

## CARRE

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

Eleni Kaldoudi

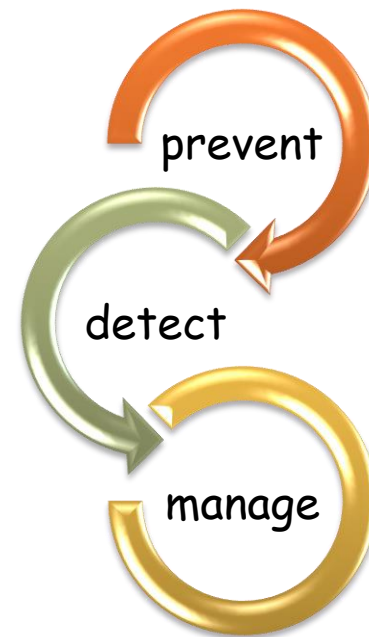
CARRE Coordinator  
Associate Professor

School of Medicine, Democritus University of Thrace, Greece

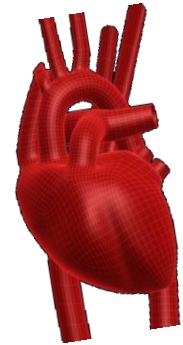


# motivation

- 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

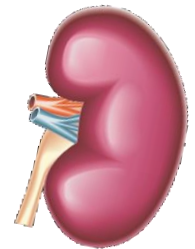


# medical domain



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



FP7-ICT-2013-611140

consortium: 6 partners from 4 EU countries

coordinator: Eleni Kaldoudi (DUTH)

duration: Nov 2013 – Oct 2016

budget: 3,210,470€

<http://carre-project.eu/>

# CARRE

Cardiorenal  
comorbidity management  
via **empowerment** and  
shared informed decision



