TRANSFoRm

An ontology-driven approach to clinical evidence modelling implementing clinical prediction rules

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Acknowledgements

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eHealth

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European Commission

What types of “knowledge” can support provision of healthcare?

Specific research knowledge

- Clinical trials
- Controlled populations
- Well-defined questions

TRANSFoRm

Routinely collected knowledge

- EHR systems
- Wide coverage
- Vast quantity
- May lack in detail and quality

Actionable knowledge

- Distilled scientific findings
- Evidence based
- Usable in clinical practice

TRANSFoRm Consortium

www.transformproject.eu/

Aims of TRANSFoRm

- TRANSFoRm - Translational Research and Patient Safety in Europe

- To develop the infrastructure in primary care to support:
  - Epidemiological research using electronic records, including genotype-phenotype studies and other record linkages
  - Decision support to assist formulating and quantifying potential diagnoses as part of clinical consultation
  - Utilise shared infrastructure – shared models, vocabulary services, provenance services

Shared Models in TRANSFoRm

- Clinical Data Integration Model (CDIM)
  - Mapping clinical data from EHRs and aggregated data repositories

Routinely collected knowledge

- Clinical Research Information Model (CRIM)
  - Research process information
  - Evolution of Primary Care Research Object Model (PCROM).

Specific research knowledge

- Clinical Evidence Model (CEM)
  - Clinical evidence upon which decision support can be derived and provided through decision support tools

Actionable knowledge

Design - Evidence obtained from literature

Table 2. Clinical Signs and Symptoms in the Prediction of Urinary Tract Infection*

Study	Positive Likelihood Ratio (95% CI)	Negative Likelihood Ratio (95% CI)
	Dysuria	
Gallagher et al[25]	1.3 (1.1-1.6)	0.3 (0.1-0.7)
Mond et al[26]	1.4 (1.1-1.8)	0.2 (0.1-0.7)
Lawson et al[27]	1.2 (1.0-1.5)	0.8 (0.6-1.0)
Nazareth and King[20]	1.1 (0.8-1.1)	0.6 (0.1-2.4)
Komaroff et al[28]	3.2 (2.7-3.7)	0.2 (0.1-0.3)
Wong et al[21]	3.0 (2.0-4.6)	0.5 (0.4-0.7)
Wigton et al[22] (training set)	1.4 (1.1-1.8)	0.7 (0.5-0.9)
Wigton et al[22] (validation set)	1.1 (0.8-1.4)	0.9 (0.7-1.2)
Summary	**1.5 (1.2-2.0)**	**0.5 (0.3-0.7)**
	Frequency	
Gallagher et al[25]	1.0 (0.9-1.1)	1.6 (0.4-5.9)
Mond et al[26]	1.0 (0.9-1.1)	1.1 (0.2-7.8)
Lawson et al[27]	1.1 (1.0-1.3)	0.7 (0.4-1.0)
Dans and Klaus[29]	1.4 (1.0-2.1)	0.6 (0.4-1.1)
Nazareth and King[20]	1.0 (0.8-1.3)	0.9 (0.2-3.8)
Komaroff et al[28]	10.3 (7.8-13.3)	0.1 (0.0-0.2)
Wong et al[21]	5.2 (3.1-8.7)	0.5 (0.3-0.6)
Wigton et al[22] (training set)	1.8 (1.0-3.5)	0.9 (0.8-1.0)
Wigton et al[22] (validation set)	1.3 (0.8-2.0)	0.9 (0.8-1.1)
Summary	**1.8 (1.1-3.0)**	0.6 (0.4-1.0)

Bent et al 2002 - Does this woman have an acute uncomplicated urinary tract infection? *Jama*, 2002:2701-10.7

