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Capturing Provenance, Evolution and Modification of Clinical Protocols via a Heterogeneous, Semantic Social Network

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Aim

A novel approach to describe, organize, manage, trace, use and reuse clinical protocols, based on a heterogeneous semantic social network

- **The proposed approach allows**
  - **Semantic tagging**
  - **Semantic enrichment**
- **Main advantages**
  - **Tracing protocol provenance, evolution and modifications**
  - **Protocol meta-description, irrespective of protocol source format**
  - **Interlinking to related scientific sources (e.g. scientific publications, PHR, etc.) and bodies (e.g. protocol issuing bodies, hospitals, etc.)**

BACKGROUND

Formal care plans

- **Clinical guidelines**

  Systematically developed recommendations
  to address various clinical problems

- **Clinical protocols**

  Detailed algorithms on how to address
  a particular clinical problem (based on guidelines)

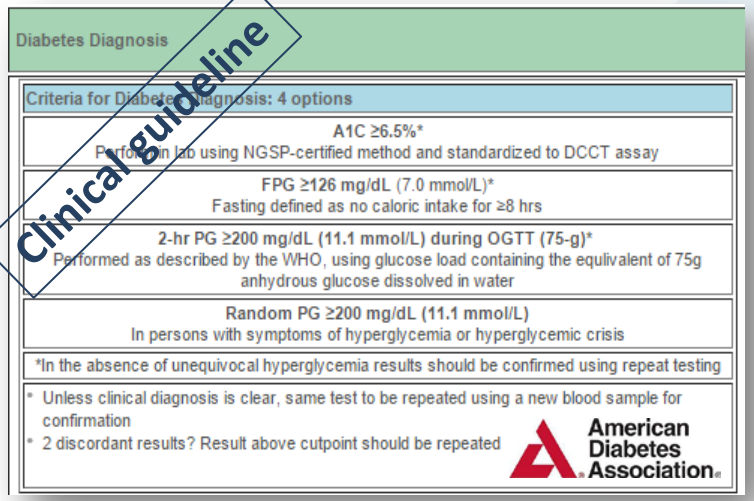
- **Care pathways**

  Care algorithms integrating multidisciplinary tasks for patient care
  in and outside the hospital (based on guidelines)

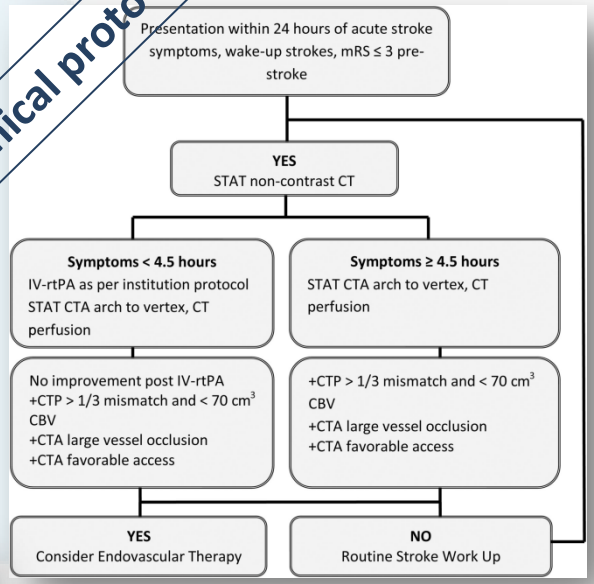
- **Other, e.g. clinical trial protocols, clinical practice guidelines, …**

Examples of formal care plans

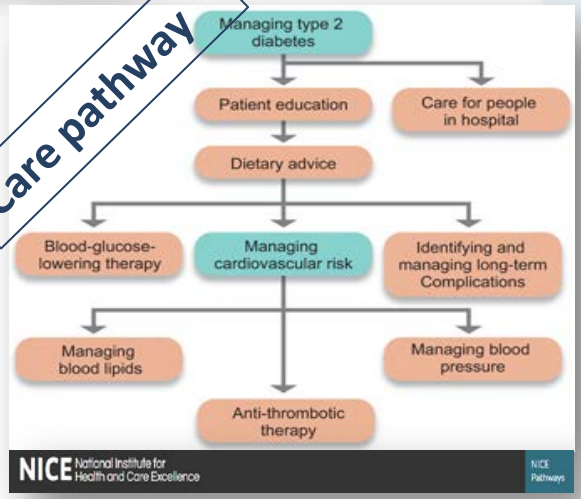
Clinical guideline



Clinical protocol



Care pathway



State of the art

- **Protocol description languages**

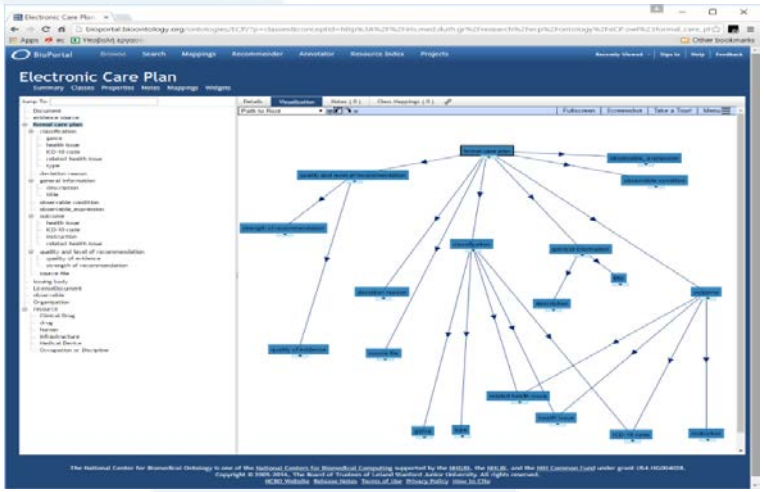
  GLIF, EON, Asbru, GUIDE, PROforma, PLAN, …
- **Protocol execution engines and management platforms**

  GLEE, SAGE, DeGeL, NewGuide, SpEM, Tallis, ArezzoTM, HeCaSe2, …

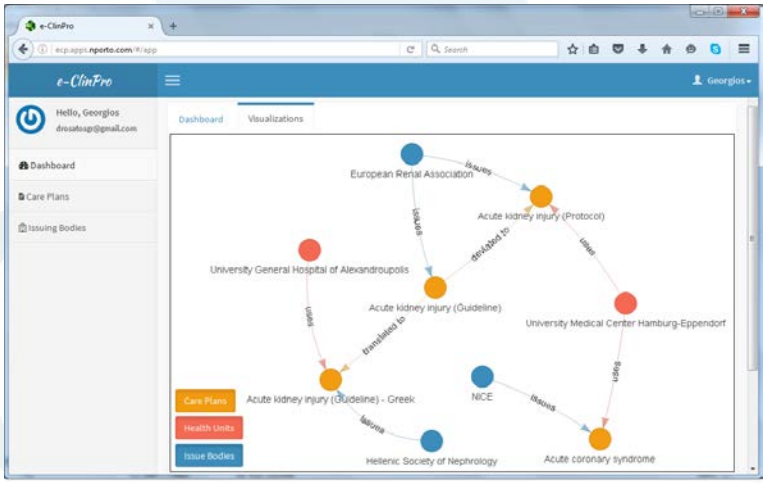
- **Current unmet needs**
  - **Choose the right protocol**
  - **Choose the right modification of a protocol (to meet local set-up)**
  - **Trace protocol use and modification history**
  - **Trace to protocol provenance, including medical evidence and issuing body**
  - **Record outcomes of protocol clinical application (e.g. for protocol evaluation)**

Our contribution

- **Formal protocol meta-description**
  - eCP ontology



- **Versatile protocol 'meta-repository'**
  - Heterogeneous social network



ECP ONTOLOGY

Kaldoudi, E., Drosatos, G., Portokallidis, N. and Third, A., 2016. **An Ontology Based Scheme for Formal Care Plan Meta-Description**. In XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016 (pp. 785-790). Springer International Publishing.

