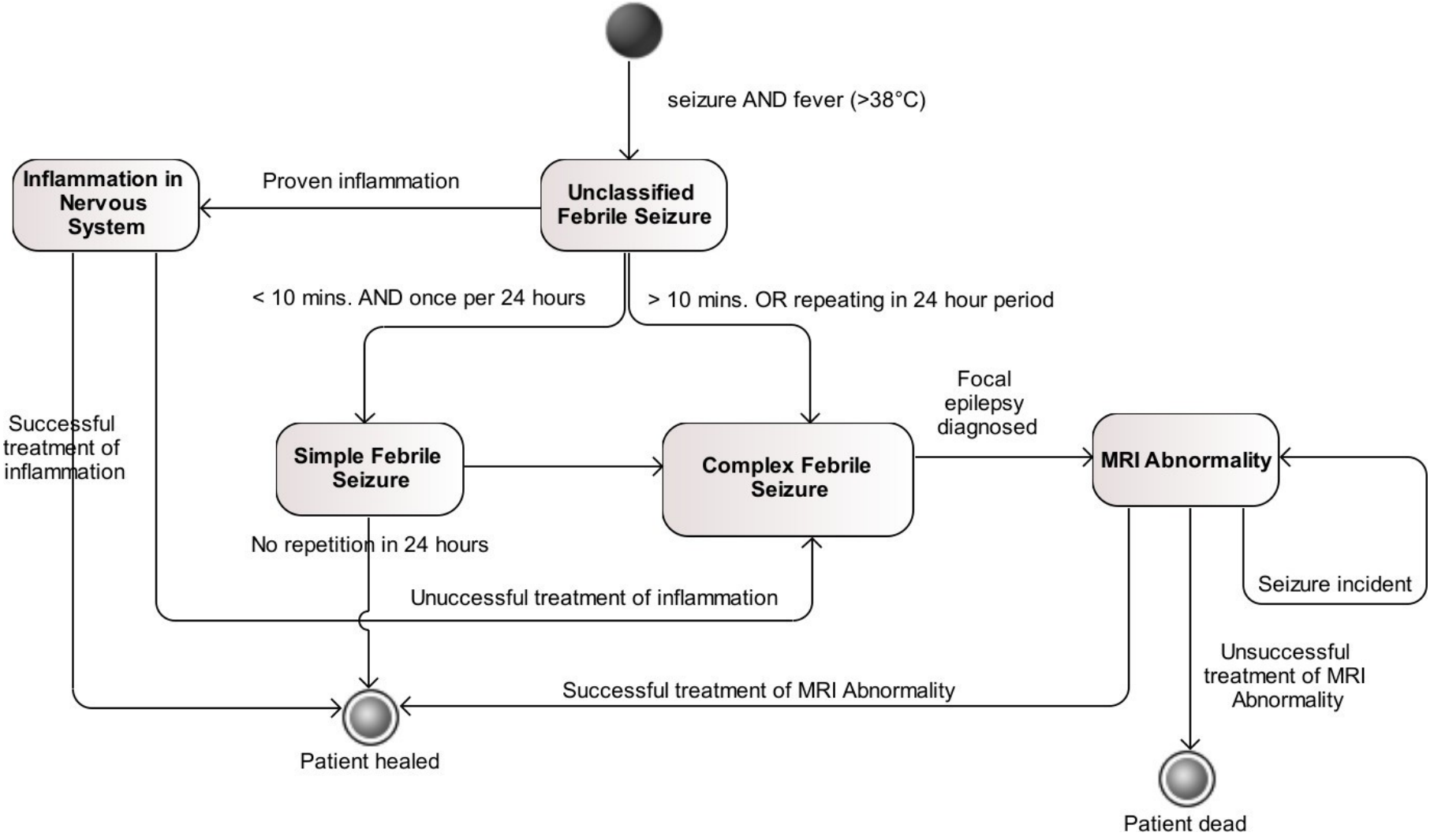
Febrile Seizure Incident Life Cycle Model



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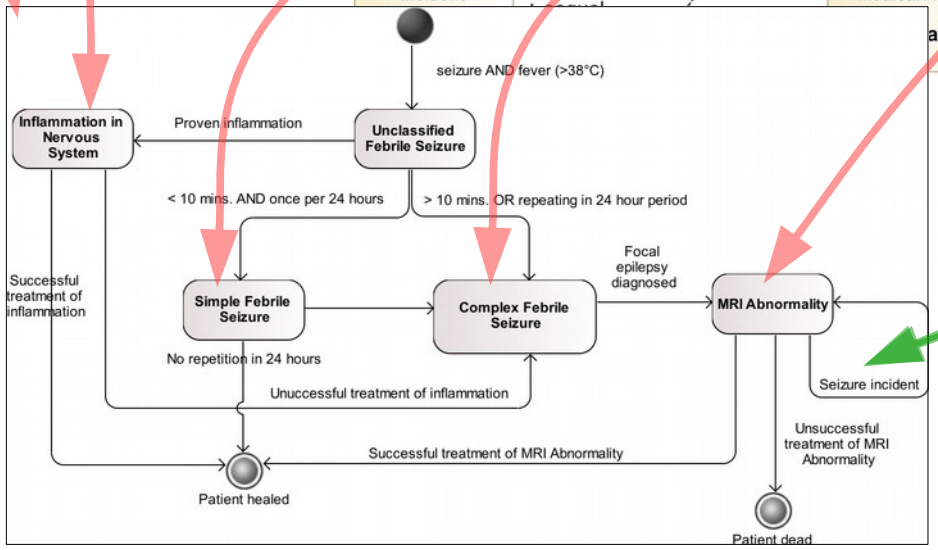
Febrile Seizure Incident Life Cycle in the conceptual context



The structure of the life cycle corresponds to the structure of HC objects and their relationships. Statechart describes the algorithm of metamorphosis of the given object (FS Incident).

