Comorbidities Modeling for Supporting Integrated Care in Chronic Cardiorenal Disease

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Goal

Aim: towards constructing a generic information model for comorbidities management

Specific aim: address the medical domain of cardio-renal disease and comorbidities.

Ultimate goal: comorbidity management via empowerment and shared informed decision:
– understanding nature of comorbidity
– informed estimation of disease progression
– personalized alerting, planning, education
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Approach

Develop models of comorbidity in order to create an information model that connects comorbid diseases with their respective risk factors and symptoms, weighing their influence on each other and on the patient's health.
– clinical models of comorbidity
– UMLS (The Unified Medical Language System, http://www.nlm.nih.gov/research/umls/) semantic network concepts and relationships
– UML modeling language

Discussion

A novel model for risk factor in medicine based on UMLS semantic network concepts and relationships.

The goal is to use this risk factor model (class) to develop a dynamic information model and ontology of the management of disease and comorbidities based on ground medical knowledge, that can be enriched to reflect current-state-of-the-art medical evidence.

Comorbidity

Comorbidity: the presence of one or more disorders in addition to a primary disease or disorder (either independently, or as a consequence of the primary condition or otherwise related) [1].
– ½ of all chronic patients present comorbidities
– only a few overall management guidelines exist
– patients receive fragmented, disease specific care

Cardiorenal disease: simultaneous (causal) dysfunction of kidney and heart
– diabetes and/or hypertension underlying causes
– a number of other comorbidities often present
– deterioration to end stage renal/heart disease is life threatening, irreversible & expensive to manage

Some numbers…
– hypertension: 1/3 of adults (US 2008)
– diabetes: 8% of overall population
– chronic kidney disease: 9-16% of overall population
– 44% of chronic kidney disease is due to diabetes
– 86% of chronic kidney disease has at least 1 comorbidity
– most patients with chronic kidney disease develop cardiovascular disease
– chronic heart failure: 1-2% of healthcare costs
– end-stage renal disease: >2% of healthcare costs

Modeling Comorbidity

Comorbidity is modeled in relation to the risk factors associated with individual disease [2]:
– no etiological association between coexisting diseases (the "luck" factor)
– direct causation: one of the diseases may cause the others;
– associated risk factors: the risk factors for each disease are correlated;
– heterogeneity: the risk factors for each disease are not correlated but each one of them can cause either disease;
– independence: the presence of the diagnostic features of each disease is actually due to a different distinct disease.
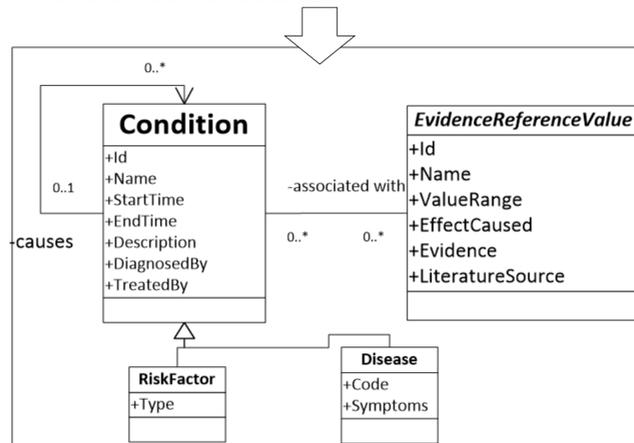
The generic entity "condition" refers both to a *disease* as well as a *risk factor* and is modeled as a parent class.

Entities Involved	UMLS SN Relationship
Disease -Disease	Precedes, co-occurs with, result of, affects, associated with, temporally related to, causes, degree of
Risk Factor-Risk Factor	Co-occurs with, complicates
Risk Factor-Disease	Evaluation of, issue in, result of, affects, causes, degree of

Modeling Risk Factors

Risk is the probability of a negative outcome on the health of a population of subjects. The agents responsible for that risk are called risk factors when they aggravate a situation and are being used to predict up to a degree the occurrence of a condition or deterioration of a patient's health [3-6].

Risk factor characteristics/attributes:
name: risk factor name (e.g. weight)
strength: value, which can be literal (e.g. 60 Kg), binary (exists or not, e.g. for a gene), or qualitative
sourceType: environmental, genetic, behavioral, biomedical, and demographic
correlate: type depending the ability of the risk factor to change its value, i.e., "fixed marker", "variable marker", "variable risk factor", "causal risk factor"
temporalType: "continuous" or "intermittent"
duration: duration of exposure to the risk factor. This is a free text string
associatedCondition: the resultant condition attached to the risk factor
"impact": the evidence-based percentage of risk factor's impact on the associated condition
evidenceSource: authoritative source of evidence for risk factor impact
lifecycle: expected duration/upgrade of evidence

Following UMLS Semantic Network, associations between a risk factor and the associated condition include:
issue_in: the risk factor is a point of discussion for a condition
affects: the risk factor produces a direct effect on the condition
causes: the risk factor brings about the condition
complicates: the risk factor causes another (risk) factor to become more complex (recursive).

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