CARRE

Personalized patient empowerment and shared decision support for cardiorenal disease and comorbidities

FP7-ICT-61440 Project Presentation

eHealth Forum 2016, Athens, Greece, 25-26 October 2016
motivation

- significant increase in the prevalence and incidence of chronic disease
- ½ of all chronic patients present comorbidities
- the chronic patient is mostly an outpatient
  - needs to care for herself at home
  - mainly away from continuous professional care
  - while trying to lead a normal life
medical domain

chronic cardiorenal disease and comorbidities

- simultaneous (causal) dysfunction of kidney and heart
- diabetes and/or hypertension common underlying causes
- a number of other serious comorbidities often present
  - nephrogenic anemia, renal osteodystrophy, malnutrition,
  - blindness, neuropathy, severe atherosclerosis,
  - cardiovascular episodes, and eventually
  - end-stage renal disease and/or heart failure,
  and death

- deterioration to end stage renal/heart disease is
  - life threatening, irreversible and expensive to manage
cardiorenal disease & comorbidities

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 total healthcare costs
- end-stage renal disease (dialysis) ⇒ >2% of total healthcare costs
CARRE

Cardiorenal comorbidity management via empowerment and shared informed decision

FP7-ICT-2013-611140

consortium: 6 partners from 4 EU countries

coordinator: Eleni Kaldoudi (DUTH)


budget: 3,210,470€

http://carre-project.eu/
CARRE approach

- Foster understanding of comorbid condition
- Calculate informed comorbidity progression
- Compile personalized empowerment services
- Support shared informed decision and integrated management
**what?**
CARRE
EU FP7-ICT-2013-611140
3.2M, 2013-2016
DUTH, OU, BED, VULSK, KTU, PIAP

**why?**
cardiorenal disease
chronic, common, dangerous, expensive, with many causing factors and complex progression

**how?**
medical evidence
quantified self
personal risk prediction
personal decision support

**for the patient**

**for the medical expert**

**for the ICT expert**

http://carre-project.eu
CARRE approach

- quantified self
  - weight
  - physical activity
  - blood pressure
  - glucose
- evidence based medical literature
- medical evidence aggregation
- social media
- personal health information

Patient empowerment & decision support services

Comorbidity model visualization (generic and personalized)

Private data harvesting & interlinking

Public

LOD
modelling health risk factors

under certain conditions

with a probability x

risk factors are reported in medical literature
(top level evidence: systematic reviews with meta-analysis)

E. Kaldoudi, et al. CARRE D.2.1, 2014
modelling health risk factors

- condition
- disorder
- genetic
- biomedical
- demographic
- behavioural
- intervention
- environmental

- type of risk element
- observable condition
- observable
- risk element
- risk evidence
- source risk element
- target risk element
- risk ratio
- evidence source
- has risk ratio
- determines risk evidence
- has evidence source
- risk evidence source
- has evidence source
- evidence source
- ratio type
- ratio value
- confidence interval
- adjustment for

E. Kaldoudi, et al. CARRE D.2.2, 2014
A. Third, E. Kaldoudi, G. Gotsis, S. Roumeliotis, K. Pafili, J. Domingue,
CARRE Risk Factor ontology

ACRONYM: CARRE
VISIBILITY: Public
BIOPORTAL PURL: http://purl.bioontology.org/ontology/CARRE
DESCRIPTION: Clinical risk factors, evidence and observables
STATUS: Beta
FORMAT: OWL
CONTACT: Allan Third, allan.third@open.ac.uk
HOME PAGE: http://www.carre-project.eu
PUBLICATIONS PAGE
DOCUMENTATION PAGE
CATEGORIES: Health

Reviews
Add your review
No reviews available.

Submissions

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<td>12/08/2014</td>
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CARRE ontology published in NCBO BioPortal
http://bioportal.bioontology.org/ontologies/CARRE

risk factor identification methodology

- search ground knowledge to identify major risk factors (guidelines and their literature: KDIGO, KDOQI, ACC/AHA, NICE, ESC, EASD, ADA)

- identify major risk factors (keywords)

- search PubMed: condition A AND condition B
  - if result found
    - yes
      - include relevant risk evidence from latest and highest level
    - no
      - if result found
        - yes
          - include all risk evidences from the most recent
        - no
          - search again for next update (1 year)

- search PubMed: condition A AND condition B (limited to systematic reviews with metaanalyses)
  - if result found
    - yes
      - include all risk evidences from the most recent
    - no
      - search PubMed: condition A AND condition B