Conceptual model of care plan meta-description

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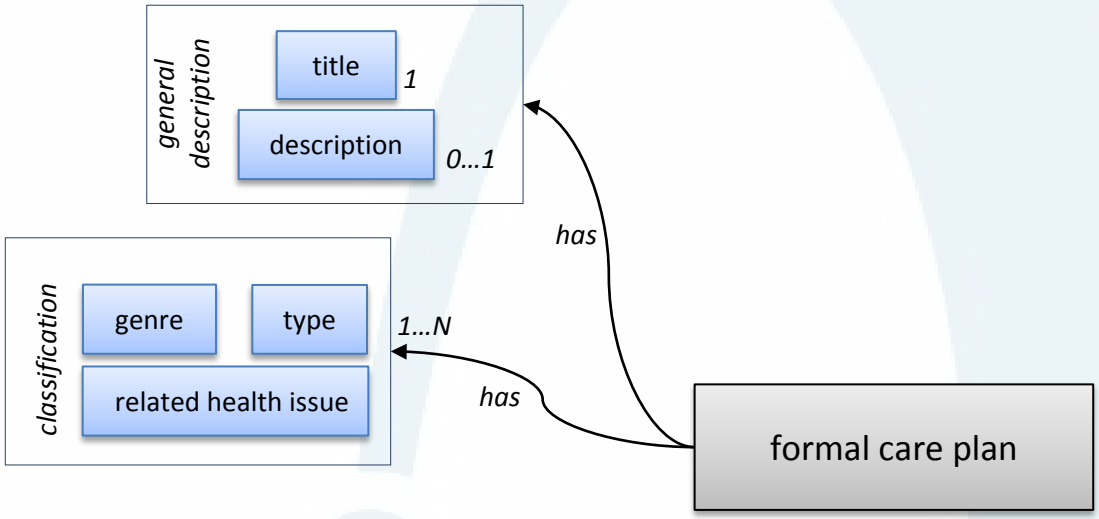
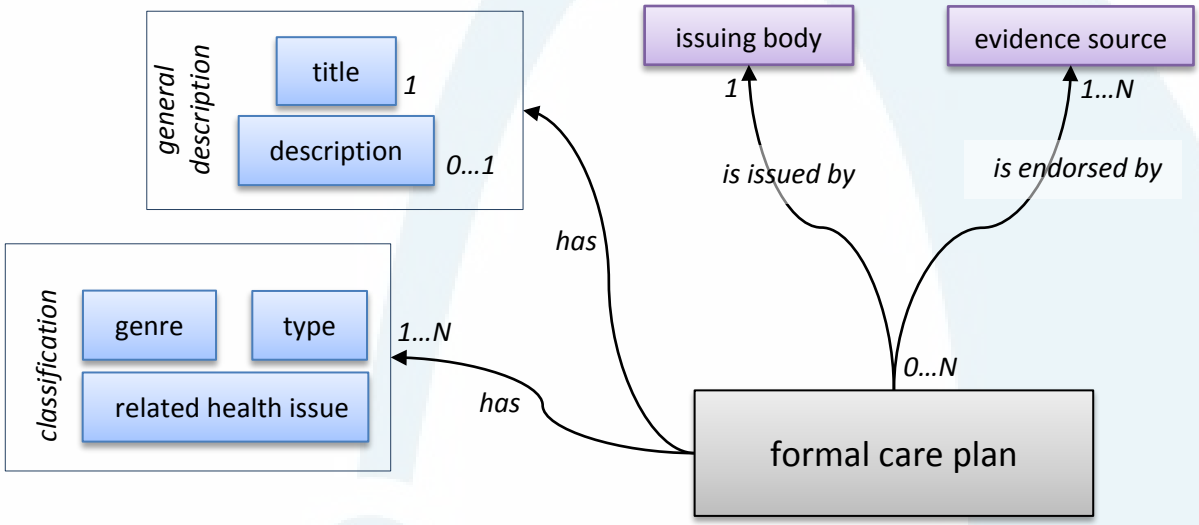
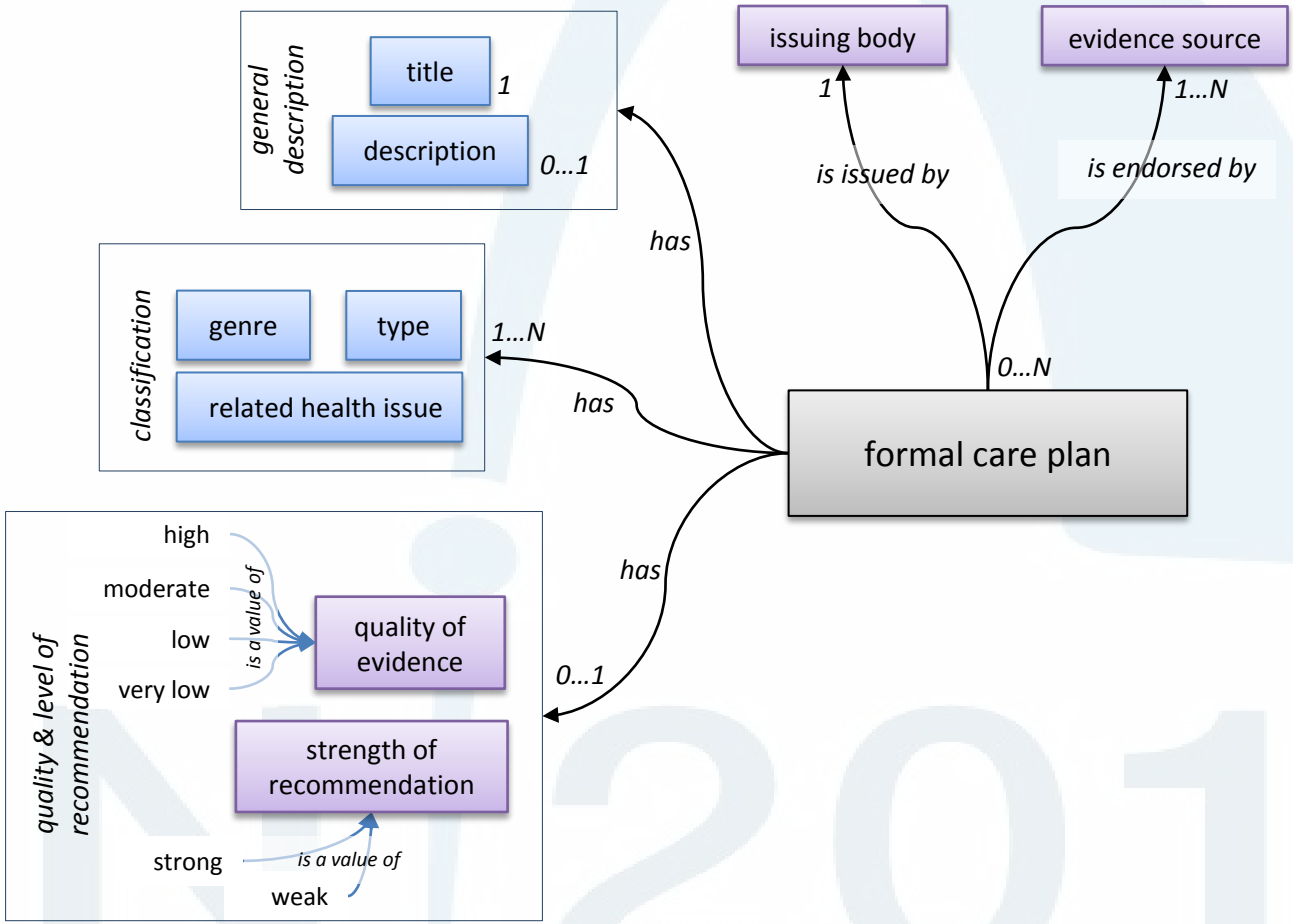


Conceptual model of care plan meta-description



Conceptual model of care plan meta-description



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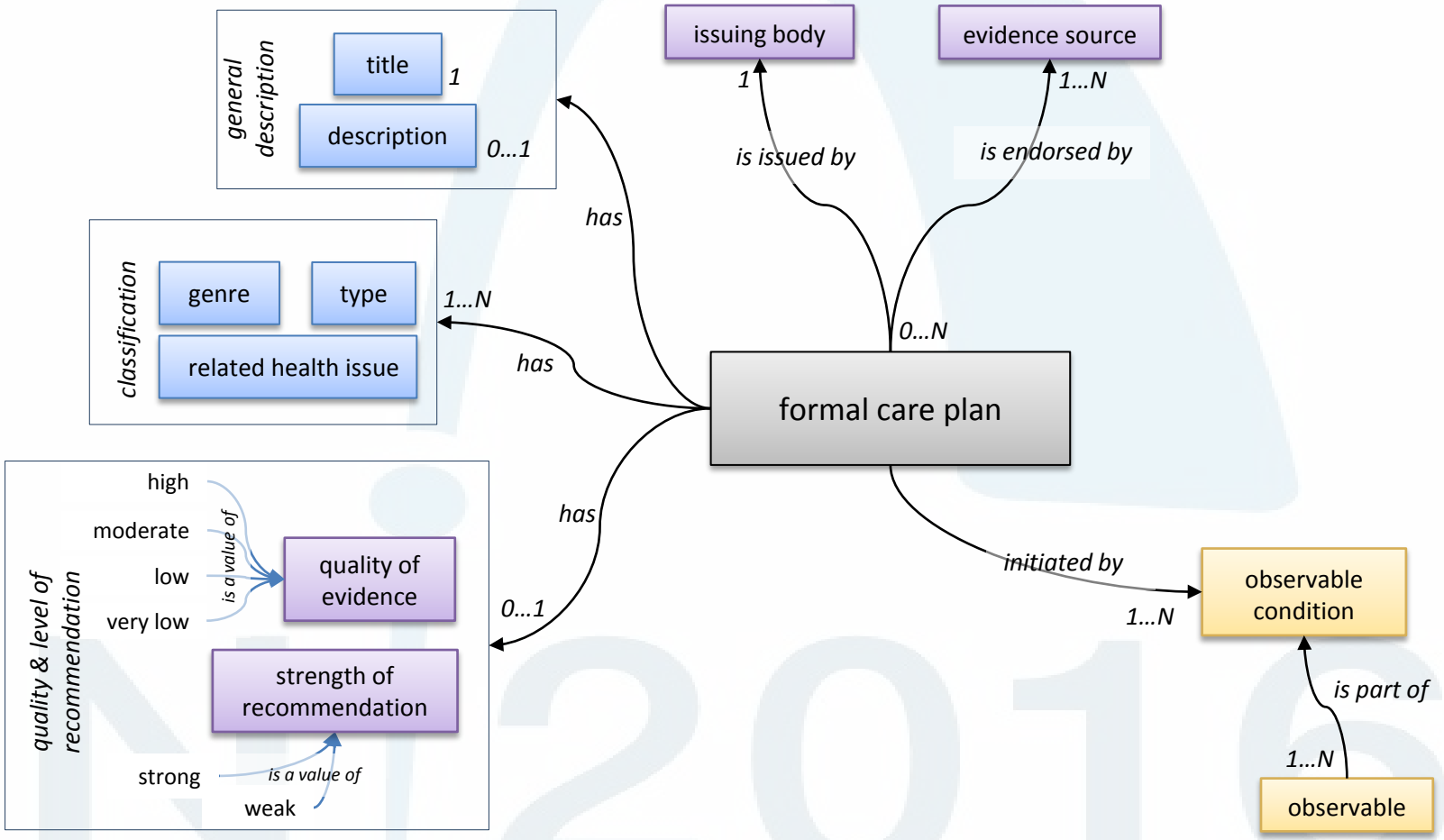