Design - Evidence derived from coded data

Diagnoses for RfE (P03) feeling depressed. Population: all		
	The Netherlands	
Rates per 1000 patient years (Episodes not pts.)	Incidence	Prevalence
Feeling depressed (P03)	5.2	7.4
Depressive disorder (P76)	10.1	36.1
General weakness/tiredness (A04)	30.6	37.5
Acute stress reaction (P02)	5.8	7.9
Feeling anxious/nervouw/tense (P01)	12.7	29.8
Neurasthenia, surmenage (P78)	4.1	6.1
Anxiety disorder/anxiety state (P74)	2.0	8.8
Relationship problem with partner (Z12)	4.8	6.9
	LR+	LR-
Rfe (P03) Feeling depressed		
Feeling depressed (P03)	**292.8 (269.4-318.2)**	**0.3 (0.3-0.3)**
Depressive disorder (P76)	**108.6 (98.1-120.1)**	0.7 (0.7-0.7)
General weakness/tiredness (A04)	1.9 (1.4-2.6)	1.0 (1.0-1.0)
Acute stress reaction (P02)	**8.0 (5.6-11.5)**	1.0 (1.0-1.0)
Feeling anxious/nervouw/tense (P01)	**3.5 (2.4-5.1)**	1.0 (1.0-1.0)
Neurasthenia, surmenage (P78)	**10.4 (7.2-15.2)**	1.0 (1.0-1.0)
Anxiety disorder/anxiety state (P74)	***12.5 (7.8-20.3)***	1.0 (0.9-1.0)
Relationship problem with partner (Z12)	**5.3 (3.3-8.6)**	1.0 (1.0-1.0)
Black = not significant (LR+ <=2, LR- >=0.5)		
Green = weak predictor (LR+ >2-8, LR- 0.2-0.4, small CI)		
Red = strong predictor (LR+ >8, LR- <0.2, small CI)		
Small CI is one which is smaller than the size of the observation		
Those with larger CI not including 1 are put in bold italics		
CI excluding unity are ignored		

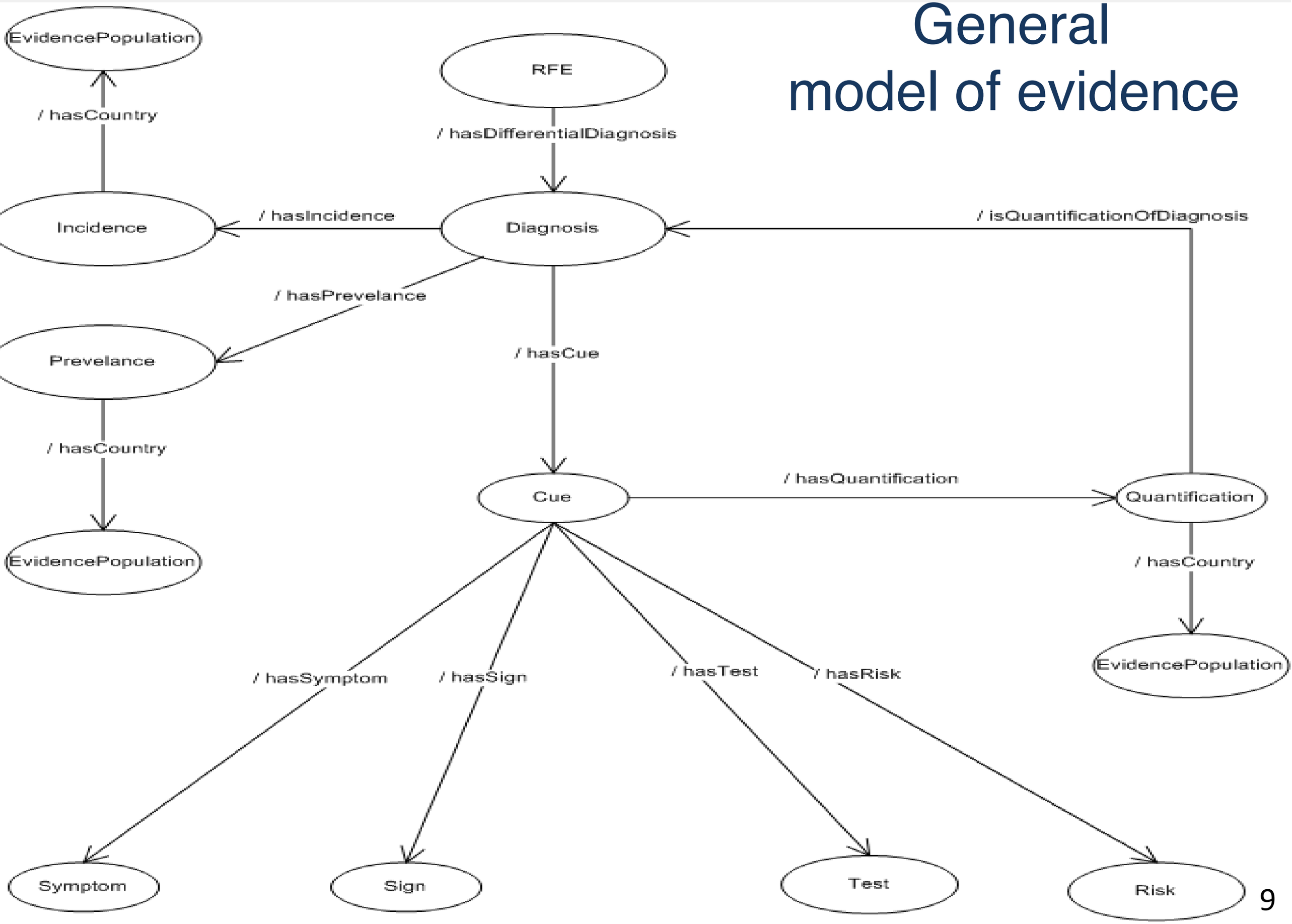
Soler, Okkes et al 2012, The interpretation of the reasons for encounter ‘cough’ and ‘sadness’ in four international family medicine populations, Informatics in Primary Care