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Conclusions

Goal of presented work

Enrich the EBHC practices with the power of modelling techniques from informatics, particularly the *conceptual modelling* with "*object life cycles*".

Using conceptual models with object life cycles in EBHC also generates significant ***challenges for the future development of the methodologies*** in the field:

- *Medical ontologies:*
  Conceptual model takes into the account general context of reflected concepts in terms of their essential relationships. This way it can provoke crucial decisions about ***possible / needed linking of defined ontology models*** and also consequential improving the ontologies themselves.

- *EBHC methodology:*
  MMABP technique for modelling the object life cycle includes the rules for achieving both ***completeness and correctness of the life cycle description***. According to these rules all possible state transitions, including the ***transitions which are not present in the model, should be taken into the account*** and evaluated. This practice strongly evokes many new research questions which answering can significantly move forward the current knowledge.

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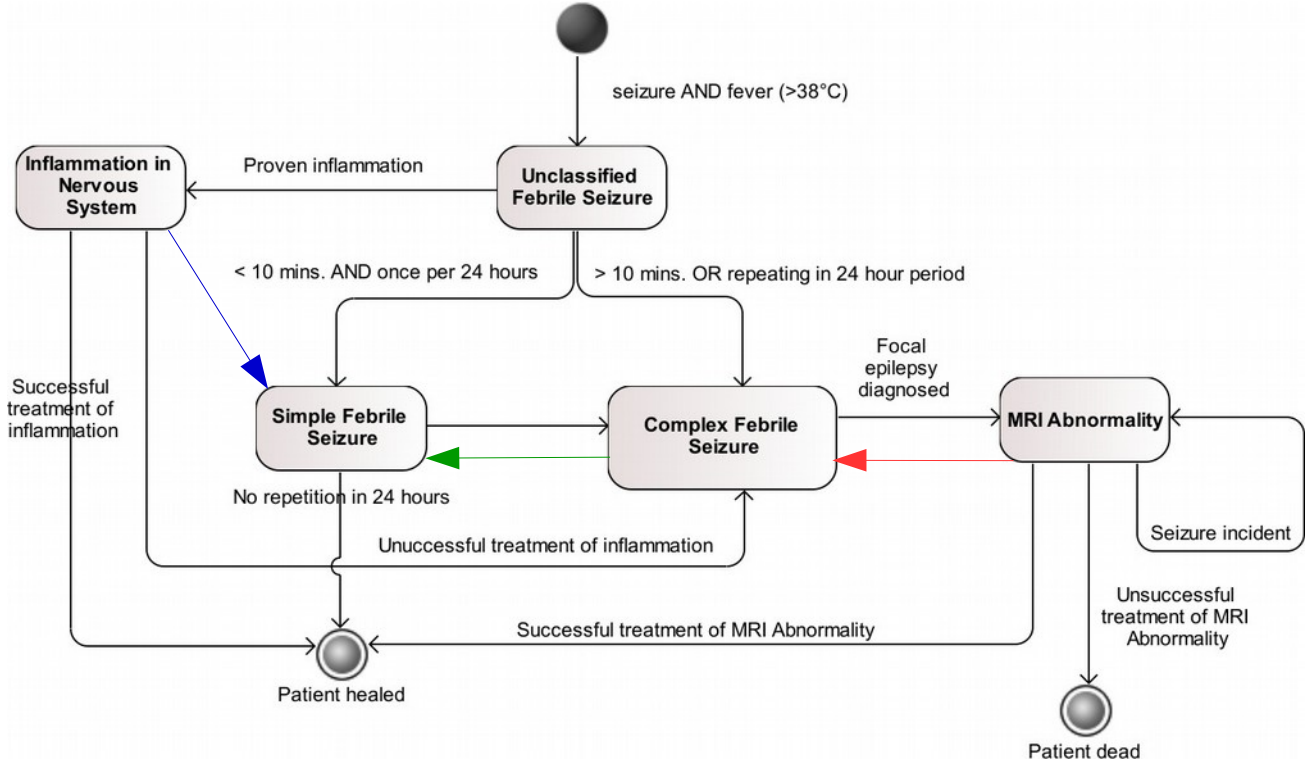
Conclusions
- example of using MMABP consistency rules -

Can MRI Abnormality cause Complex Febrile Seizure? If so, under which conditions, what is the related event, what are related medical actions?

Can Complex Febrile Seizure turn back to Simple Febrile Seizure? If so, under which conditions, what is the related event, what related medical actions should be Performed?

Can Inflammation in Nervous System cause just the Simple Febrile Seizure?



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Future Work

i. ***Evaluation*** of the approach in as broad as possible practical use and its ***consequential further development***.

ii. ***Development of supporting software tools***
as a basic prerequisite for the massive use and consequential development of the approach.

iii. ***Increase of the scope*** of modelling:

- ***Process descriptions in the field of healthcare***.
  Ontological conceptual models can be used for basic definitions of healthcare concepts and their mutual relationships, in terms of the ***modality*** of the domain, including also its ***causality*** (objects' life cycles). Nevertheless, the healthcare domain, even the field of Evidence-Based Healthcare, naturally contains also the ***process (intentional) dimension***. (see the "best practices", "recommended practices", or "practical guidelines" as an essence of the EBHC).

- ***Building the complex integrated information modelling methodology in EBHC.***
  MMABP puts the great emphasis on the consistent integration of both ontological and process models of the Real World:

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