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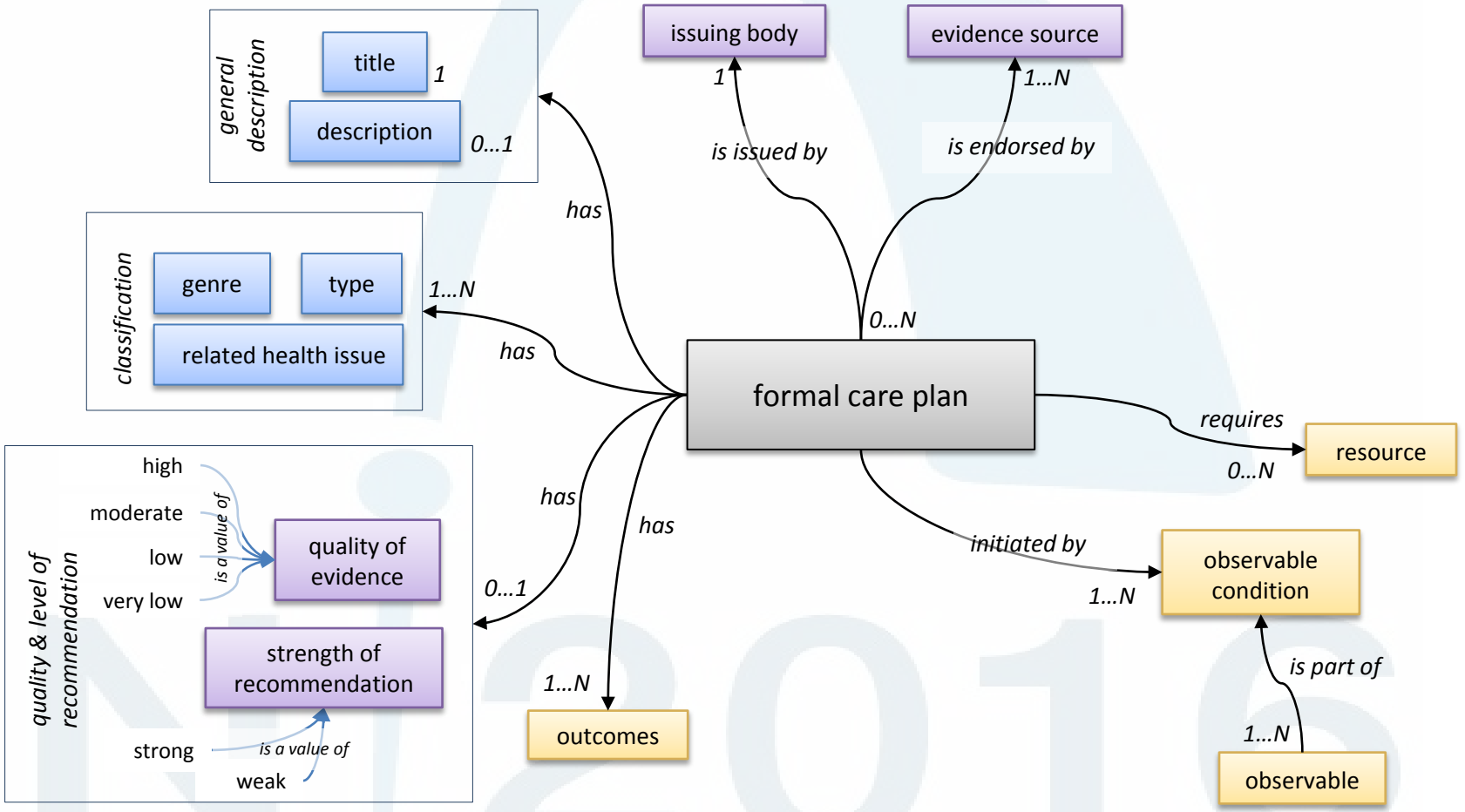
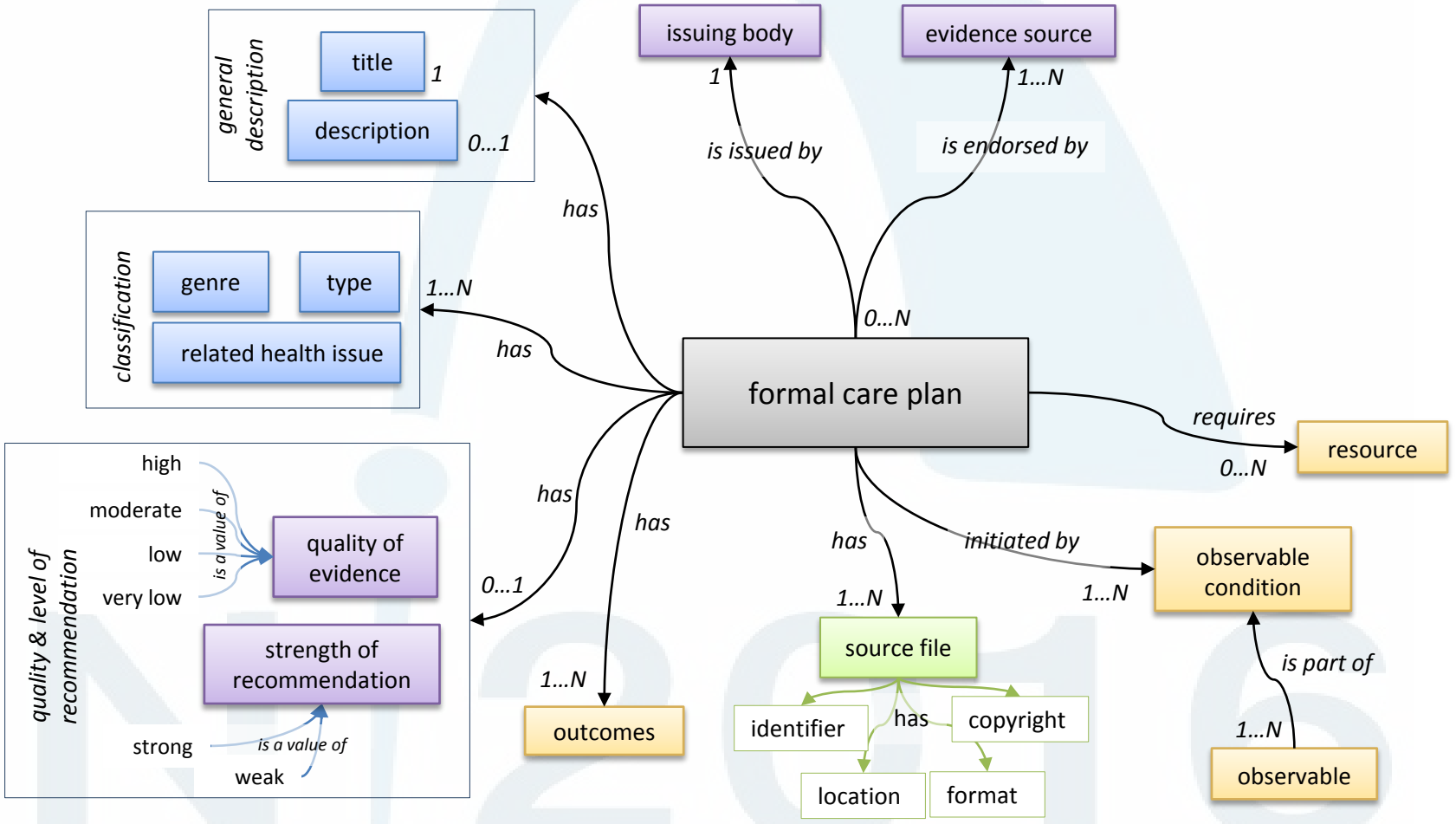
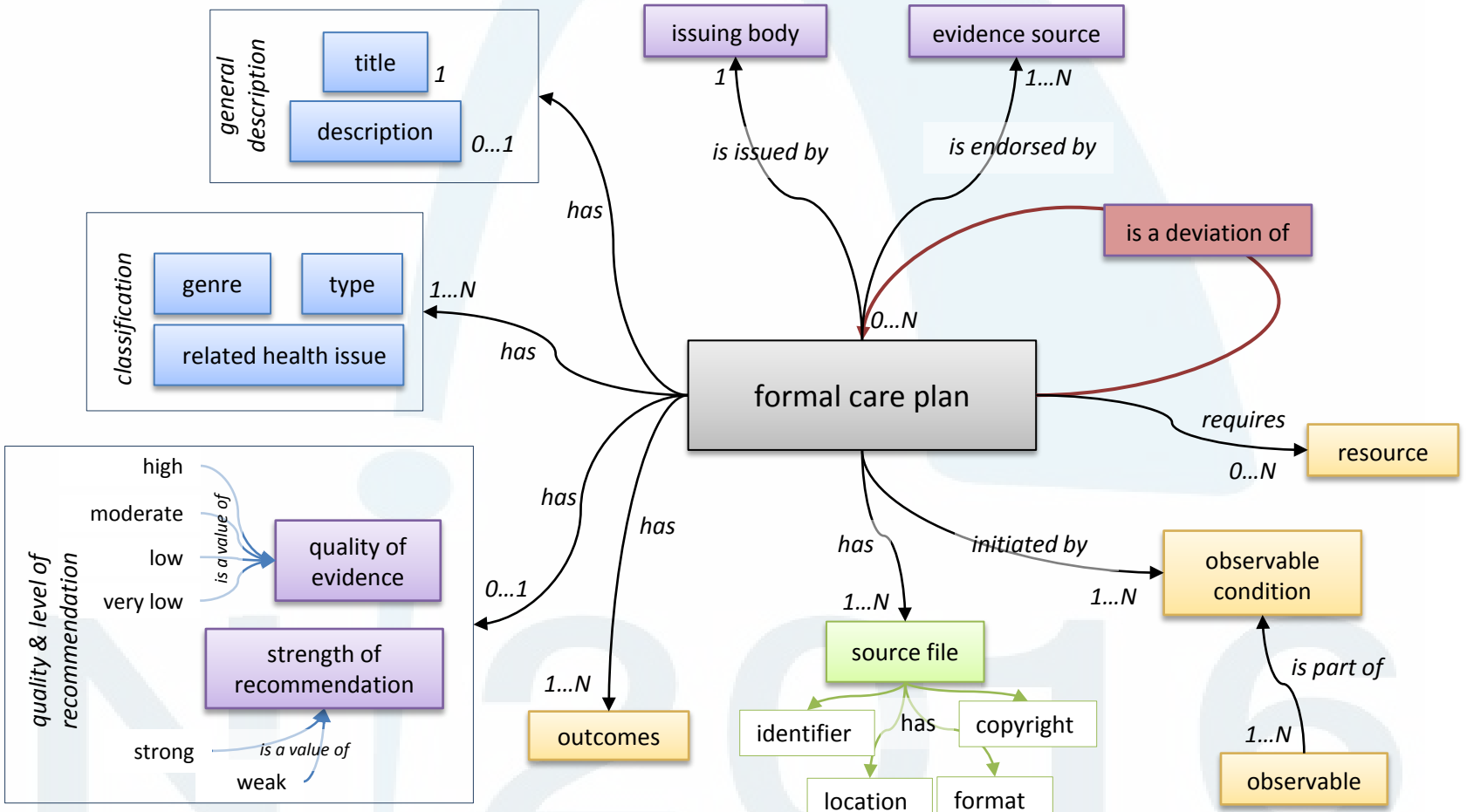