Design - Clinical Prediction Rules

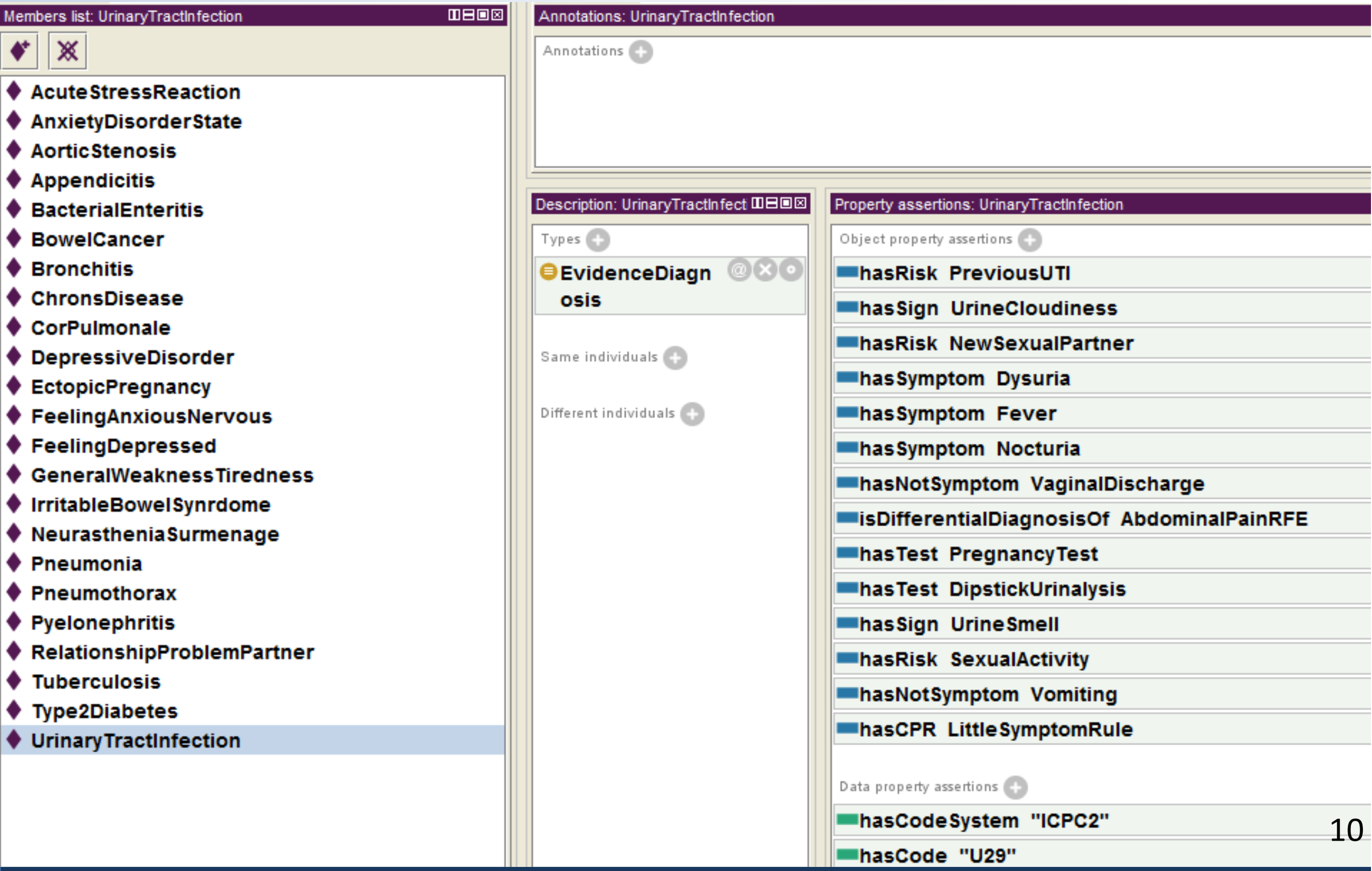
Little Symptom Rule	
Diagnostic Cues and Criteria	• Urine cloudiness present • Urine smell present • Dysuria present • Nocturia present
Scoring Scheme	1 point is scored for each of the 4 criteria that are found to be true in the patient
Scoring Stratification	0 = Low risk 1-2 = Medium risk 3-4= High risk
Decision Outcome	Low = No treatment Medium = Requires further testing High = Empirical treatment with antibiotics