E. Kaldoudi, et al. CARRE D.2.2, 2014
some of the major related conditions

1. Acute kidney injury
2. Acute myocardial infarction
3. Age
4. Albuminuria
5. Anaemia
6. Angina pectoris
7. Asthma
8. Atrial fibrillation
9. Chronic kidney disease
10. Chronic obstructive pulmonary disease
11. Cholelithiasis
12. Colorectal Cancer
13. Coronary and carotid revascularisation
14. Death
15. Depression
16. Diabetes
17. Diabetic nephropathy
18. Drugs
19. Dyslipidemia
20. Family history
21. Heart Failure
22. Hyperkalemia
23. Hypertension
24. Hyperuricemia
25. Hypoglycaemia
26. Ischemic heart disease
27. Ischemic stroke
28. Left ventricular hypertrophy
29. Obesity
30. Obstructive Sleep Apnoea
31. Myocardial infarction
32. Osteoarthritis
33. Pancreatic Cancer
34. Peripheral Arterial Disease
35. Physical activity
36. Smoking
37. ...
medical evidence aggregator
https://www.carre-project.eu/innovation/medical-evidence-aggregator/

sentence splitter
(tokenizer (GATE & Jape))
part-of-speech tagging
dependency parsing
semantic role labelling

E. Liu, et al. CARRE D.3.4, 2015
medical evidence aggregator
https://www.carre-project.eu/innovation/medical-evidence-aggregator/

E. Liu, et al. CARRE D.3.4, 2015
Obesity causes diabetes when $23 \leq \text{BMI} \leq 34$, risk ratio = 1.61.

Obesity causes heart failure when $25 \leq \text{BMI} \leq 30$ AND sex=female, risk ratio = 2.50.

Obesity causes hypertension when $99.4 \leq \text{Waist Circumference} \leq 106.2$ AND sex=male, risk ratio = 2.50.
when systolic BB $\geq 140$mmHg AND/OR diastolic BB $\geq 90$ mmHg

hypertension

causes

canonic renal
disease

risk ratio = 2.00

when smoking status = current AND sex=male

smoking

is an issue in

canonic renal
disease

risk ratio = 2.40

so far... 253 major risk associations (or evidences) identified in medical literature (which involve 53 health conditions and 82 related observables) as included in the CARRE risk factor database and predictive model
risk factor reference repository
Risk factors reference repository

Risk evidence:
- Risk factor: age (as an issue in ischemic heart disease)
  - Observable: age (years), sex
  - Observable condition: age (years) ≤ 59 AND age (years) ≥ 64 AND sex = 'female'
  - Ratio type: relative risk
  - Ratio value: 0.63
  - Confidence interval min: 0.33
  - Confidence interval max: 0.90
- Adjusted for: age, study year, and area, smoking, HDL cholesterol ratio, systolic blood pressure, BMI, diabetes

Source: 10009784
- Entered by: Kartlop Patil
- Reviewed by: Stefanos Roumeliotis, Gihtare Juozalaitis, Poumis Paspardakis

Article: 10009784 (link to PubMed)

Sex, age, cardiovascular risk factors, and coronary heart disease: a prospective follow-up study of 14,796 middle-aged men and women in Finland

Josip M P(1), Vartiainen E, Tuomilehto J, Poska P

Author Information:
(1)National Public Health Institute, Department of Epidemiology and Health Promotion, Helsinki, Finland; peka.josip@iki.fi

BACKGROUND: Coronary heart disease (CHD) is markedly more common in men than in women. In both sexes, CHD risk increases with age, but the increase is sharper in women. We analyzed the extent to which major cardiovascular risk factors can explain the sex difference and the age-related increase in CHD risk.

METHODS AND RESULTS: The study cohort consists of 14,796 Finnish men and women 23 to 64 years old at baseline. The following cardiovascular risk factors were determined: smoking, serum total cholesterol, HDL cholesterol, blood pressure, body mass index, and diabetes. Risk factor measurements were done in 1982 or 1992, and the cohorts were followed up until the end of 1994. The Cox proportional hazards model was used to assess the relation between risk factors and CHD risk. CHD incidence in men compared with women was approximately 3 times higher and mortality was approximately 5 times higher. Most of the risk factors were more favorable in women, but the sex difference in risk factor levels diminished with increasing age. Differences in risk factors between sexes, particularly in HDL cholesterol and smoking, explained nearly half of the difference in CHD risk between men and women. Differences in serum total cholesterol level, blood pressure, body mass index, and diabetes prevalence explained about one-third of the age-related increase in CHD risk among men and 50% to 60% among women.