Conceptual model of care plan meta-description

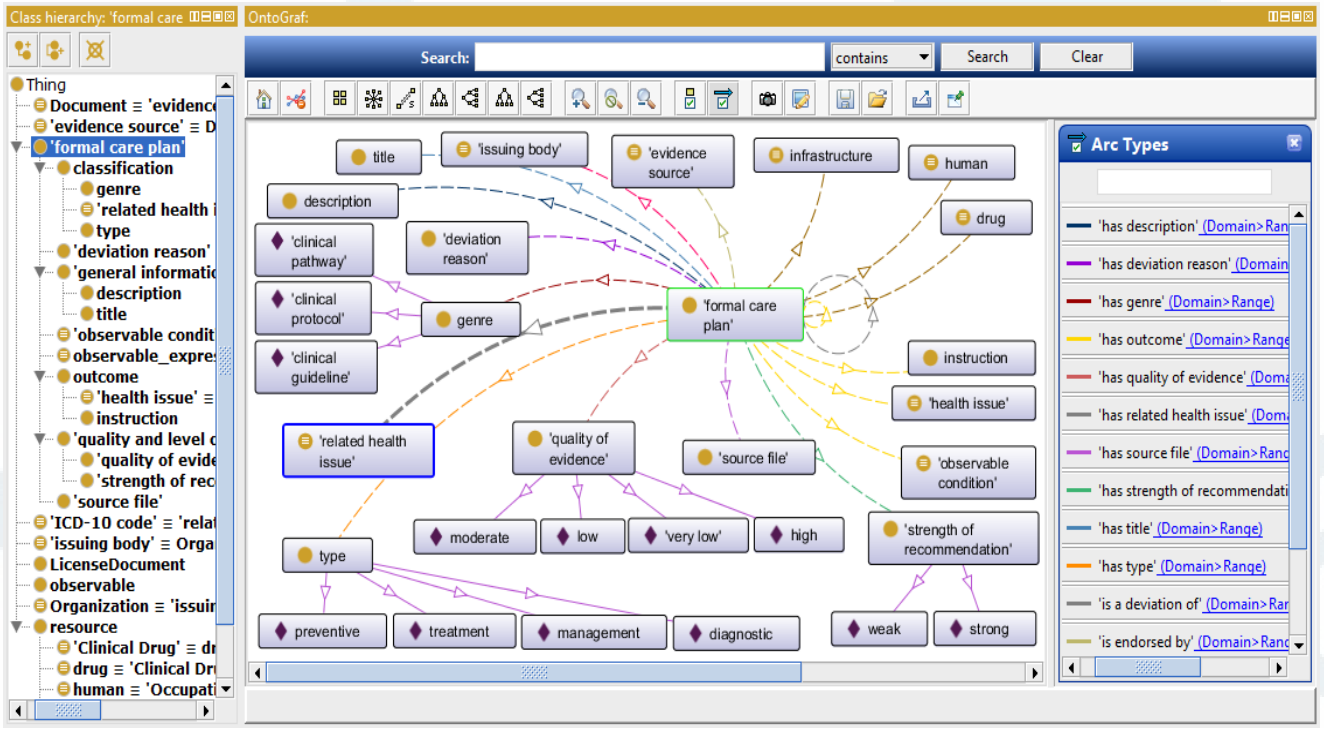


Conceptual model of care plan meta-description



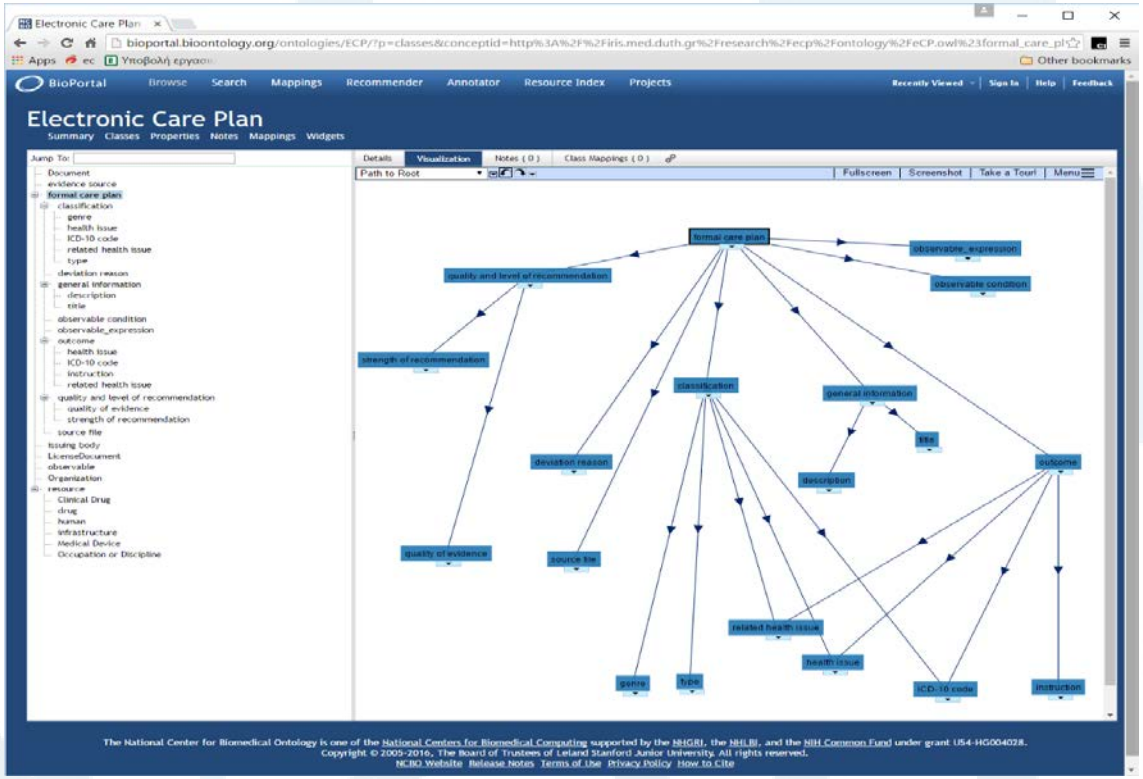
Ontology implementation

- **Implemented with OWL2 using Protégé**
- **Integrated with commonly used standards and controlled vocabularies:**
  - **ICD-10, SNOMED-CT, QUDT, UO, GRADE and UMLS**



Ontology implementation

Available online in: http://purl.bioontology.org/ontology/ECP



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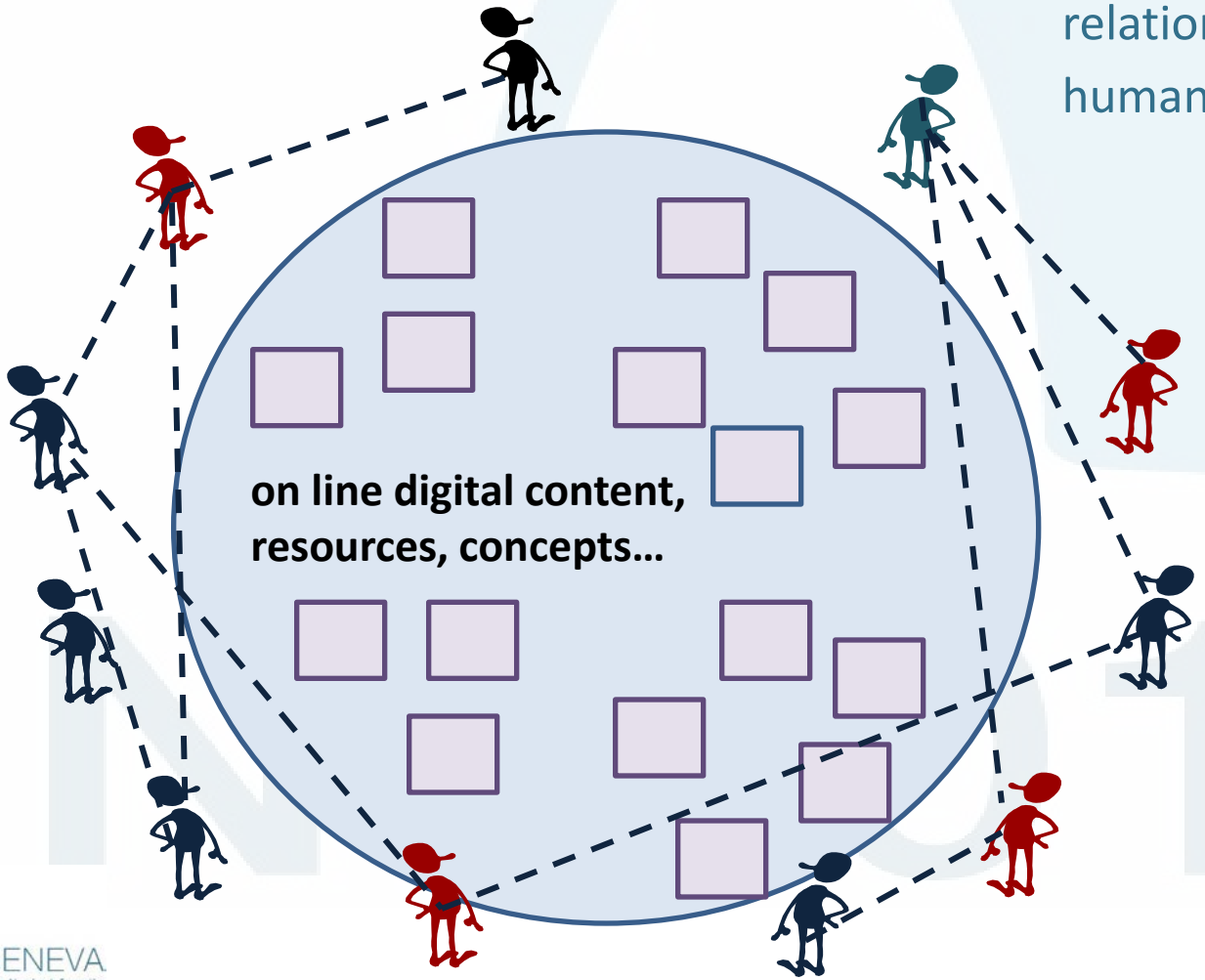
E-CLINPRO: CLINICAL PROTOCOL MANAGEMENT SYSTEM