Little et al 2006 - Developing clinical rules to predict urinary tract infection in primary care settings: sensitivity and specificity of near patient tests (dipsticks) and clinical scores. *Br J Gen Pract*, 2006:606-12.

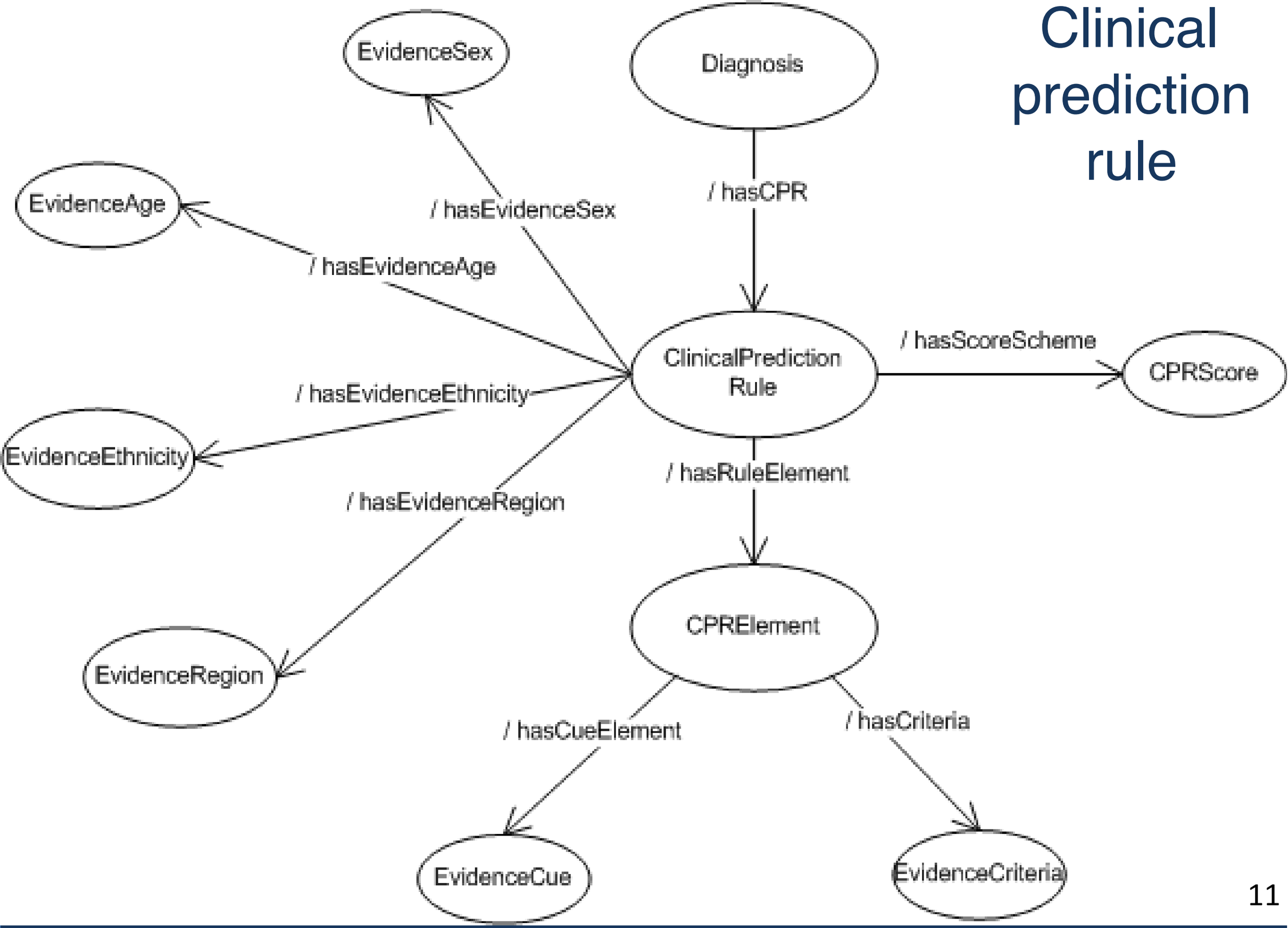
General model of evidence



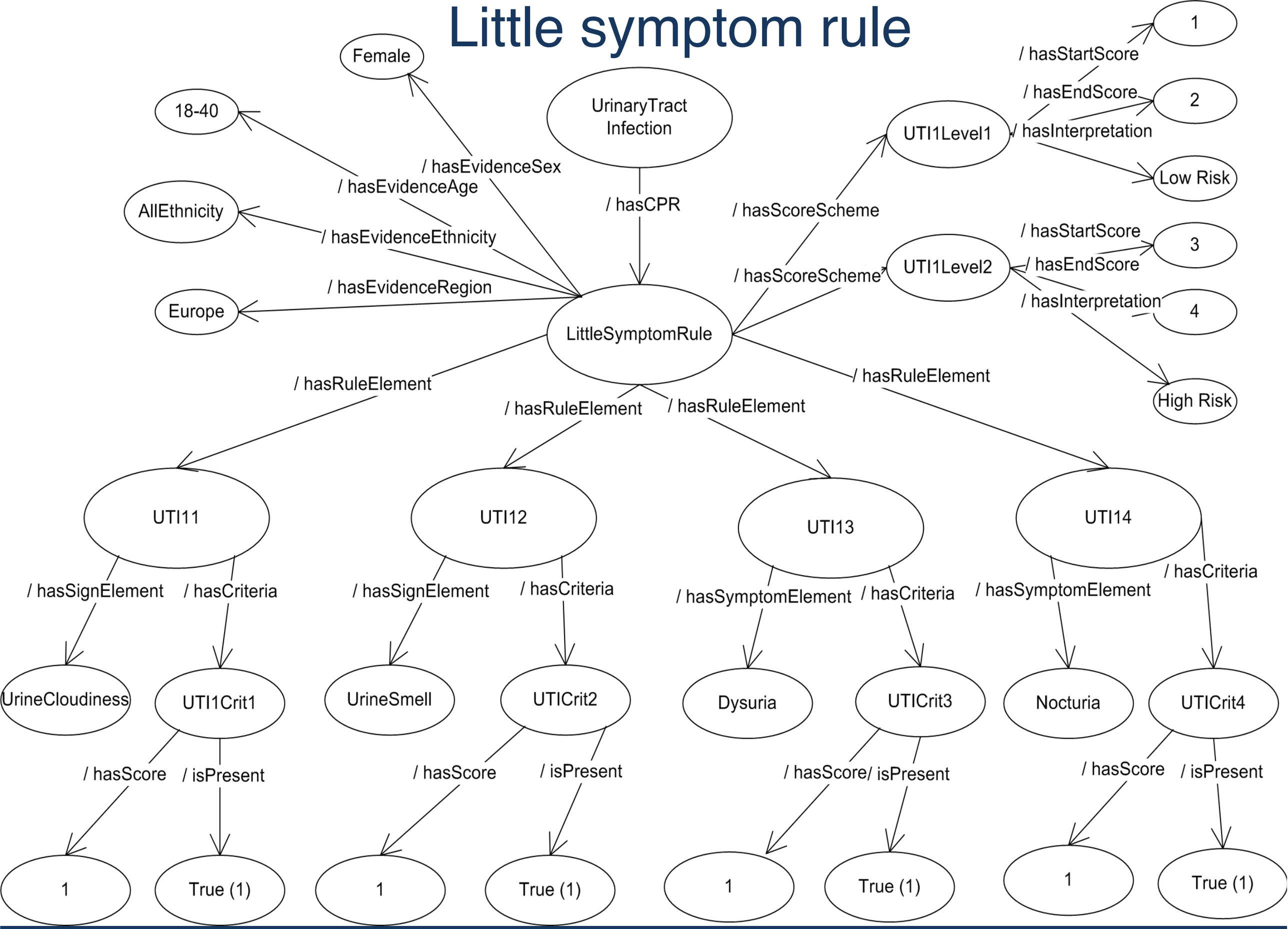
Protégé – defining instances of knowledge



Clinical prediction rule



Little symptom rule



Sesame query platform

Query Repository

Query Language: SPARQL

```
PREFIX rdf:<http://www.w3.org/1999/02/22-rd
PREFIX swrlb:<http://www.w3.org/2003/11/swr
PREFIX owl:<http://www.w3.org/2002/07/owl#>
PREFIX foaf:<http://xmlns.com/foaf/0.1/>
PREFIX dcterms:<http://purl.org/dc/terms/>
PREFIX xsd:<http://www.w3.org/2001/XMLSchem
PREFIX evd:<http://www.semanticweb.org/onto
PREFIX dctype:<http://purl.org/dc/dcmitype/
PREFIX swrl:<http://www.w3.org/2003/11/swrl
PREFIX rdfs:<http://www.w3.org/2000/01/rdf-
PREFIX dc:<http://purl.org/dc/elements/1.1/

SELECT ?anyEvidenceCue
WHERE {?anyEvidenceCue evd:isCueOf evd:Urin
```

Query:

Limit results: 100

☑ Include inferred statements

Execute

Query Result (

Limit results: 100

AnyEvidenceCue
ClinicalEvidence:Fever
ClinicalEvidence:UrineCloudiness
ClinicalEvidence:Dysuria
ClinicalEvidence:NewSexualPartner
ClinicalEvidence:Nocturia
ClinicalEvidence:DipstickUrinalysis
ClinicalEvidence:PregnancyTest
ClinicalEvidence:PreviousUTI
ClinicalEvidence:SexualActivity
ClinicalEvidence:UrineSmell