CONCLUSIONS: Differences in major cardiovascular risk factors explained a substantial part of the sex difference in CHD risk. An increase in risk factor levels was associated with the age-related increase in CHD incidence and mortality in both sexes but to a larger extent in women.

PMID: 10009784 (Published - Indexed for MEDLINE)
risk factor reference repository
risk factor reference repository
risk factor reference repository
risk factor reference repository
CARRE approach

- weight
- physical activity
- blood pressure
- glucose

quantified self

personal health information

social media

patient empowerment & decision support services

comorbidity model visualization (generic and personalized)

medical evidence aggregation

medical literature

PubMed

MedlinePlus

Educational resources

private data harvesting & interlinking

public

LOD
personal data aggregators

- sensor aggregators
- medical data aggregators from personal health record
- manual entry system for personal medical data
- intention extraction form web searches
aggregator integration
https://carre.kmi.open.ac.uk/devices/

CARRE D.3..2 & D.3.3, 2015
CARRE approach

quantified self

patient empowerment &
decision support services

comorbidity model visualization
(generic and personalized)

data harvesting & interlinking

private

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weight
physical activity
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glucose

social media

educational resources

FP7 – ICT - 614440

http://www.carre-project.eu
public RDF SPARQL endpoint


A SPARQL query to retrieve RDF triples about educational objects

http://www.carre-project.eu
triples about educational objects

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<td>tissue, ultimately promoting visceral adiposity, insulin resistance, dy effects on the bone, causing &amp; low turnover;</td>
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<td>&quot;Angina is chest pain or discomfort you feel when there is not enough heart muscle needs the oxygen that the blood carries. Angina may f cheek. It may feel like indigestion. You may also feel pain in your sh high substance called plaque builds up in the arteries that supply blood to t three types of angina:Stable angina is the most common type. It happens</td>
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restful API

CARRE approach

- Evidence based medical literature
  - PubMed
  - MedlinePlus
  - Educational resources

- Medical evidence aggregation

- Quantified self
  - Weight
  - Physical activity
  - Blood pressure
  - Glucose
  - Personal health information
  - Social media

- Private data harvesting & interlinking

- Public data

- LOD

- Patient empowerment & decision support services

- Comorbidity model visualization (generic and personalized)
visual analytics for the patient
visual analytics for the patient
visual analytics for the patient
decision support services

interlace personal data and medical evidence for personalized services to

- plan
- monitor
- alert
- educate
visual analytics for the patient
educational aggregator

https://edu.carre-project.eu/
### Evaluation Framework & Plan*

<table>
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<th>CARRE System Functions</th>
<th>Human Perspectives</th>
<th>Context and Environment</th>
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<td>Experts</td>
<td>Patients</td>
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<td>aggregators and</td>
<td>changes to working</td>
<td>new skills, and</td>
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<td><strong>Process</strong></td>
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<td>satisfaction</td>
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1: component testing
2: service testing & understanding
3: service evaluation
evaluation

- 2 center randomized control trial

- primary objectives
  - increase health literacy
  - increase level of patient empowerment (SUSTAINS instrument)
  - improve quality of life (SF-36 instrument)
  - reduce personal risk for cardiorenal disease and comorbidities
  - improve or prevent disease progression (clinical & laboratory parameters)
  - improve lifestyle habits (sensor readings)
  - limit no. or dose of necessary drugs (dose of essential drugs)
  - assess intervention acceptability

- study population for each pilot site (total = 160 patients)
- group 1: patients at risk of heart or renal disease (80 patients)
- group 2: patients with heart or renal disease (80 patients)

primary population
- group 1: patients at risk of heart or renal disease (80 patients)
- CARRE intervention (40 patients)
- control group (40 patients)
- group 2: patients with heart or renal disease (80 patients)
- CARRE intervention (40 patients)
- control group (40 patients)

secondary population
- CARRE D.7.4, 2016 (in progress)

http://www.carre-project.eu
**what?**
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3.2M, 2013-2016
DUTH, OU, BED, VULSK, KTU, PIAP

**why?**
cardiorenal disease
chronic, common, dangerous, expensive, with many causing factors and complex progression

**how?**
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for the patient

thank you !!!
acknowledgment

work funded under project CARRE

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Information and Communication Technologies (ICT)
7th Framework Programme
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CARRE: Personalized patient empowerment
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http://www.carre-project.eu/
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