Social networks

Connections and relationships among humans



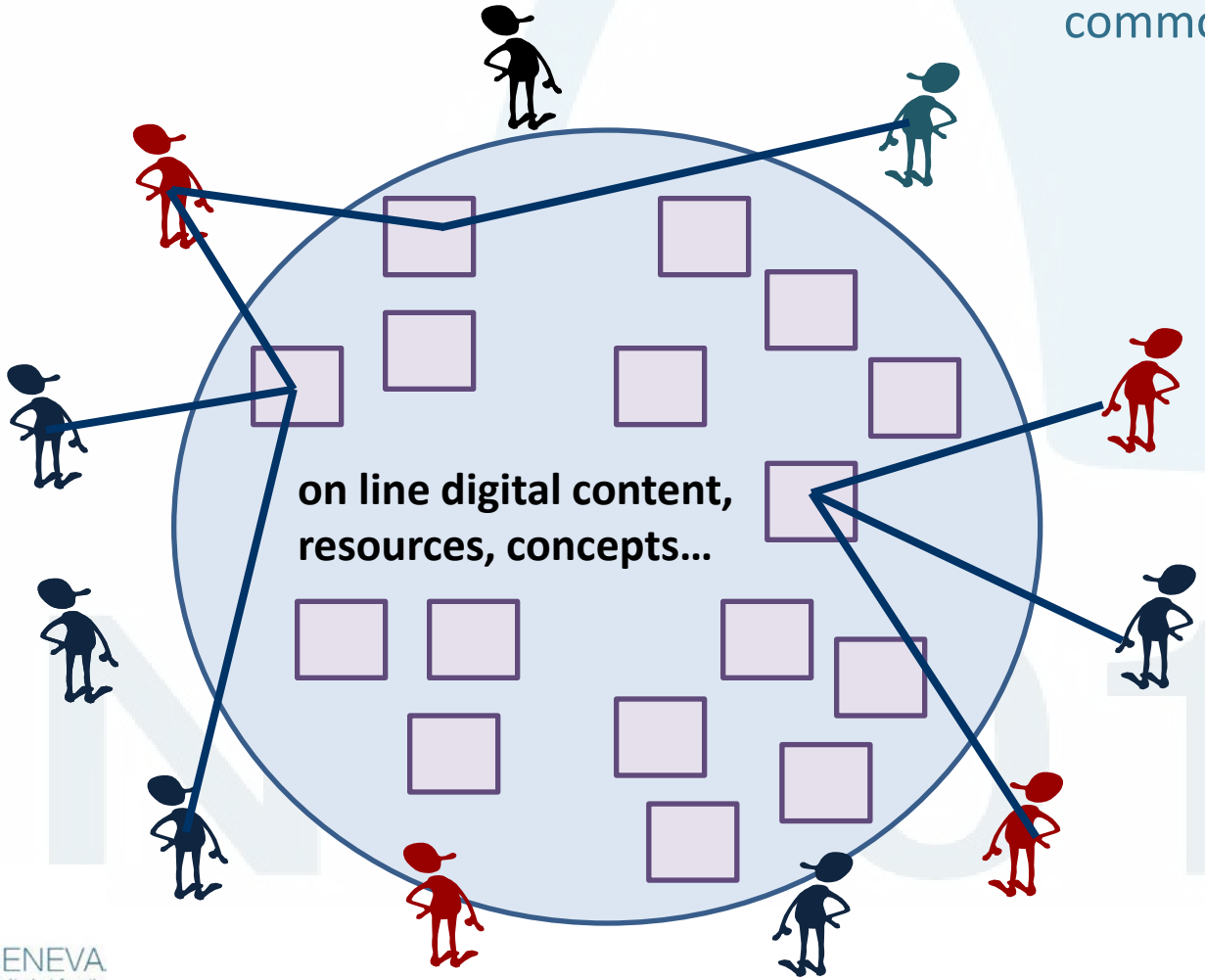
Facebook

LinkedIn

CarePages

Object centered social networks

People interacting on a common social object

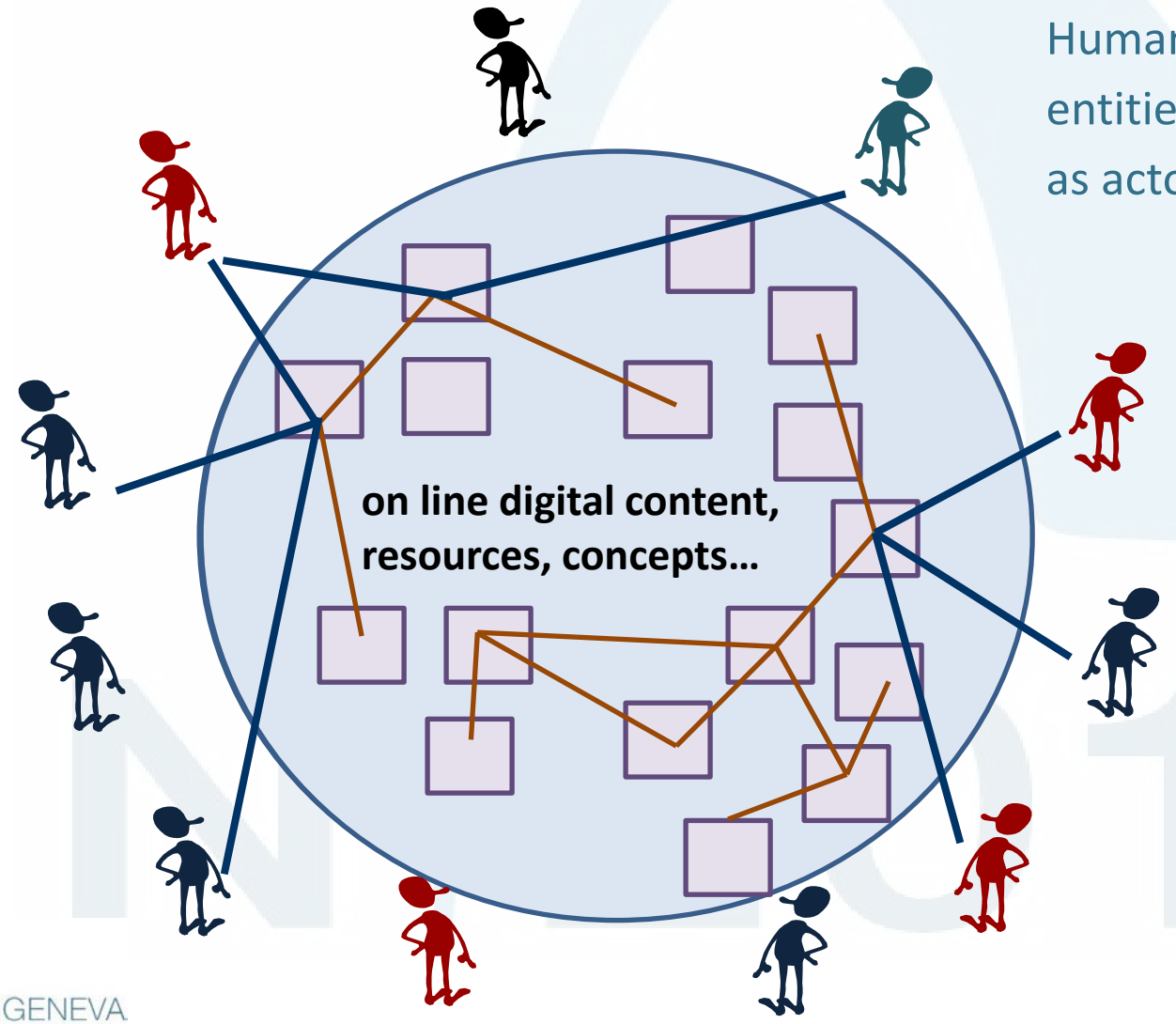


ResearchGate

Academia

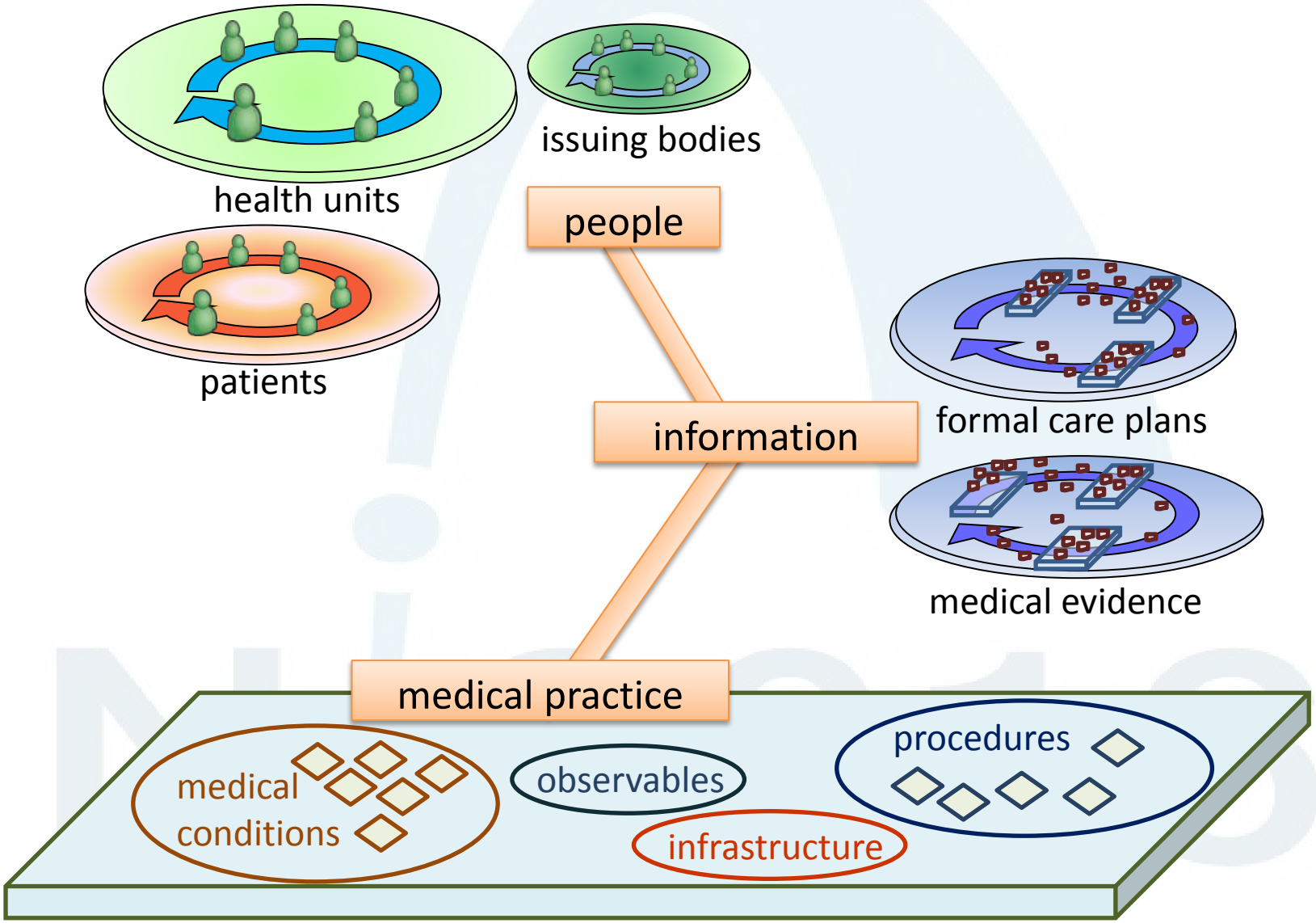
PatientsLikeMe

Heterogeneous social networks



Human and non-human entities are all treated alike, as actors

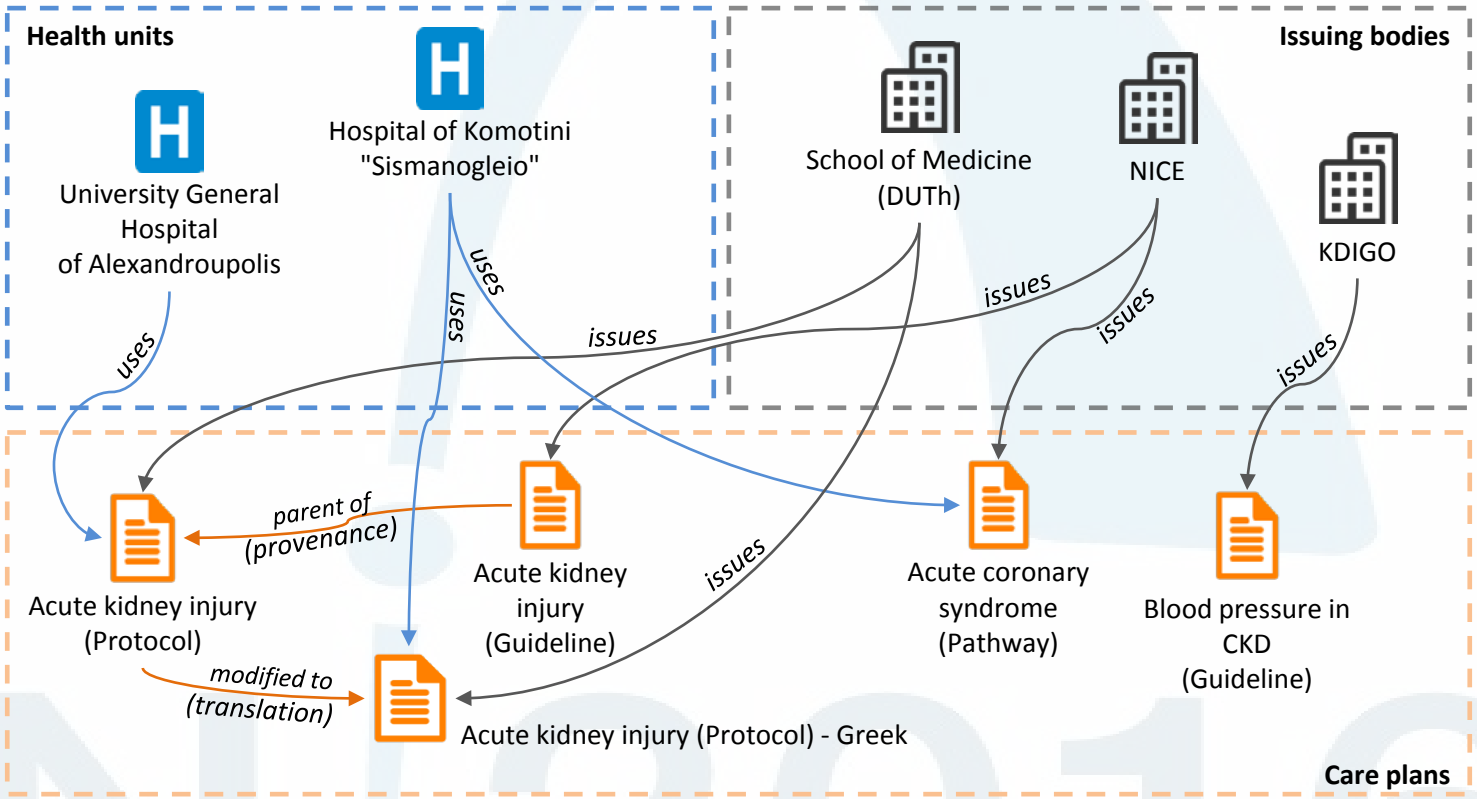
e-ClinPro heterogeneous network



Clinical protocol provenance, evolution and modification

- **Provenance**
  - **Issuing bodies**
  - **Clinical practice guidelines**
  - **Scientific evidence sources**
- **Evolution**
  - **Update of a previous version,** e.g. due to new evidence
- **Modification**
  - **Infrastructure limitations**, e.g. lack of a diagnostic equipment
  - **Clinical restrictions**, e.g. due to concurrent clinical protocols
  - **Patient choices and objections**, e.g. due to religion
  - **Insurance policy constraints**, e.g. to firstly perform a lower cost procedure
  - **Adaptation to local settings**, e.g. different language
  - **Restrictions due to comorbidities**