Democritus Univ. of Thrace  
DUTH, GR



The Open  
University, UK



Univ. of Bedfordshire, UK



Vilnius Univ. Hospital, LT

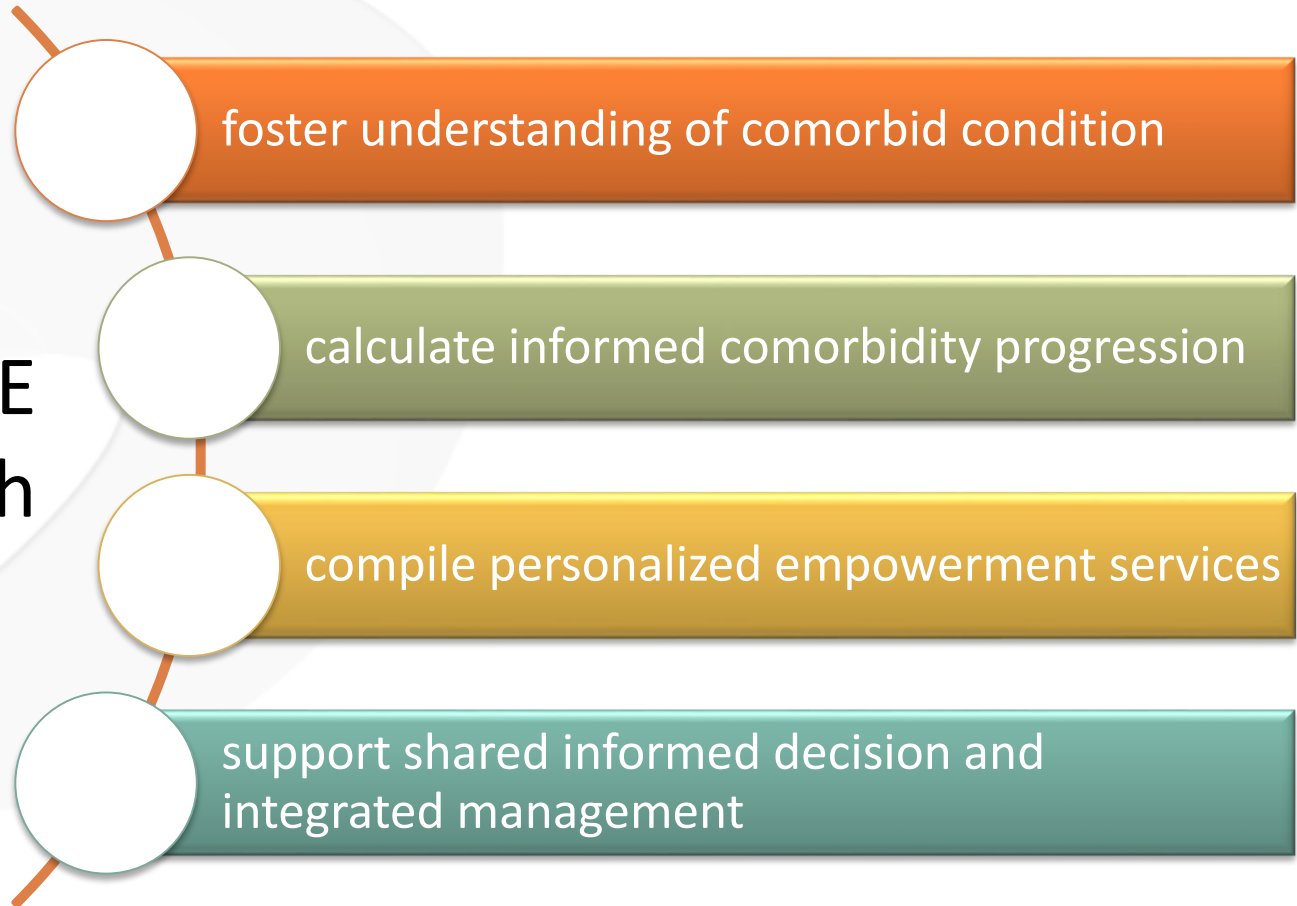


Kaunas Univ., LT

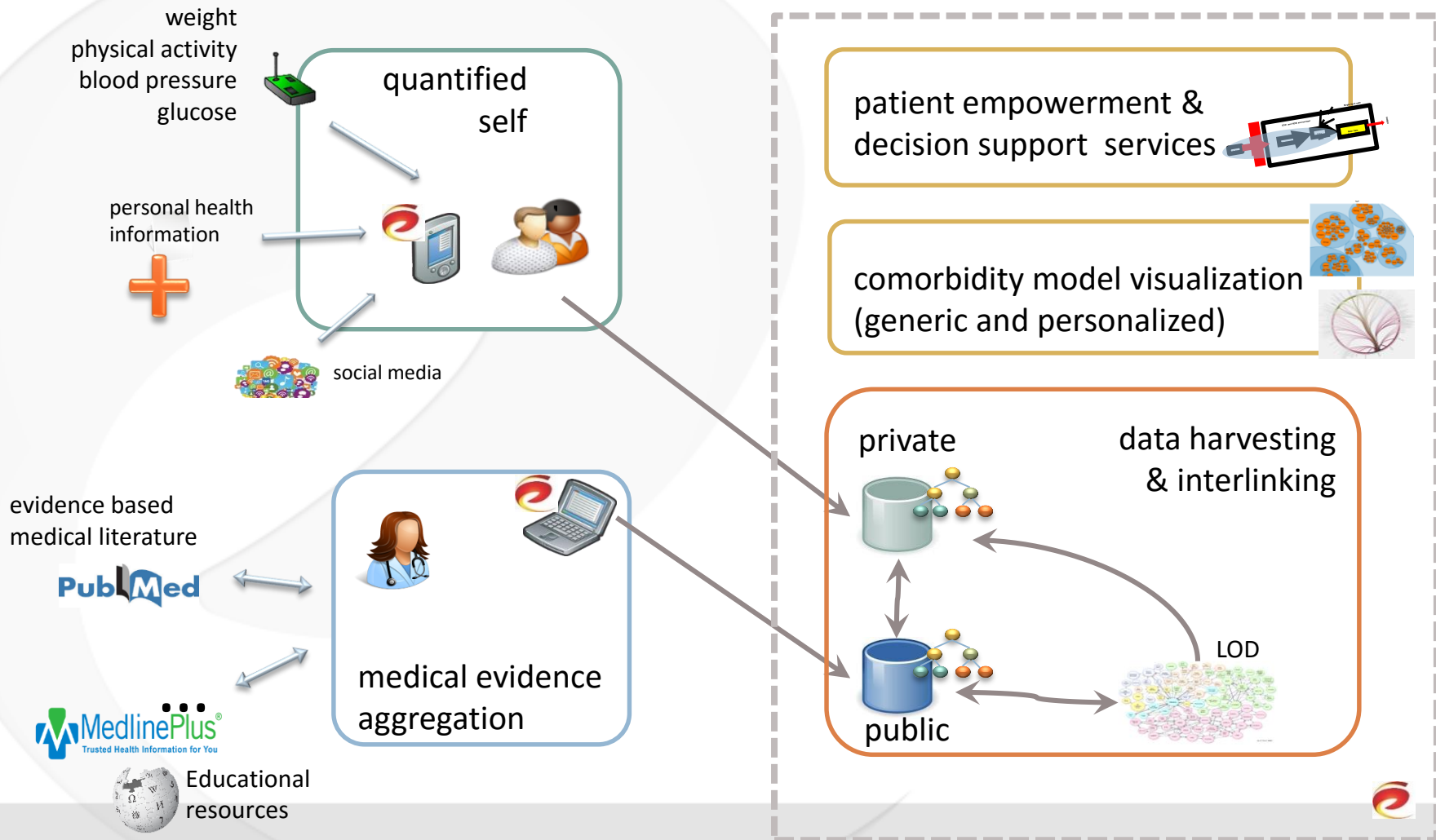


Industrial Research Institute  
for Automation & Measurements, PL

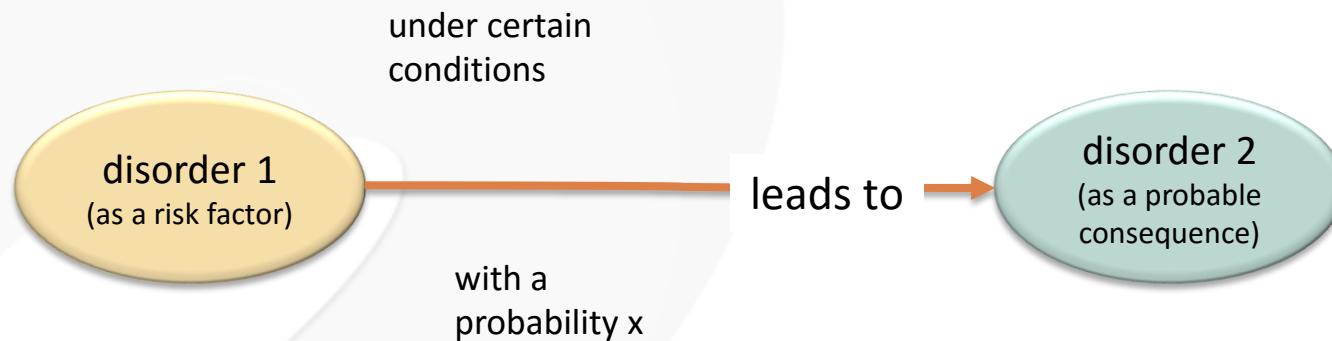
## CARRE approach



# CARRE approach



# risk factor as a central concept



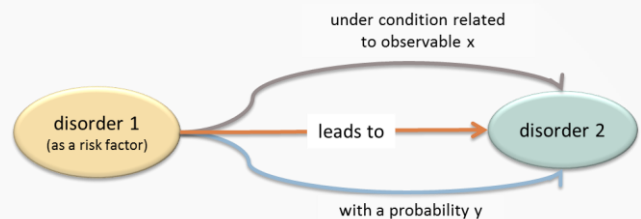
risk factors are reported in medical literature  
(top level evidence: systematic reviews with meta-analysis)

E. Kaldoudi, et al. CARRE D.2.1, 2014, [www.carre-project.eu](http://www.carre-project.eu)

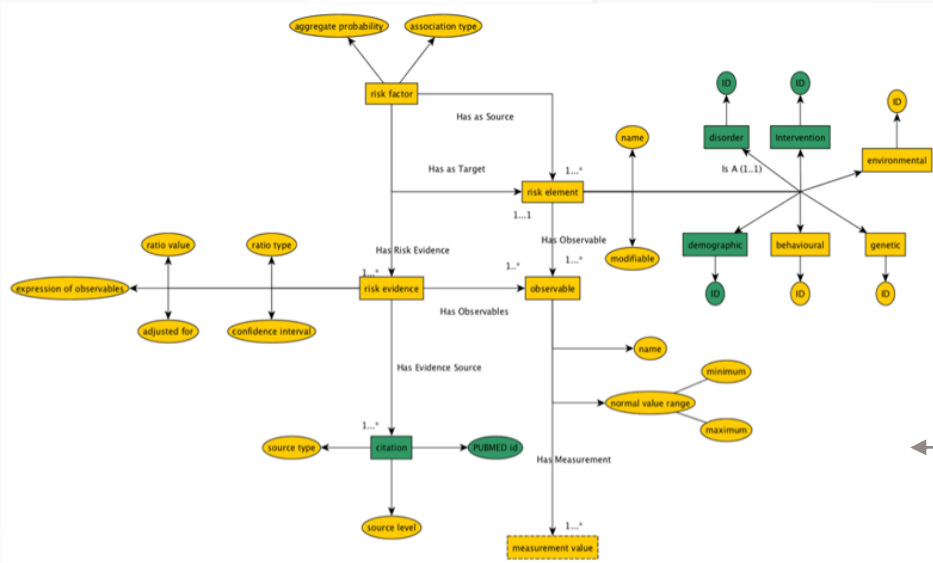
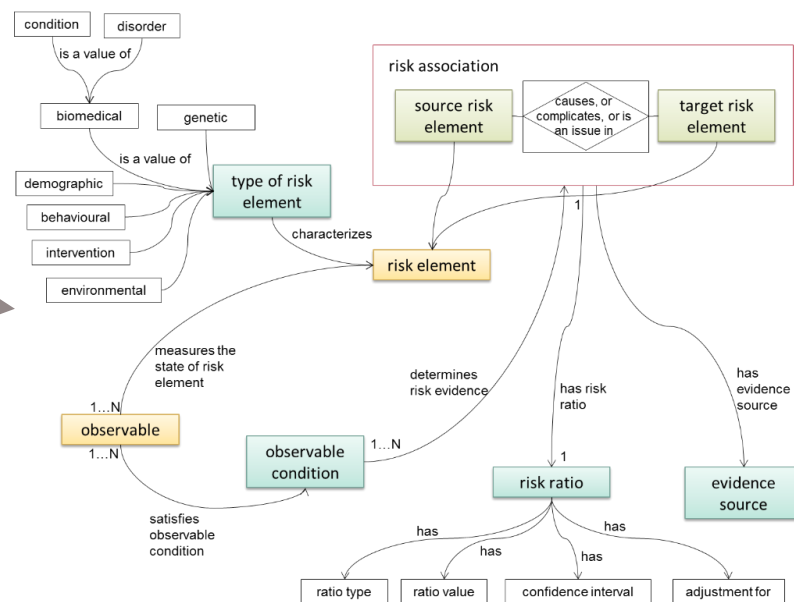
A. Third, E. Kaldoudi, G. Gotsis, S. Roumeliotis, K. Pafili, J. Domingue,



