



Integrating medical scientific knowledge with the semantically Quantified Self

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CARRE PERSONALIZED PATIENT EMPOWERMENT

Clinical Risk Factors



- Key source of medical advice
 - Obesity increases diabetes risk by 3.5, etc.
 - Cardiac patients
 - at risk of kidney problems
 - which can lead to other heart problems...
 - at risk of low physical activity
 - which can lead to
- Comorbidity risk management



A risk factor association

• Diabetes causes ischemic heart disease

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- Diabetic and male: 2.82 x more likely to develop IHD
 - Confidence interval 2.35 3.38
 - Source: Pubmed ID 24859435
- Diabetic and female: 2.16 x more likely to develop IHD
 - Confidence interval 1.82 2.56
 - Source: Pubmed ID 24859435



Existing risk calculators



Framingham 10 Year Risk of General Cardiovascular < Share Disease (2008 paper)

put:		Results
Sex	Female 💿 🛛 Male 🔵	
		Risk Factors
Age	ŷ yr ♦	Risk %
Sys BP	c) mmHg 🛟	
Total Chol	ĵ mg/dL ♦	Decimal Precision: 2 +
HDL Chol	ĵ mg/dL ♦	
On hypertension medication	No (2.76157)	
Cigarette smoker	No (0)	
Diabetes present	No (0) \$	











Connecting to the patient

- "Quantified Self"
 - Cheap
 - Easy to use
 - Lots of data



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Recording QS measurements

- Lightweight measurement schema in RDF
- Common vocabularies
 - Clinical Measurements Ontology
 - Unit Ontology
 - UMLS where relevant
- Automatic data aggregation

Access-controlled quadstore



Integrating QS & risk factor data



- RF initial conditions
 - diabetic & (days since myocardial inf. < 30)
 - (physical activity NOT "high") OR
 (25 < BMI < 35)
- Need
 - Complex custom functions
 - Disjunction
 - Negation
 - Somehow still easy for doctors...





Custom expression language

- Simple language expressing conditions on QS data
- Custom function implemented
 BMI, estimated glomerular filtration rate,...
- Readable by medical experts
 - Graphical tool for writing by medical experts
- Stored with risk association











Risk factor data capture

- 96 risk factors
 - Grade I evidence, 60 scientific publications
 - 253 risk associations based on
 - 53 clinical states
 - 90 different observables
- Cf. reference.medscape.com
 - 36 risk factors, ~36 scientific publications
 - Grade unknown











Quantified Self data capture

- 10 pilot users
 - Activity, blood pressure, weight, sleep quality
- Data collection over 12 months (min.)
- Approx. 22k measurements/user
 Average 110 483 triples/user
- Range of health profiles/risk status





Personalised risk prediction





Patient evaluation



- Ongoing clinical trials with ~80 patients
- User experience
- Changing behaviour
- Changing outcomes



Evaluation



- Risk factor formalisation
 - Clinical language obscures model generalities
 - "Risk factor" vs. "intervention effectiveness"
 - Clinical literature ambiguities
 - "cardiovascular disease" vs. "angina pectoris",
 "ischemic heart disease", etc.
- Grounding expressions
 - Technical difficulties overcome by training



Gaps in clinical evidence



- Automatic & *literature-based* risk calculation agrees everywhere
- Clinical practice-based risk calculation shows gaps
 - -e.g., BMI > 34.5: no diabetes risk
- No grade I clinical evidence about some "common knowledge"



Resources & Future work

- Risk data explorable at: <u>https://entry.carre-project.eu</u>
- SPARQL endpoint at: <u>http://devices.carre-project.eu:8890/sparql</u>

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- Extend to other areas of medicine
- Incorporate other sources of data – E.g., environmental, nutritional
- Deeper analysis of clinical research areas





Thank you!

• Any questions?