Example of clinical protocols' relationships in the semantic social network



Semantic tagging and interlinking

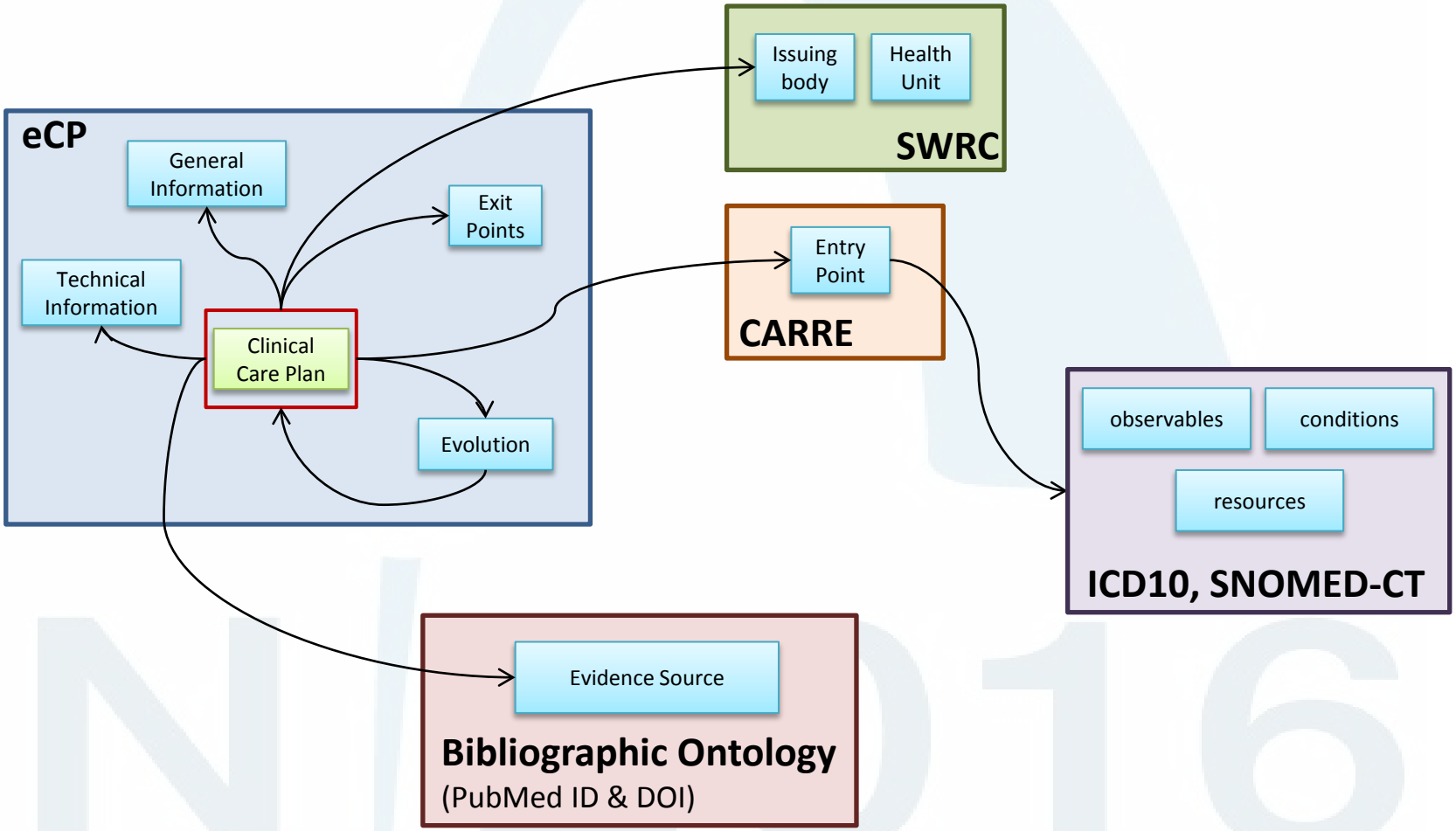
- Profile of clinical protocol based on the eCP ontology[1]
- Entry point: observables and observable condition described via the CARRE ontology[2]
- Issuing bodies and healthcare units are described following the SWRC ontology[3]
- Semantic tagging of medical terms with external resources via ICD-10 and SNOMED
- Medical evidence description based on the Bibliographic Ontology (via PubMed identifier and DOI)

[1]Kaldoudi, E., Drosatos, G., Portokallidis, N. and Third, A., 2016. **An Ontology Based Scheme for Formal Care Plan Meta-Description**. In XIV Mediterranean Conference on Medical and Biological Engineering and Computing 2016 (pp. 785-790). Springer International Publishing.

[2]Third, A., Kaldoudi, E., Gotsis, G., Roumeliotis, S., Pafili, K. and Domingue, J., 2015. **Capturing scientific knowledge on medical risk factors**. In K-CAP2015: 8th International Conference on Knowledge Capture. ACM.

[3]Sure, Y., Bloehdorn, S., Haase, P., Hartmann, J. and Oberle, D., 2005. **The SWRC ontology–semantic web for research communities**. In Portuguese Conference on Artificial Intelligence (pp. 218-231). Springer Berlin Heidelberg.

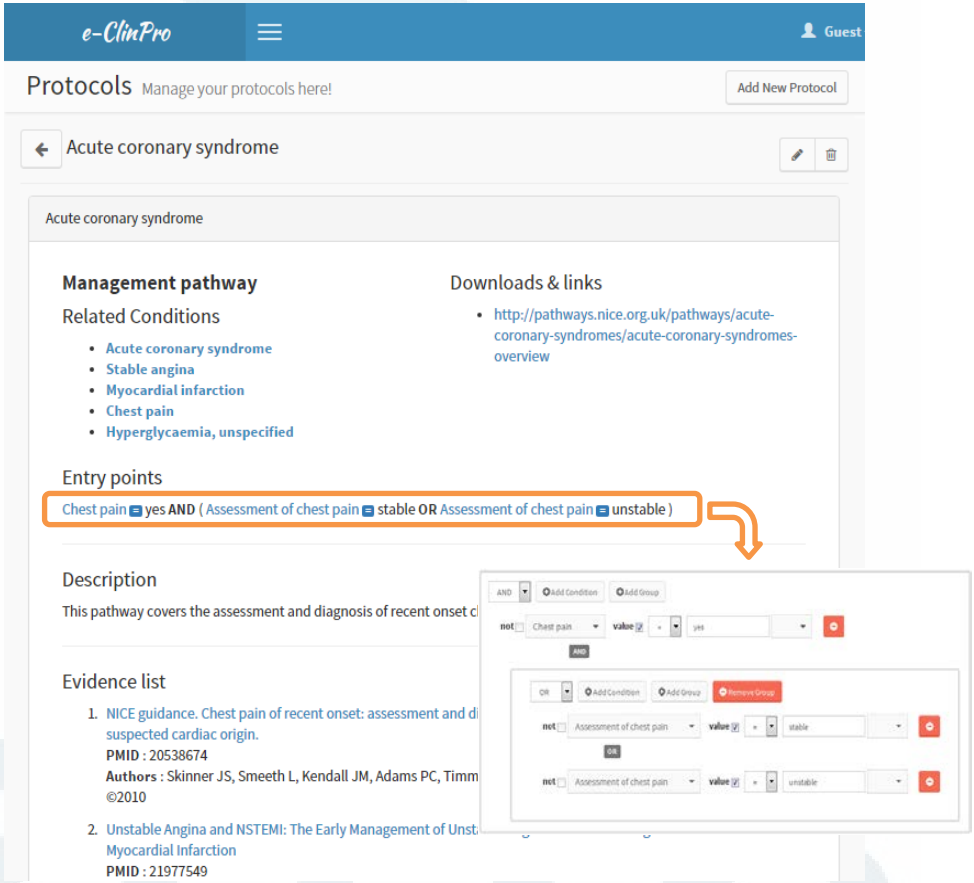
Semantic tagging and interlinking



E-CLINPRO: IMPLEMENTATION

e-ClinPro implementation

- **Backend**
  - Server: NodeJS
  - API: LoopBack framework
  - Database: MongoDB
- **Frontend**
  - Visual Interface: AngularJS
  - Graph visualizations: Vis.JS
- **Integration with**
  - NCBO BioPortal API
  - PubMed API
- **Available online in:**
  http://iris.med.duth.gr/research/ecp