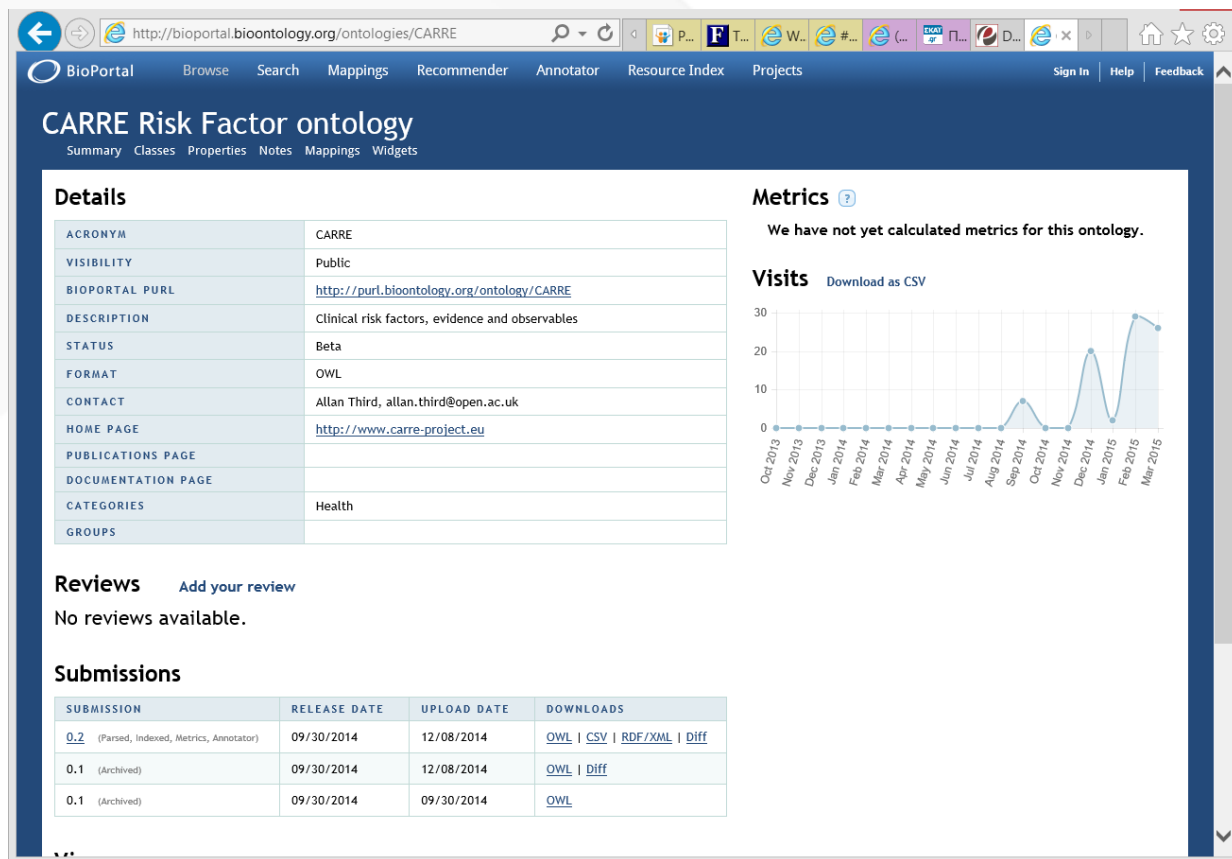
# CARRE risk factor ontology



## conceptual model

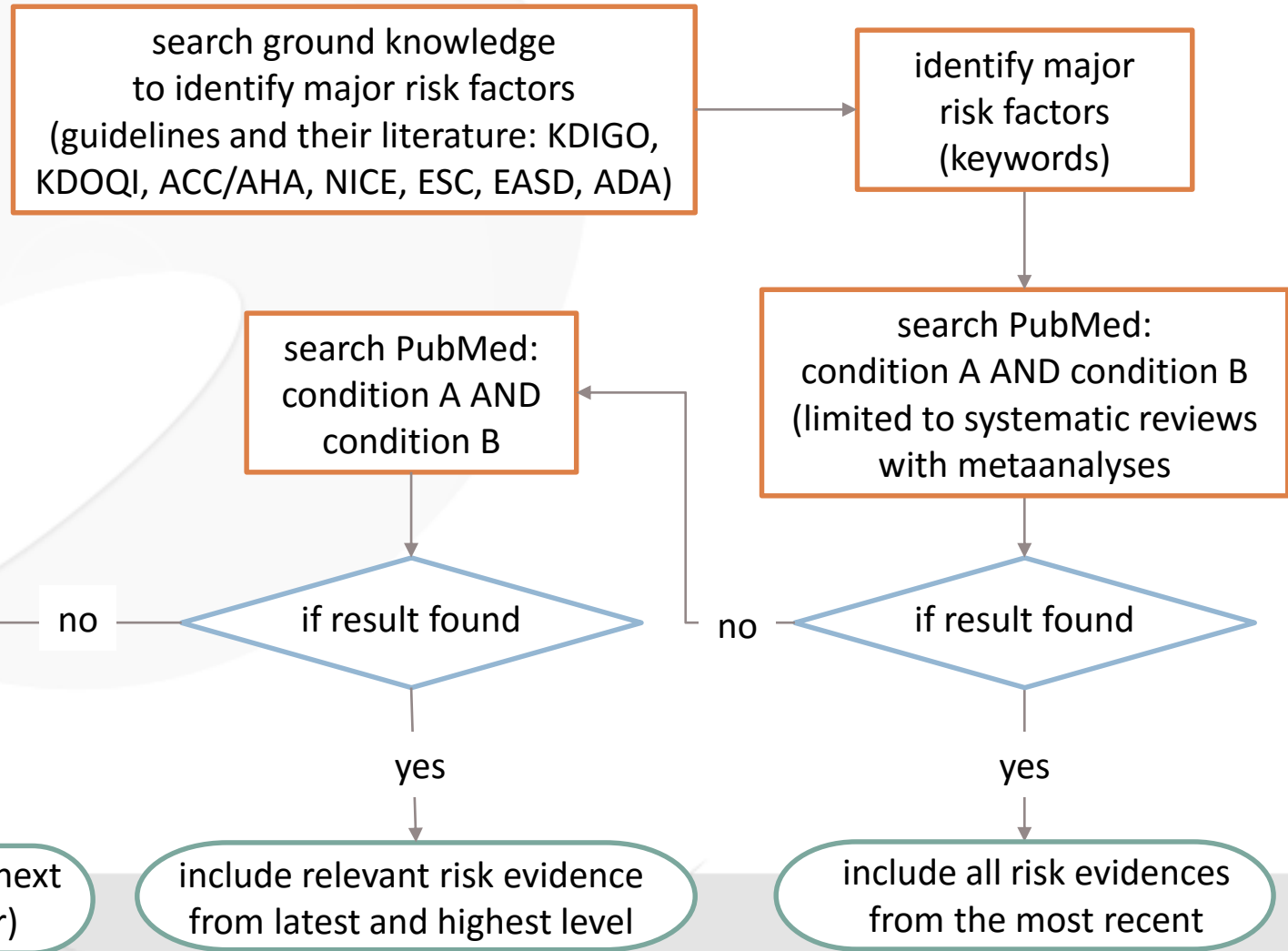


# CARRE risk factor ontology



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

# risk factor identification methodology

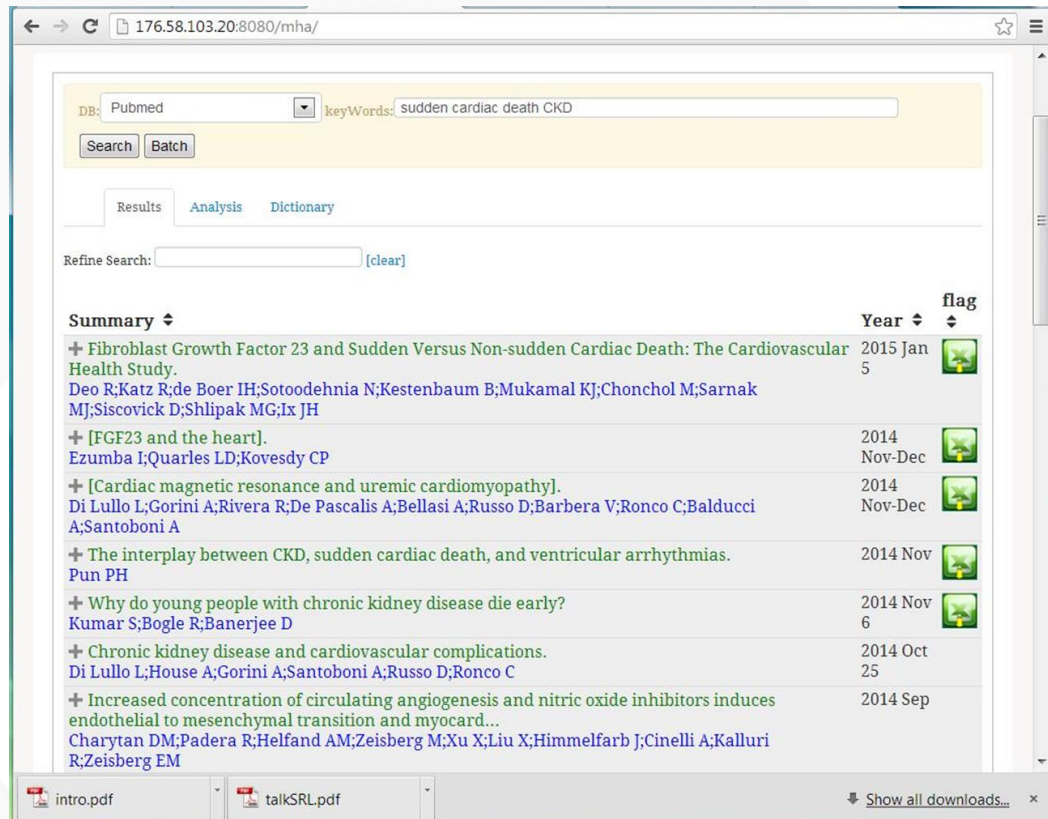


# some of the **major** related conditions

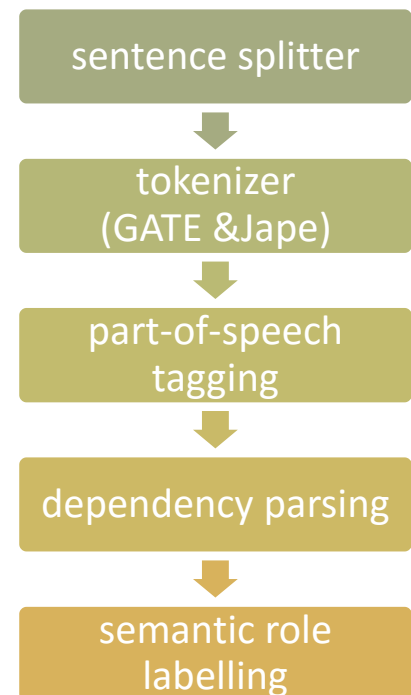
1. *Acute kidney injury*
2. *Acute myocardial infarction*
3. *Age*
4. *Albuminuria*
5. *Anaemia*
6. *Angina pectoris*
7. *Asthma*
8. *Atrial fibrillation*
9. *Chronic kidney disease*
10. *Chronic obstructive pulmonary disease*
11. *Cholelithiasis*
12. *Colorectal Cancer*
13. *Coronary and carotid revascularisation*
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/>



E. Liu, et al. CARRE D.3.4, 2015



# medical evidence aggregator

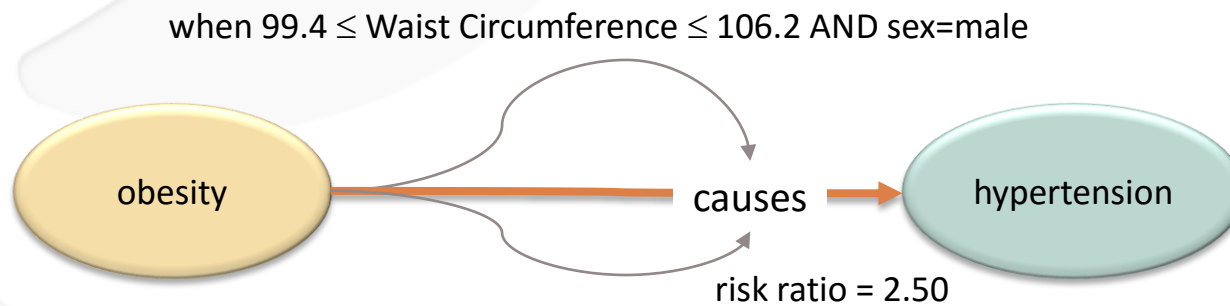
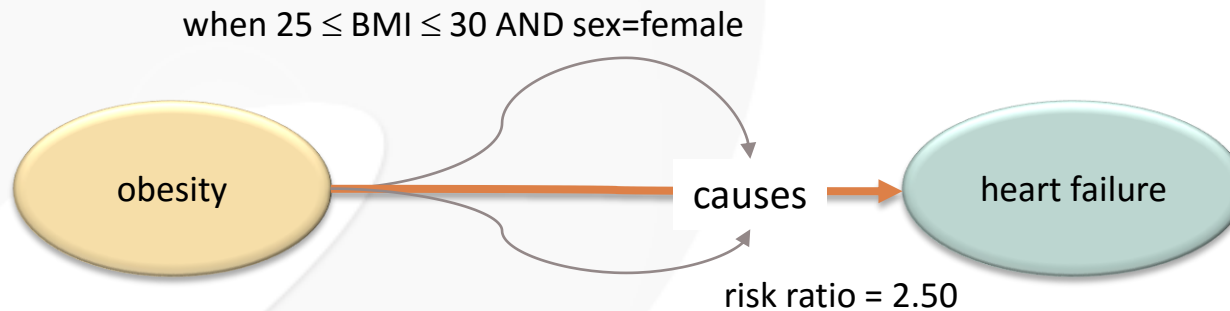
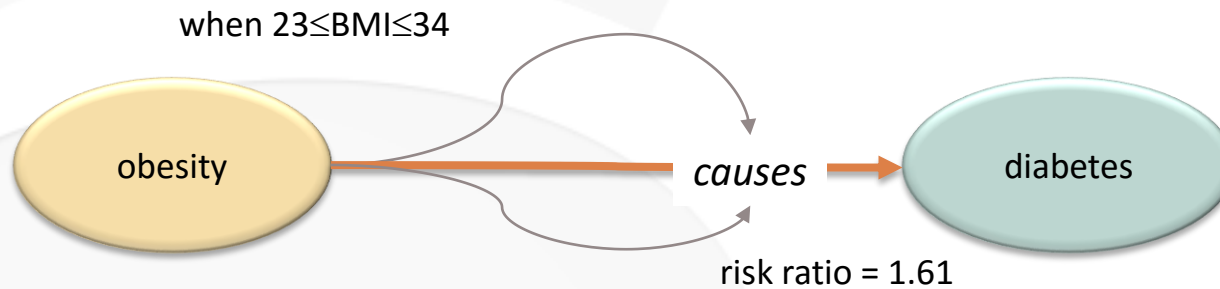
<https://www.carre-project.eu/innovation/medical-evidence-aggregator/>