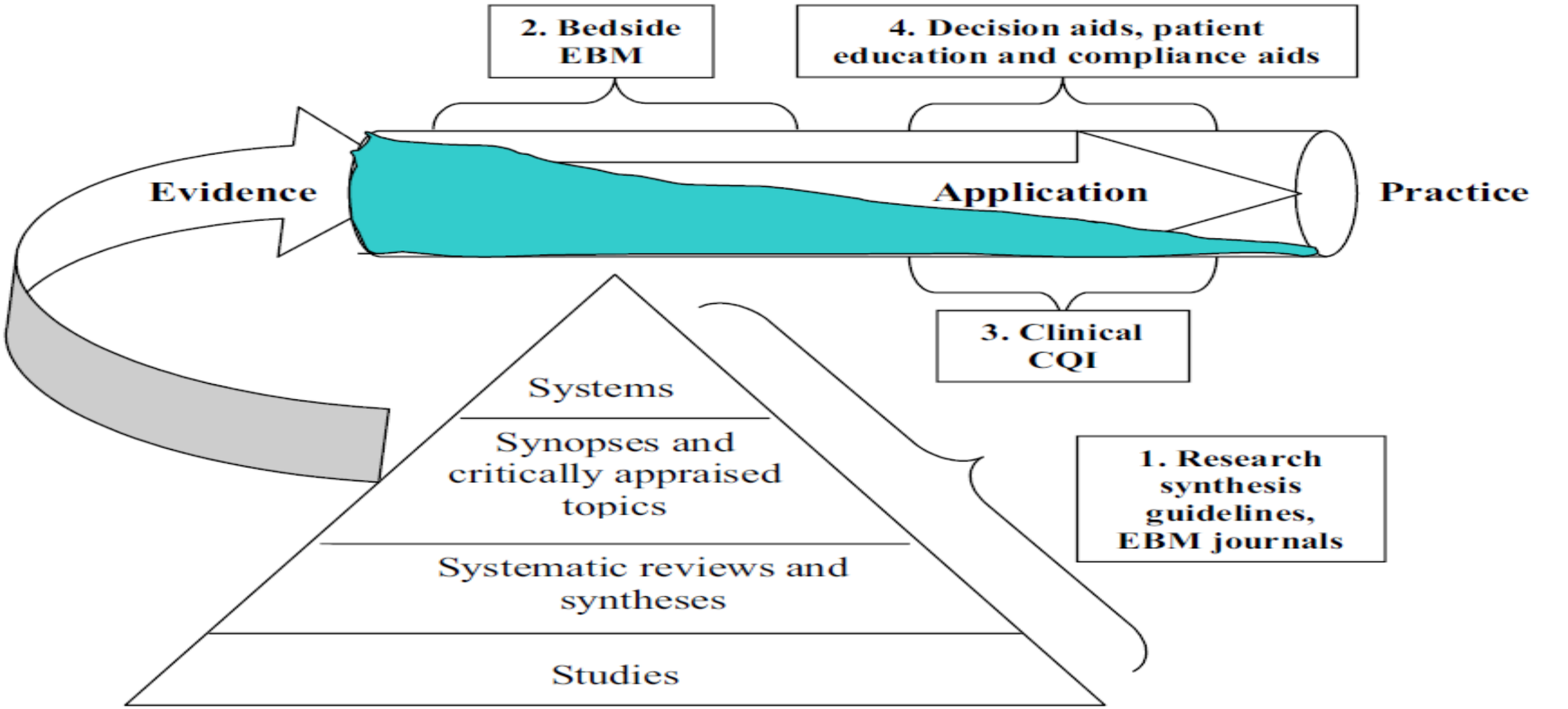
Decision Support Tool

The Decision Support Tool will provide patient-specific advice at the moment of consultation so that clinicians are able to access and quantify likely differential diagnoses framed in terms of diagnostic probability and alternative diagnostic possibilities.

Decision Support Tool Characteristics:

- Embedded within the eHR
- Triggered by a ‘reason for encounter’
- Collects ontologically controlled diagnostic cue data
- Presents diagnostic prompts based on queries to a clinical evidence service
- Alerts/suggests for potential missed diagnoses

Bridging the knowledge gap



Lang et al 2007, “Knowledge Translation: Closing the Evidence-to-Practice Gap”, Annals *of Emergency Medicine*

- How TRANSFoRm bridges the gap:
  - Creation of shared clinical models at the system evidence level
  - Generation and analysis of underlying evidence from electronic sources
  - Providing infrastructure to support rapid dissemination, validation and impact analysis of clinical evidence in practice

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