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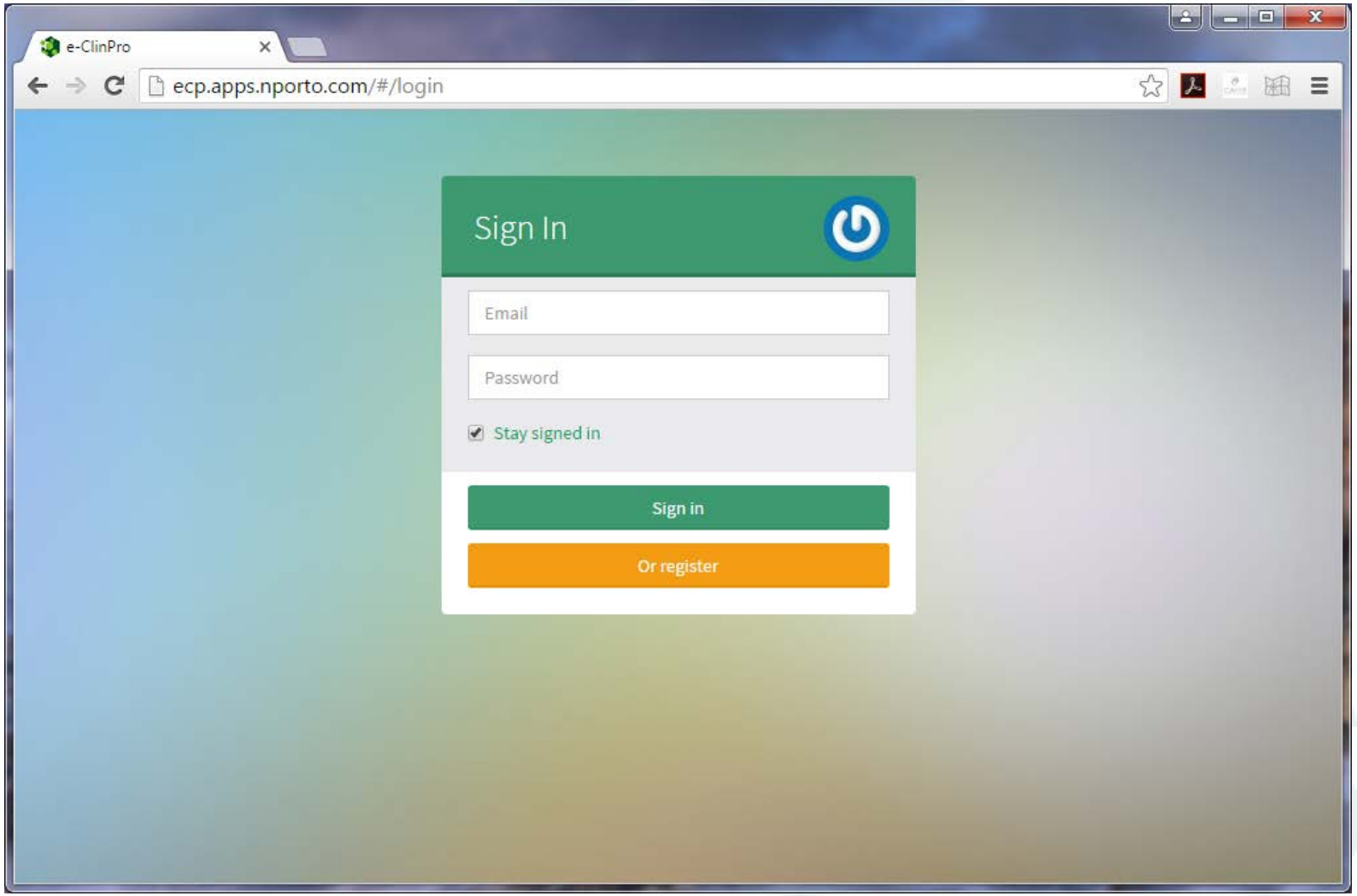
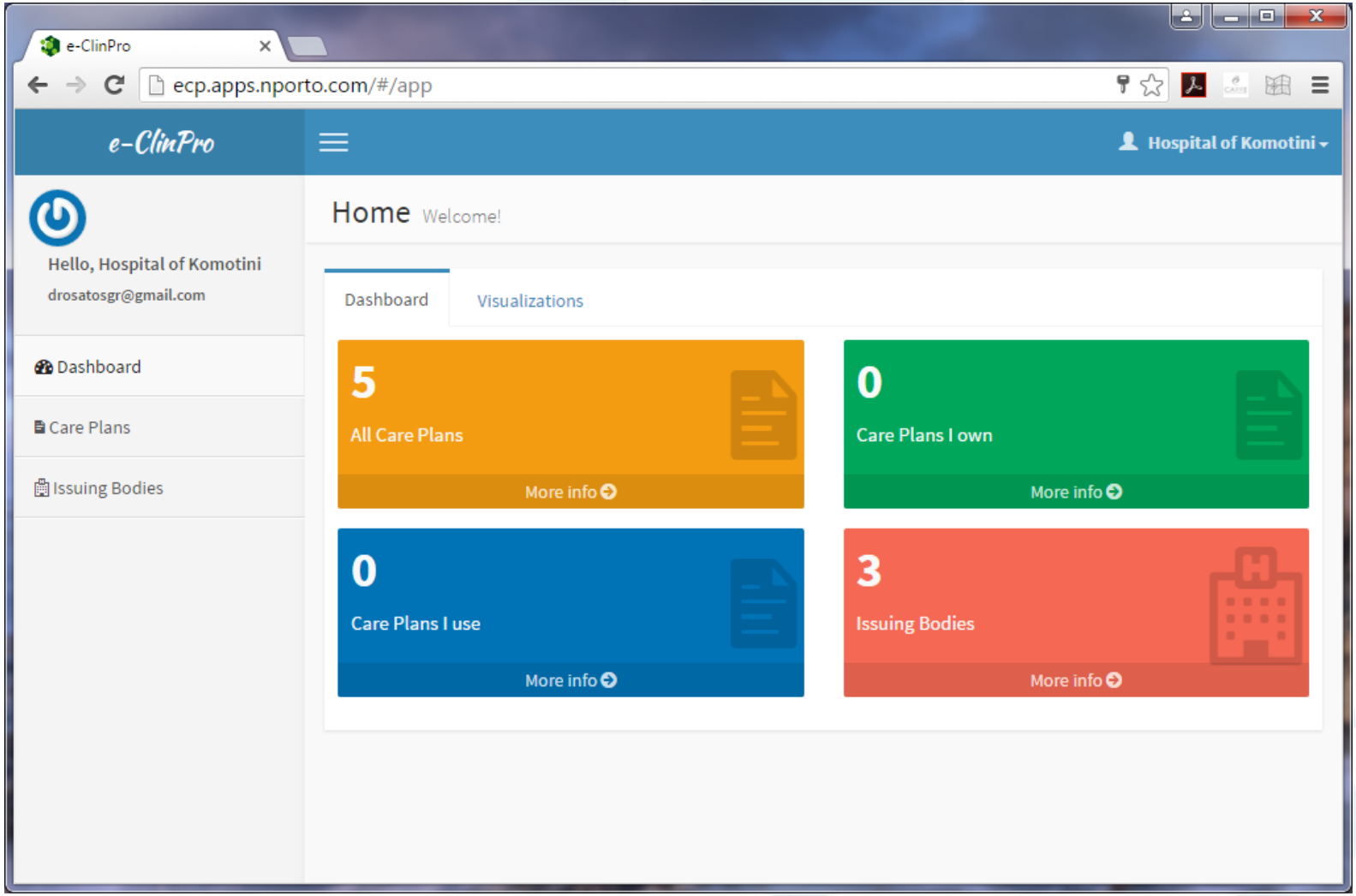
E-ClinPro: Login