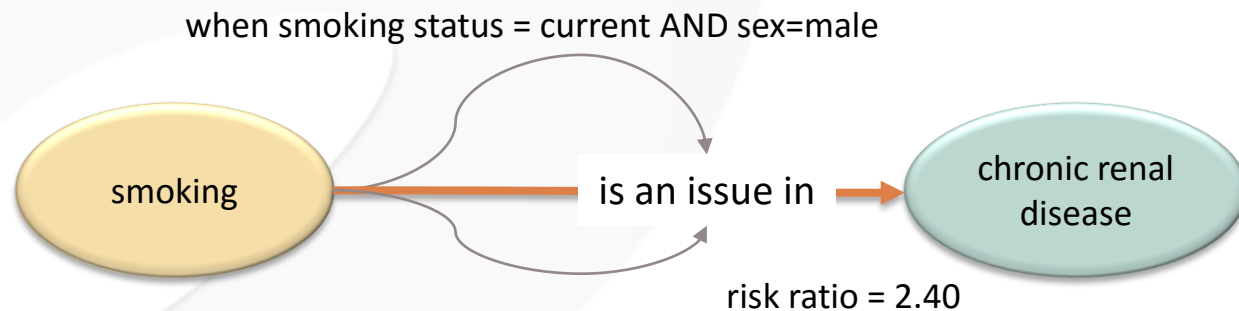
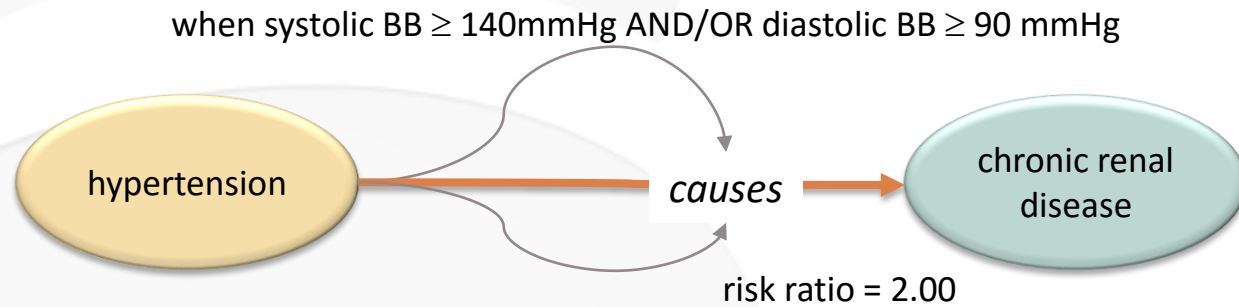
The interface shows a search for 'sudden cardiac death CKD' in the Pubmed database. The results list several articles, including 'Fibroblast Growth Factor 23 and Sudden Versus Non-sudden Cardiac Death: The Car Health Study' and 'Fibroblast Growth Factor 23 and Sudden Versus Non-sudden Cardiac Death: The Car Health Study'.

The analysis of the selected article shows the following keyword tags: **patients\_withTag**, **NumberFactor**, **NumberTag**, **PercentTag**, **DecimalTag**, **CarreTags**, **CA\_NewRiskLinkTag**, **CA\_PositiveStrongLinkTag**, **CarreRiskTag**, **CarreResultTag**, **CA\_NegativeStrongLinkTag**, **CA\_NegativeWeakLinkTag**, **CA\_PositiveWeakLinkTag**, **HotmapTags**, **HM\_PositiveStrongLinkTag**, **HM\_NegativeWeakLinkTag**, **HM\_PositiveWeakLinkTag**, **GeneTag**, **HM\_NegativeStrongLinkTag**, **TumorTag**.

The analysis also shows the following extracted knowledge: **unknown Knowledge** (1. Strong Prove, 2. Normal Association, 3. Weak Prove, 4. Strong Prove, 5. Normal Association) and **known Knowledge**.

E. Liu, et al. CARRE D.3.4, 2015





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**

# http://entry.carre-project.eu/

Μήνυμα ενότητος | HEALTHINF 2016 | BIOSTEC 2016 - ε | Google Maps | Analysis of H2021 | "a high proportic | CARRE Risk E

entry.carre-project.eu

Add to the favorites bar by selecting ☆, or by getting them from another browser. [Import your favorites](#)

Dashboard

- Risk Factors
- Risk Evidences
- Risk Elements
- Observables
- Citations
- Measurement Types
- Medical experts

```
graph TD
    condition -- "is a value of" --> disorder
    condition -- "is a value of" --> biomedical
    condition -- "is a value of" --> genetic
    condition -- "is a value of" --> demographic
    condition -- "is a value of" --> behavioural
    condition -- "is a value of" --> intervention
    condition -- "is a value of" --> environmental
    condition -- "is a value of" --> type_of_risk_element
    type_of_risk_element -- "characterizes" --> risk_element
    risk_element -- "determines risk evidence" --> risk_ratio
    risk_ratio -- "has risk ratio" --> risk_factor
    risk_ratio -- "has evidence source" --> evidence_source
    risk_ratio -- "has" --> ratio_type
    risk_ratio -- "has" --> ratio_value
    risk_ratio -- "has" --> confidence_interval
    risk_ratio -- "has" --> adjustment_for
    observable -- "measures the state of risk element" --> risk_element
    observable -- "satisfies observable condition" --> observable_condition
    observable -- "1..N" --> risk_ratio
    observable -- "1..N" --> observable_condition
    observable -- "1..N" --> risk_factor
    observable -- "1..N" --> evidence_source
    risk_factor -- "causes, or complicates, or is an issue in" --> target_risk_element
```

Category	Count
Risk Factors	96
Risk Evidences	253
Risk Elements	53
Observables	82
Citations	60

Hello Guest!  
Please login if you want to add/edit data.

**i** 96  
reviewed!

Risk Factors

**i** 253  
0 unreviewed!

Risk Evidences

**i** 53  
0 unreviewed!

Risk Elements

**i** 82  
17 unreviewed!

Observables

**i** 60

Citations

CARRE Project © 2015

CARRE project is partly funded by the EC under the grant no. FP7-ICT-611140.

CARRE Risk Entry Sys

entry.carre-project.eu/risk\_factors

CARRE Risk entry system

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## Risk factors

View	Source	Target	Association type
<input type="checkbox"/>	acute kidney disease	chronic kidney disease	is an issue in
<input type="checkbox"/>	acute kidney disease	death	causes
<input type="checkbox"/>	age	ischemic heart disease	is an issue in
<input type="checkbox"/>	age	peripheral arterial disease	is an issue in
<input type="checkbox"/>	anemia	acute myocardial infarction	is an issue in
<input type="checkbox"/>	anemia	death	is an issue in
<input type="checkbox"/>	atrial fibrillation	heart failure	is an issue in
<input type="checkbox"/>	atrial fibrillation	ischemic stroke	is an issue in
<input type="checkbox"/>	beta-blockers	diabetes	is an issue in
<input type="checkbox"/>	cardiovascular events group 4	peripheral vascular disease	is an issue in

Total Items: 96 (Showing Items: 10)

1

/ 10

10

items per page

1 \_ 10 of 96 items

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entry.carre-project.eu/risk\_factors/RF\_1

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ID: RF\_1

Source: acute kidney disease

Target: chronic kidney disease

Association type: is an issue in

Entered by: Laurynas Rimsevicius

Reviewed by: Stefanos Roumeliotis, Ploumis Passadakis

Related risk evidences

View	Risk factor	Observable condition	Ratio value
	acute kidney disease [is an issue in] chronic kidney disease	acute kidney disease diagnosis = 'yes'	8.8
	acute kidney disease [is an issue in] chronic kidney disease	acute kidney disease diagnosis = 'mild'	2.0
	acute kidney disease [is an issue in] chronic kidney disease	acute kidney disease diagnosis = 'moderate'	3.3
	acute kidney disease [is an issue in] chronic kidney disease	acute kidney disease diagnosis = 'severe'	28.2



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entry.carre-project.eu/risk\_evidences

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## Risk evidences

✓	View	Risk factor <sup>▲</sup> <sub>0</sub>	Observable condition	Ratio value
✓		central obesity [is an issue in] acute myocardial inf...	waist circumference >= 88 AND se...	1.4
✓		central obesity [reduces] high-density lipoprotein c...	( waist circumference < 102 AND w...	1.7
✓		central obesity [reduces] high-density lipoprotein c...	waist circumference >= 102 AND s...	2.0
✓		central obesity [reduces] high-density lipoprotein c...	( waist circumference < 88 AND wa...	1.8
✓		central obesity [reduces] high-density lipoprotein c...	waist circumference >= 88 AND se...	2.6
✓		chronic kidney disease [causes] cardiovascular ev...	( estimated glomerular filtration rate...	1.4
✓		chronic kidney disease [causes] cardiovascular ev...	( estimated glomerular filtration rate...	2.0
✓		chronic kidney disease [causes] cardiovascular ev...	( estimated glomerular filtration rate...	2.8
✓		chronic kidney disease [causes] cardiovascular ev...	estimated glomerular filtration rate ...	3.4
✓		chronic kidney disease [causes] death	chronic kidney disease diagnosis (...)	1.2

Total Items: 253 (Showing Items: 10)

◀

◀

5

/ 26

▶

▶

10 items per page

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<http://entry.carre-project.eu/>

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entry.carre-project.eu/risk\_evidences/RV\_48

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ID: RV\_48

Risk factor: **chronic kidney disease [causes] cardiovascular events group 1**

Observable: **chronic kidney disease diagnosis (5 levels, sublevels), estimated glomerular filtration rate**

Observable condition: ( **estimated glomerular filtration rate <= 29 AND estimated glomerular filtration rate >= 15** ) OR **chronic kidney disease diagnosis (5 levels, sublevels) = 'stage4'**

Ratio type: **hazard ratio**

Ratio value: **2.8**

Confidence Interval min: **2.6**

Confidence Interval max: **2.9**

Is adjusted for: **age, sex, income, education, use or nonuse of dialysis, the presence or absence of prior Ischemic heart disease, prior chronic heart failure, prior ischemic stroke or transient ischemic attack, prior peripheral arterial disease, diabetes mellitus, hypertension, dyslipidemia, cancer, a serum albumin level of 3.5 g per deciliter or less, dementia, cirrhosis or chronic liver disease, chronic lung disease, documented proteinuria, prior hospitalizations**

Article : 15385656 [link to PubMed](#)

1. N Engl J Med. 2004 Sep 23;351(13):1296-305.

Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization.

Go AS(1), Chertow GM, Fan D, McCulloch CE, Hsu CY.

Author information:

(1)Division of Research, Kaiser Permanente of Northern California, Oakland, CA

94612-2304, USA. alan.s.go@kp.org

Erratum in

N Engl J Med. 2008;18(4):4.

Comment in

N Engl J Med. 2005 Jan 13;352(2):199-200; author reply 199-200.

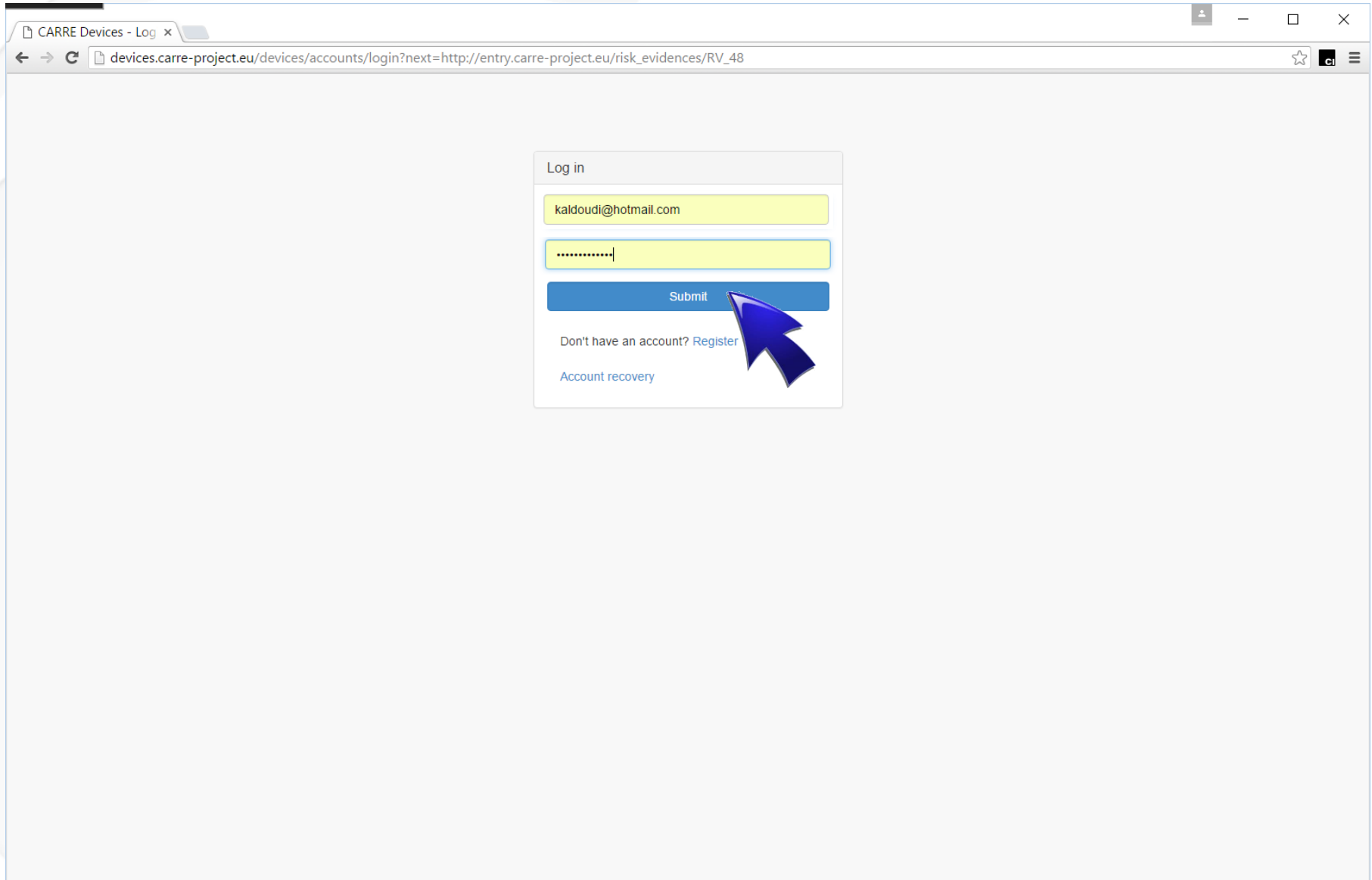
ACP J Club. 2005 Mar-Apr;142(2):50-1.

N Engl J Med. 2004 Sep 23;351(13):1344-6.

N Engl J Med. 2005 Jan 13;352(2):199-200; author reply 199-200.

BACKGROUND: End-stage renal disease substantially increases the risks of death, cardiovascular disease, and use of specialized health care, but

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ID: RV\_48

Edit

Risk factor: chronic kidney disease [causes] cardiovascular events group 1

Observable: chronic kidney disease diagnosis (5 levels, sublevels), estimated glomerular filtration rate

Observable condition: ( estimated glomerular filtration rate <= 29 AND estimated glomerular filtration rate >= 15 ) OR chronic kidney disease diagnosis (5 levels, sublevels) = 'stage4'

Ratio type: hazard ratio

Ratio value: 2.8

Confidence Interval min: 2.6

Confidence Interval max: 2.9

Is adjusted for: age, sex, income, education, use or nonuse of dialysis, the presence or absence of prior Ischemic heart disease, prior chronic heart failure, prior ischemic stroke or transient ischemic attack, prior peripheral arterial disease, diabetes mellitus, hypertension, dyslipidemia, cancer, a serum albumin level of 3.5 g per deciliter or less, dementia, cirrhosis or chronic liver disease, chronic lung disease, documented proteinuria, prior hospitalizations

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Risk factor

chronic kidney disease [causes] cardiovascular events group 1

Observables

chronic kidney disease diagnosis (5 levels, sublevels)

estimated glomerular filtration rate

Condition

estimated glomerular filtration rate <= 29 AND estimated glomerular filtration rate >= 15

OR chronic kidney disease diagnosis (5 levels, sublevels) = stage4

Show editor

Ratio value

2.8

Ratio Type

Hazard ratio

Evidence source

Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization

Go AS, Chertow GM, Fan D, McCulloch CE, Hsu CY

N Engl J Med

Adjusted for

age

sex

income

education

use or nonuse of dialysis

the presence or absence of prior ischemic heart disease

Confidence Interval Minimum

2.7

Confidence Interval Maximum

2.9

Pubmed Id

15385656

Article : 15385656 link to PubMed

1. N Engl J Med. 2004 Sep 23;351(13):1296-305.

Chronic kidney disease and the risks of death, cardiovascular events, and hospitalization.

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chronic kidney disease [causes] cardiovascular events group 1

Observables

chronic kidney disease diagnosis (5 levels, sublevels)

estimated glomerular filtration rate

Condition

(estimated glomerular filtration rate <= 29 AND estimated glomerular filtration rate >= 15) OR chronic kidney disease diagnosis (5 levels, sublevels) = stage4

Hide editor

OR

Add Condition

Add Group

AND

Add Condition

Add Group

Remove Group

estimated glomerular filtration rate

<=

29

ml/min/1.73 m^2

AND

estimated glomerular filtration rate

>=

15

ml/min/1.73 m^2

OR

=

stage4

200.