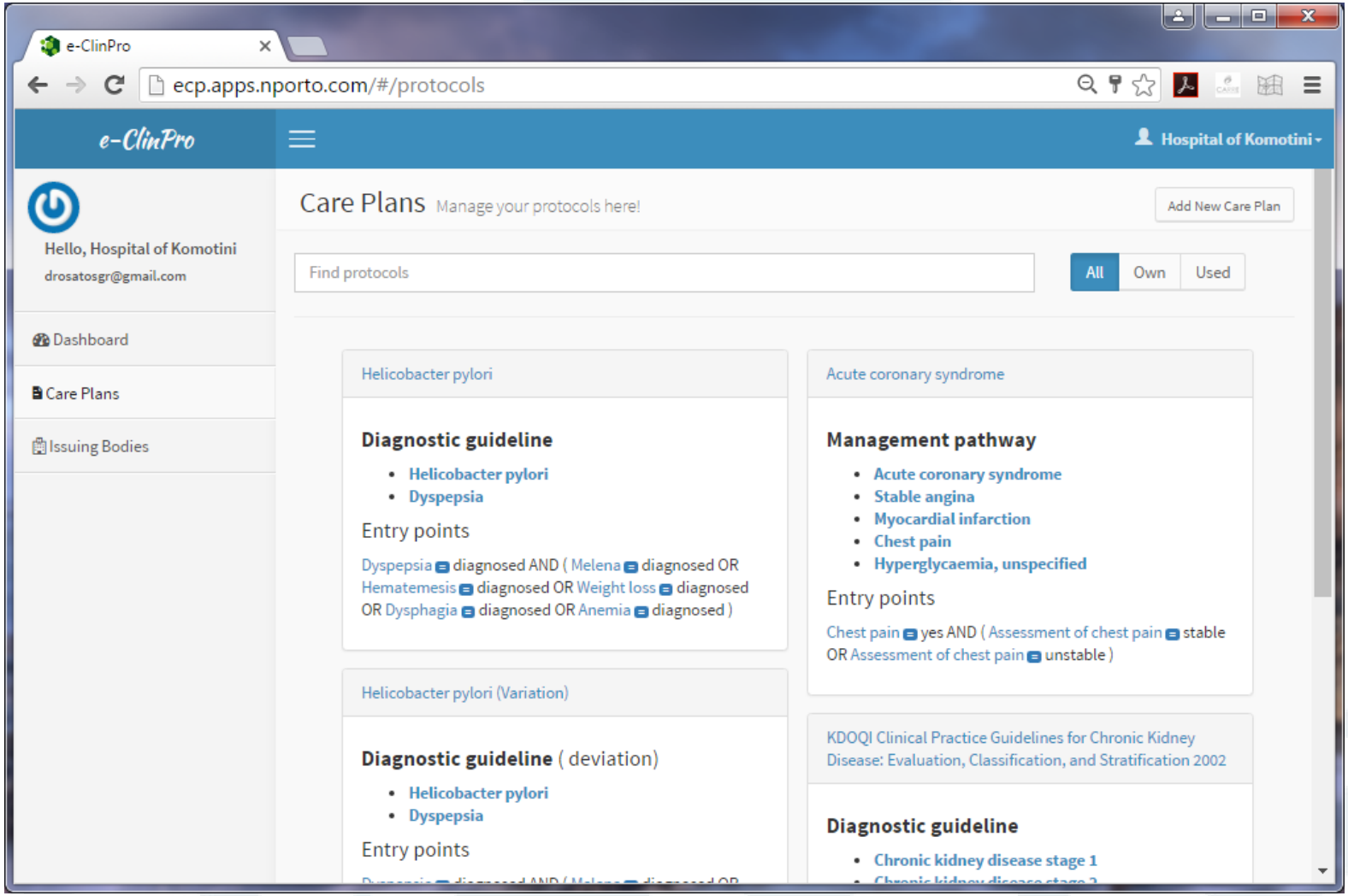


E-ClinPro: Dashboard

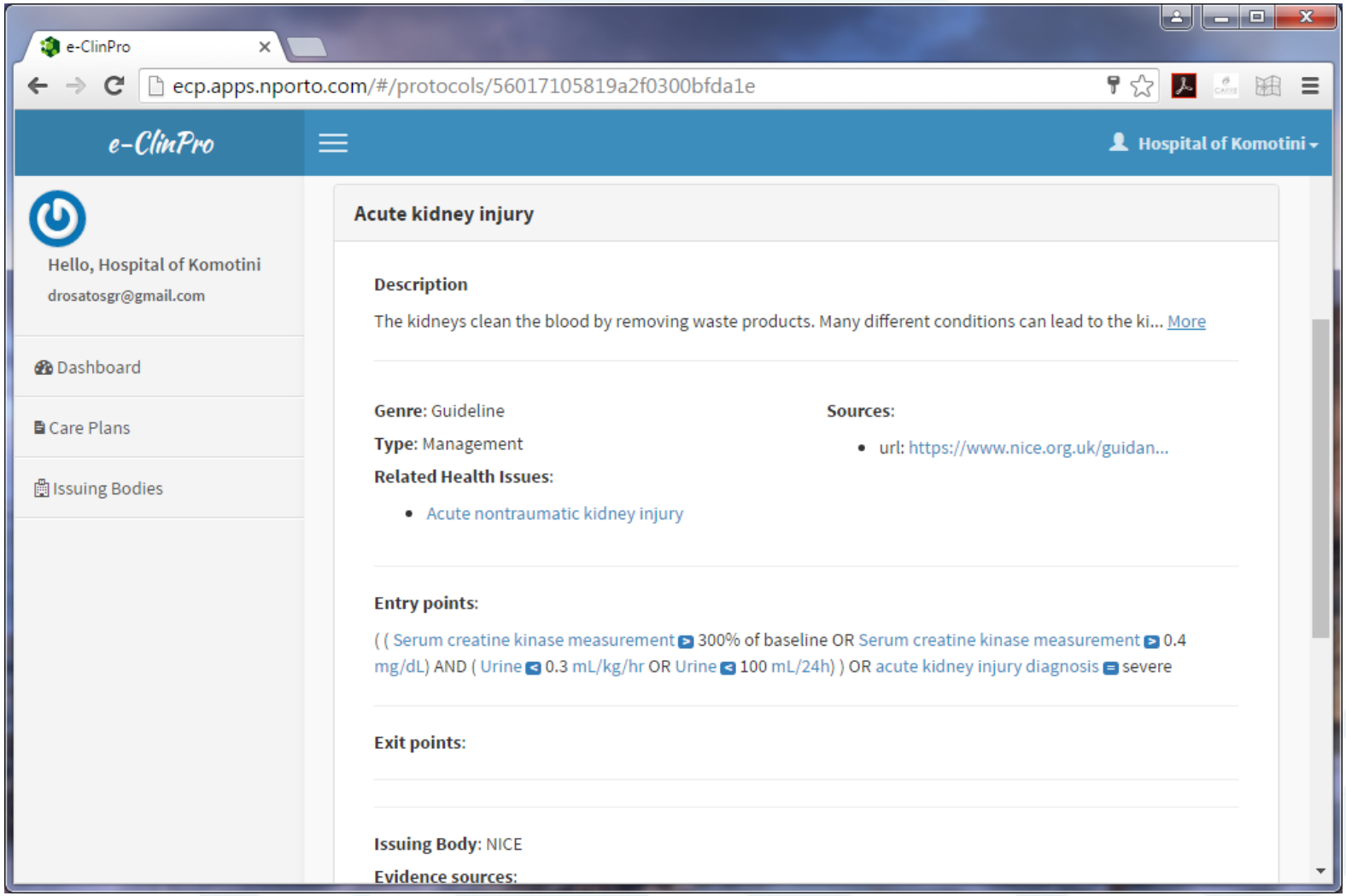


E-ClinPro: Visualizations

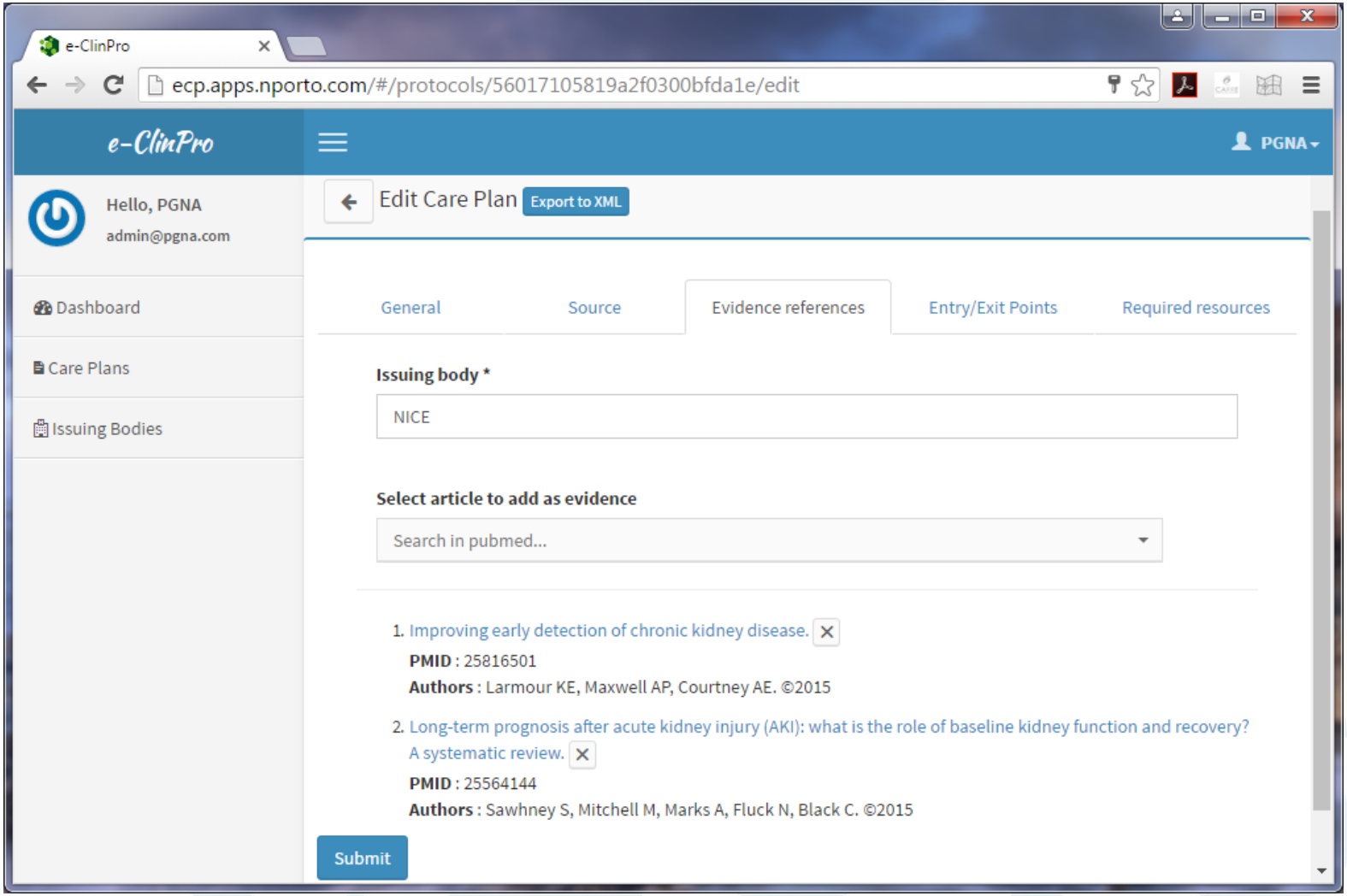
E-ClinPro: Care plans list



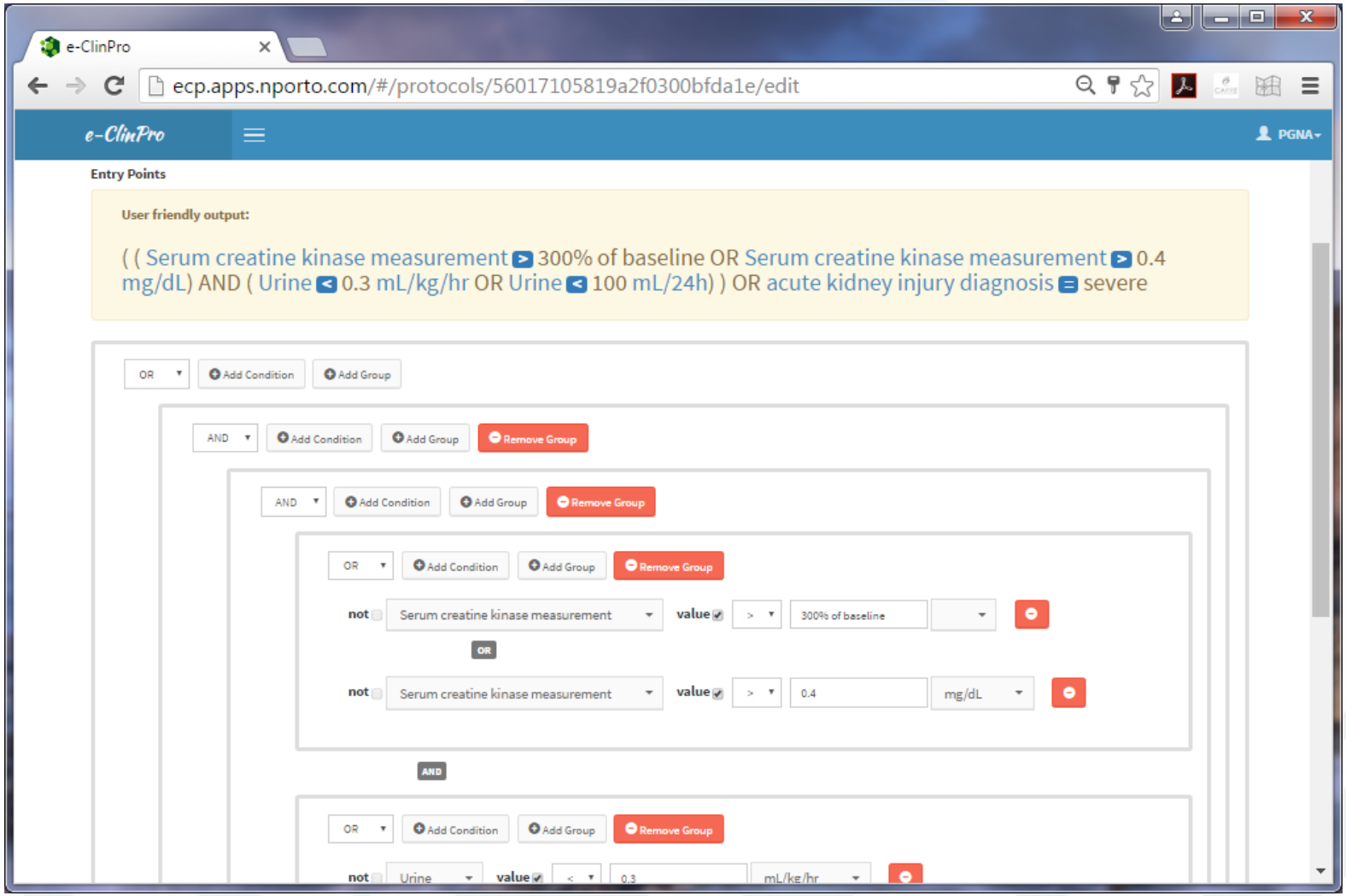
E-ClinPro: Care plan profile



E-ClinPro: Edit care plan



E-ClinPro: Initial condition builder



CONCLUSION

Work in progress

- **Extensive ontology and system evaluation**

  Structured interviews and focus groups of different types of system users, including experts, nurses, residents, and medical students

- **Support relationships between doctors, patients, and protocols for clinical protocol evaluation based on the assessment of**
  - **The extent of clinical protocol use**
  - **Type and number of clinical protocol modifications**
  - **Outcomes of protocol clinical application**

Any questions?

THANK YOU

Acknowledgement

This work was financially supported by the projects

eCP: Development of electronic clinical protocols, (MIS 375876), the Greek National Programme Thales

CARRE Project: Personalized patient empowerment and shared decision support for cardiorenal disease and comorbidities, Grant no. 611140, FP7-ICT (http://www.carre-project.eu/)

both co-funded by the European Commission.