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**i** About

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## Medical Experts

Vassilis Vargemezis, MD, PhD

[View profile](#)

## Nephrologist

- > Professor Emeritus in Nephrology,  
School of Medicine, Democritus  
University of Thrace (DUTH), Greece  
> (Former) Director of Nephrology  
Clinic, University General Hospital of  
Alexandroupoli, Greece

### Coordinator

DUTH Team

Laurynas Rimsevicius, MD, PhD

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## Nephrologist

- > Lecturer, Faculty of Medicine, Vilnius University, Lithuania
- > Head of Dialysis Unit, Vilnius University Hospital Santariskiu Klinikos, Lithuania

VULSK Team

Domantas Stundys, MD

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## Surgeon

- > Surgeon, Vilnius University Hospital Santariskiu Klinikos, Lithuania
- > Lecturer, Faculty of Medicine, Vilnius University, Lithuania

### Coordinator

VULSK Team

Dimitris Papazoglou, MD, PhD

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## Internal medicine

- > Professor in Internal Medicine (Diabetes), School of Medicine, Democritus University of Thrace (DUTH), Greece

DUTH Team

Ploumis Passadakis, MD, PhD

[View profile](#)

## Nephrologist

- > Professor in Nephrology, School of Medicine, Democritus University of Thrace (DUTH), Greece
  - > Dean of Faculty of Health Sciences, Democritus University of Thrace (DUTH), Greece
  - > Director of Nephrology Clinic, University General Hospital of Alexandroupoli, Greece
- DUTH Team

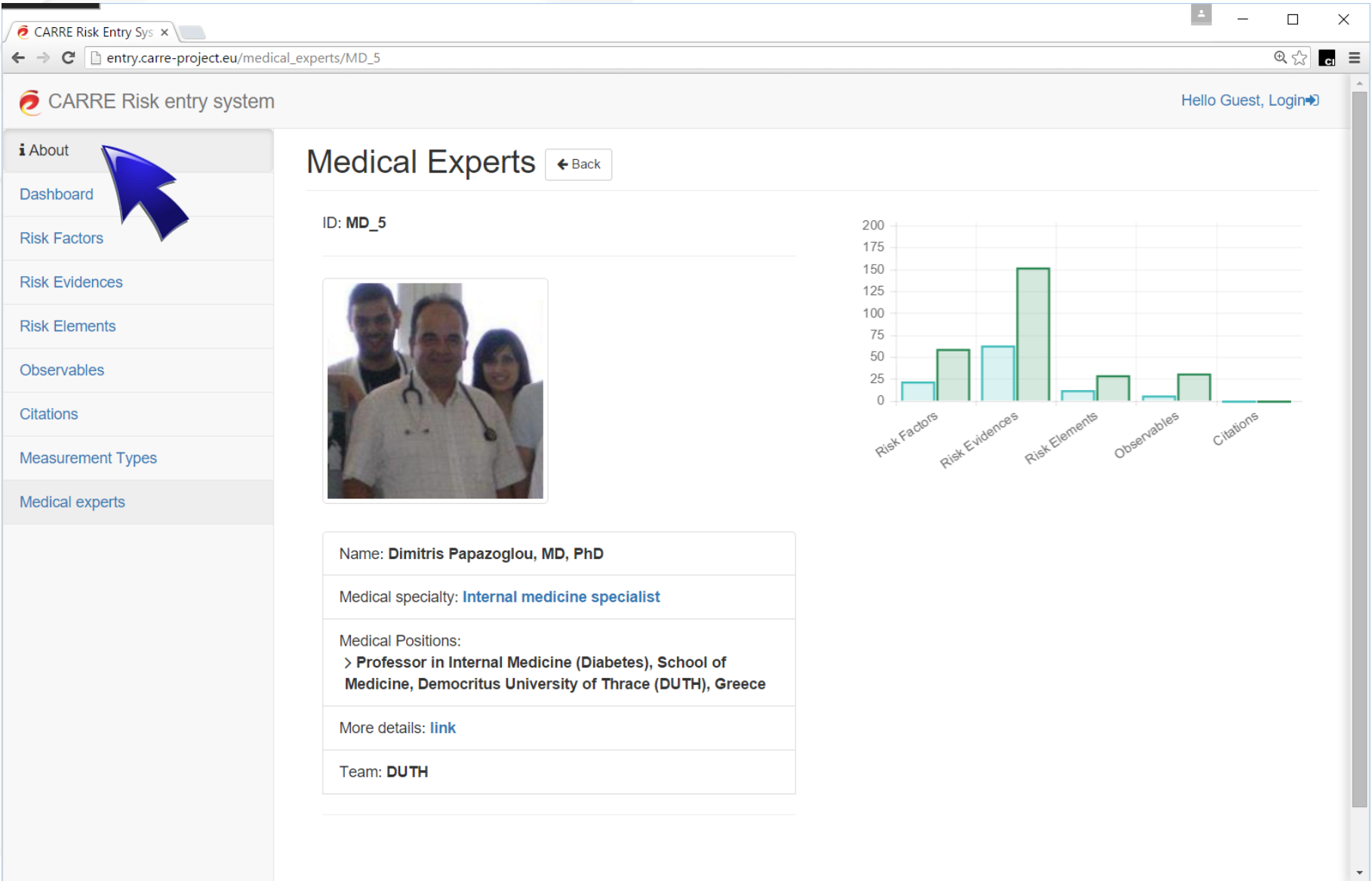
Zydrune Visockiene, MD, PhD

[View profile](#)

## Endocrinologist

- > Associate Professor of Endocrinology, Faculty of Medicine, Vilnius University, Lithuania
- > Head of Endocrinology Center, Vilnius University Hospital Santariskiu Klinikos, Lithuania

VULSK Team



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ID: MD\_5



Name: Dimitris Papazoglou, MD, PhD

Medical specialty: Internal medicine specialist

Medical Positions:  
> Professor in Internal Medicine (Diabetes), School of Medicine, Democritus University of Thrace (DUTH), Greece

More details: link

Team: DUTH

×

The CARRE risk entry system enables the [medical experts](#) in the [CARRE project](#) to encode the risk factors between biological, demographic, lifestyle and environmental elements and clinical outcomes in accordance with evidence from the clinical literature. The presented system is based fundamentally on Linked Data principles, aiming in order to make the best use of these encoded data, the data is made available as Linked Data through the [CARRE SPARQL Endpoint](#), making use of control vocabularies ([UMLS](#), [SNOMED](#), etc.) and the [CARRE risk factor ontology](#); specifically, they are encoded in the (standard) Resource Description Framework ([RDF](#)) format.

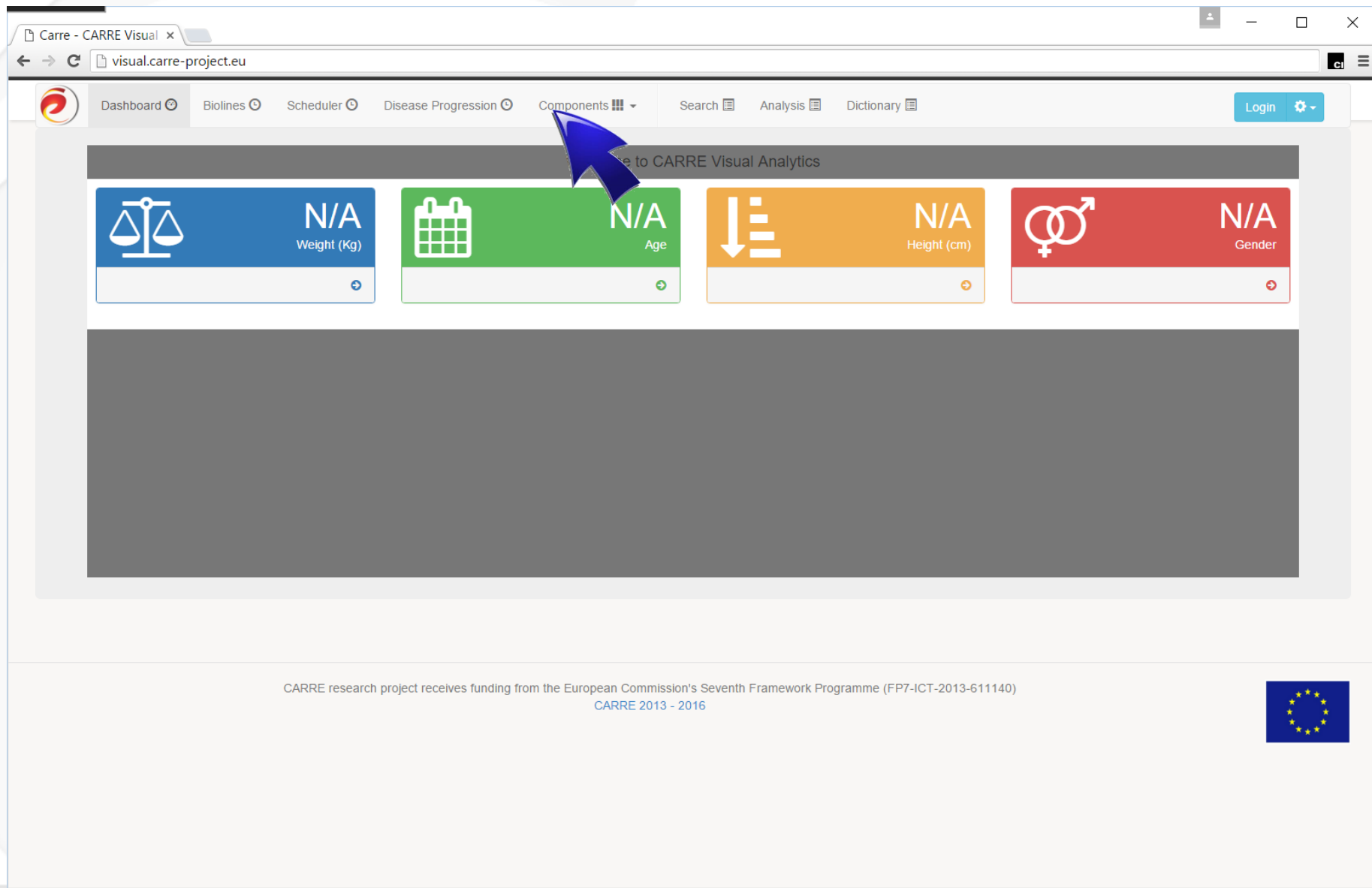
The system has been developed as a client side web application that follows the [Microservices](#) architectural style and provides native RDF support via the [CARRE API](#) and the [CARRE SPARQL Endpoint](#). Moreover custom form components have been developed to reflect the structure of the [CARRE risk factor ontology](#), so that citations, observables, risk elements, risk evidences and risk factors are automatically stored into the CARRE RDF triple store. The CARRE risk entry system is implemented in [HTML5](#), [CSS](#) and [JavaScript](#) using the [AngularJS](#) framework. The system is open source and the source code is available at [GitHub](#). The system maintains referential integrity, so that if “diabetes” is entered as a risk element entity, then a risk factor representing an observed link between diabetes and hypertension will refer to the existing diabetes risk element entity. Medical experts are supported in the reuse of data already entered into the system by the user interface, which allows existing relevant entities to be selected via appropriate searchable lists wherever possible.

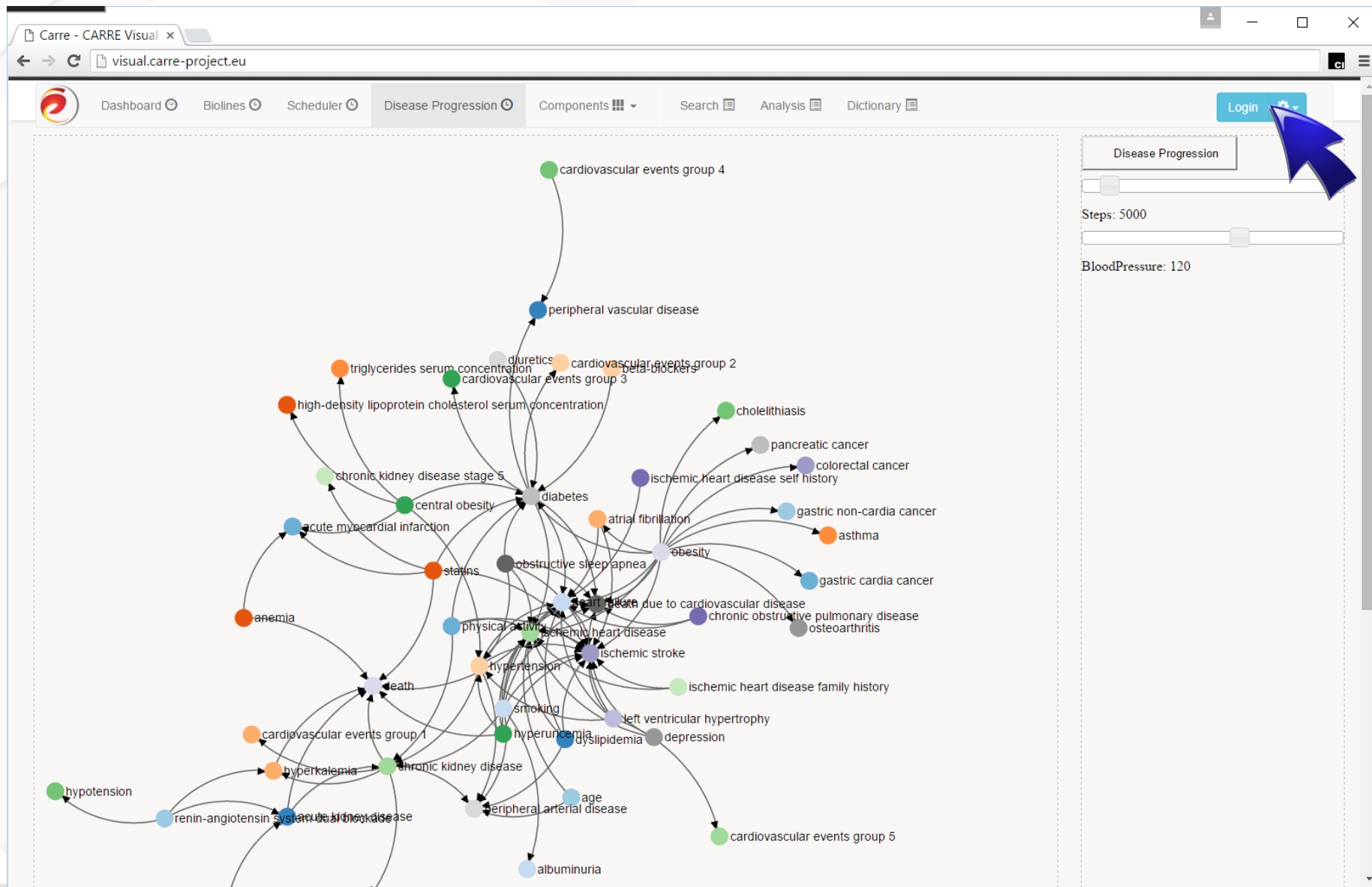
Web development: [Nick Portokallidis](#)

Data cleansing: [George Drosatos](#)

Scientific supervision: [Eleni Kaldoudi](#)

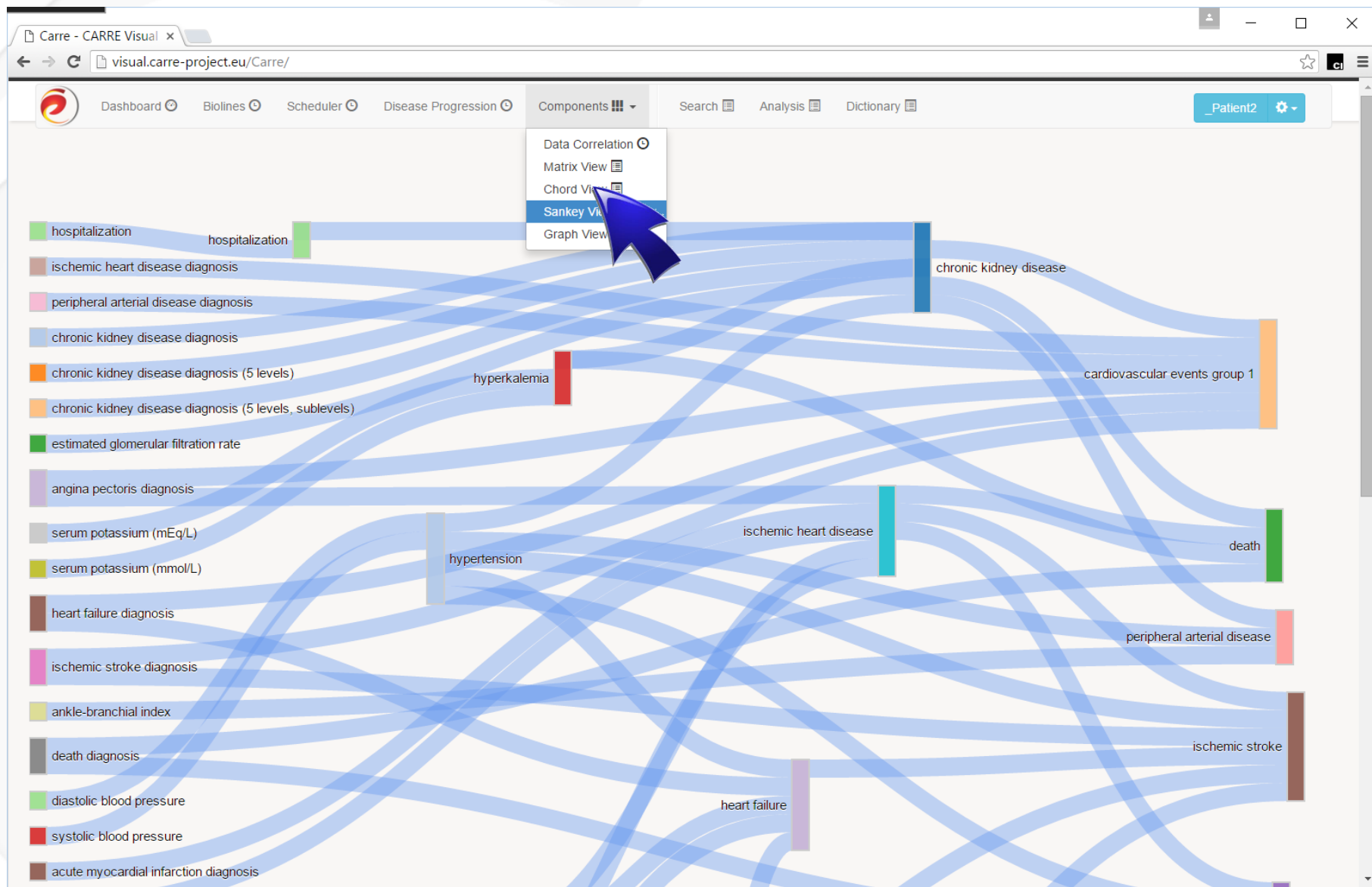
http://entry.carre-project.eu/

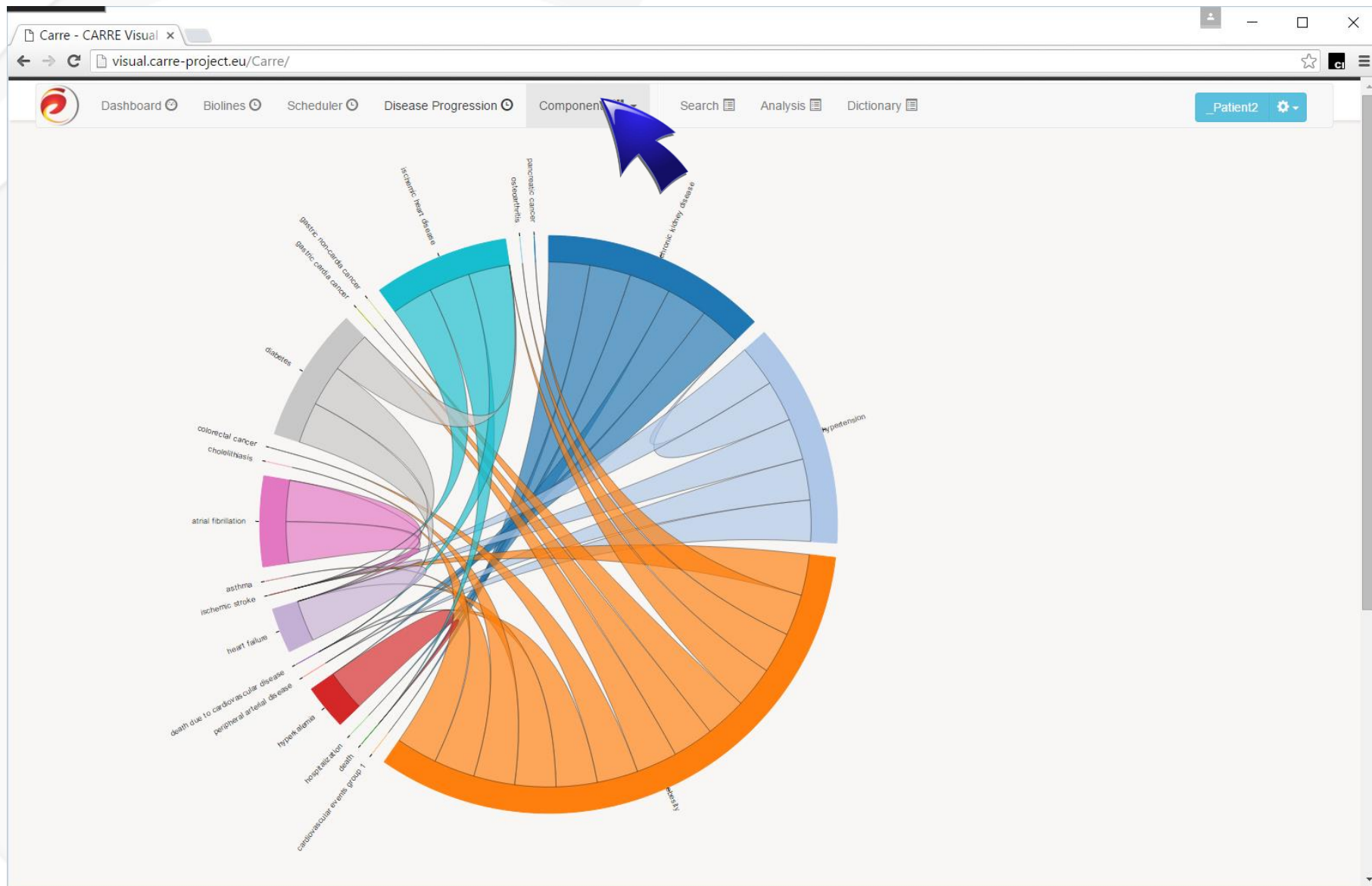


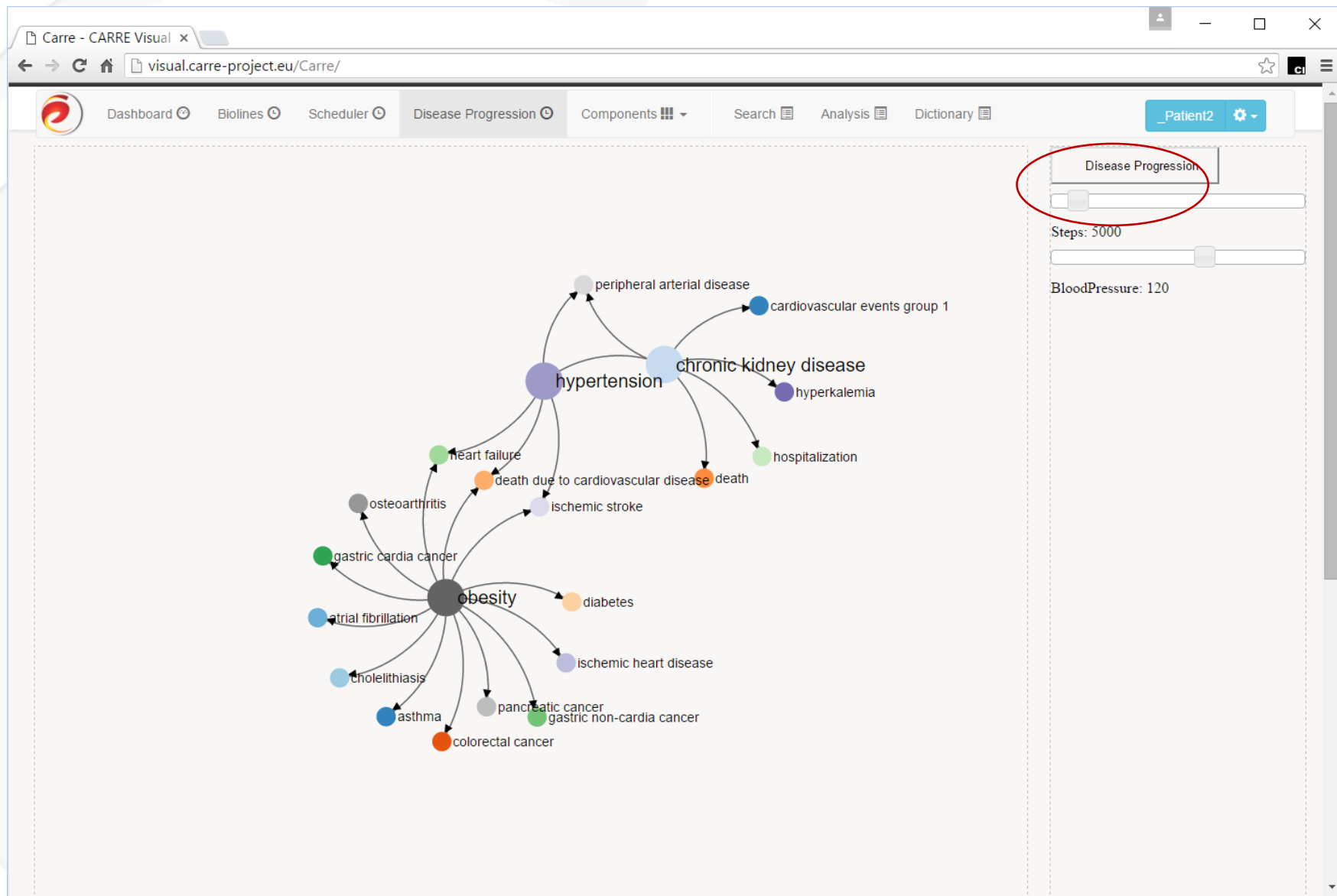


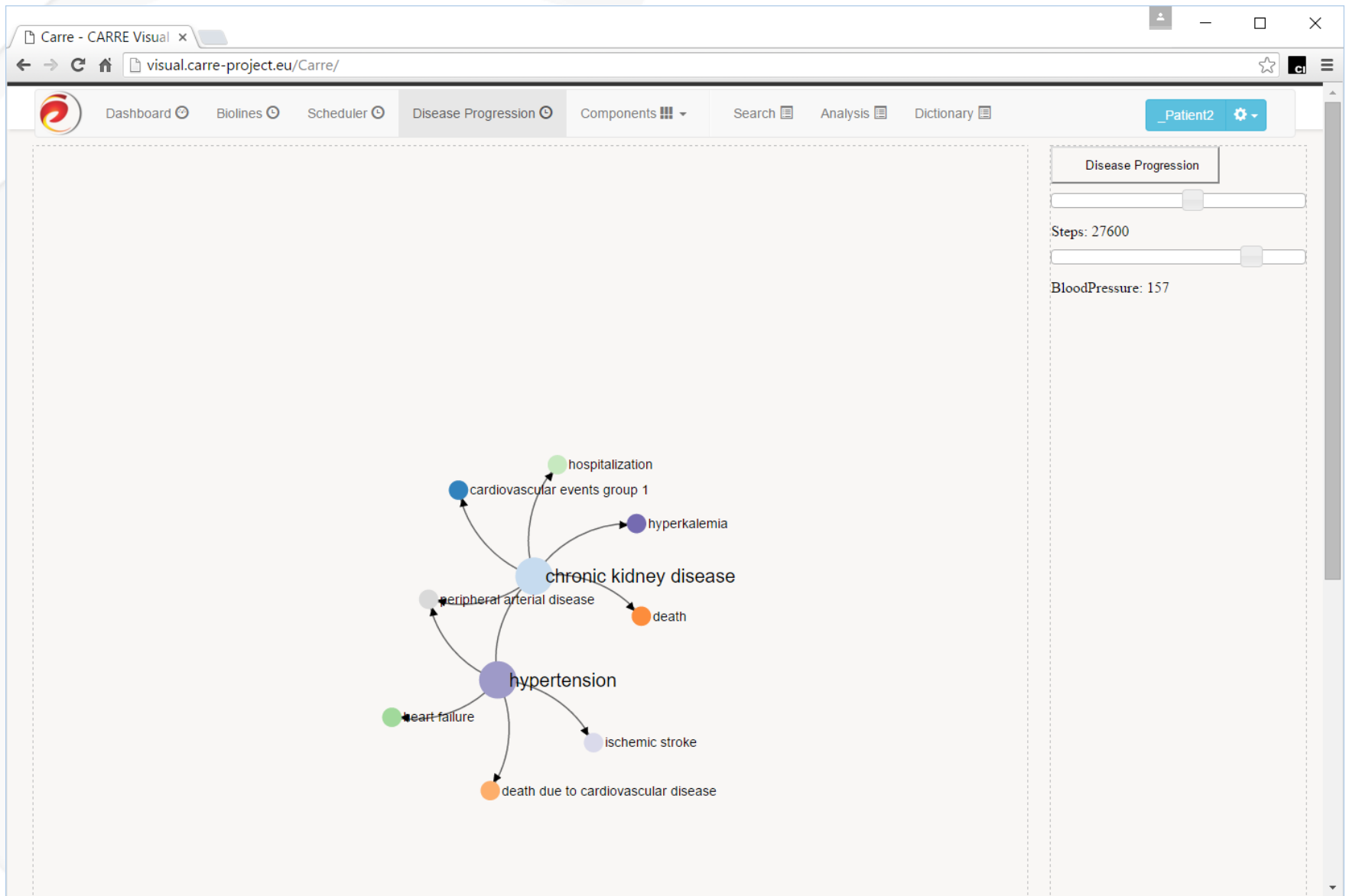
<http://entry.carre-project.eu/>



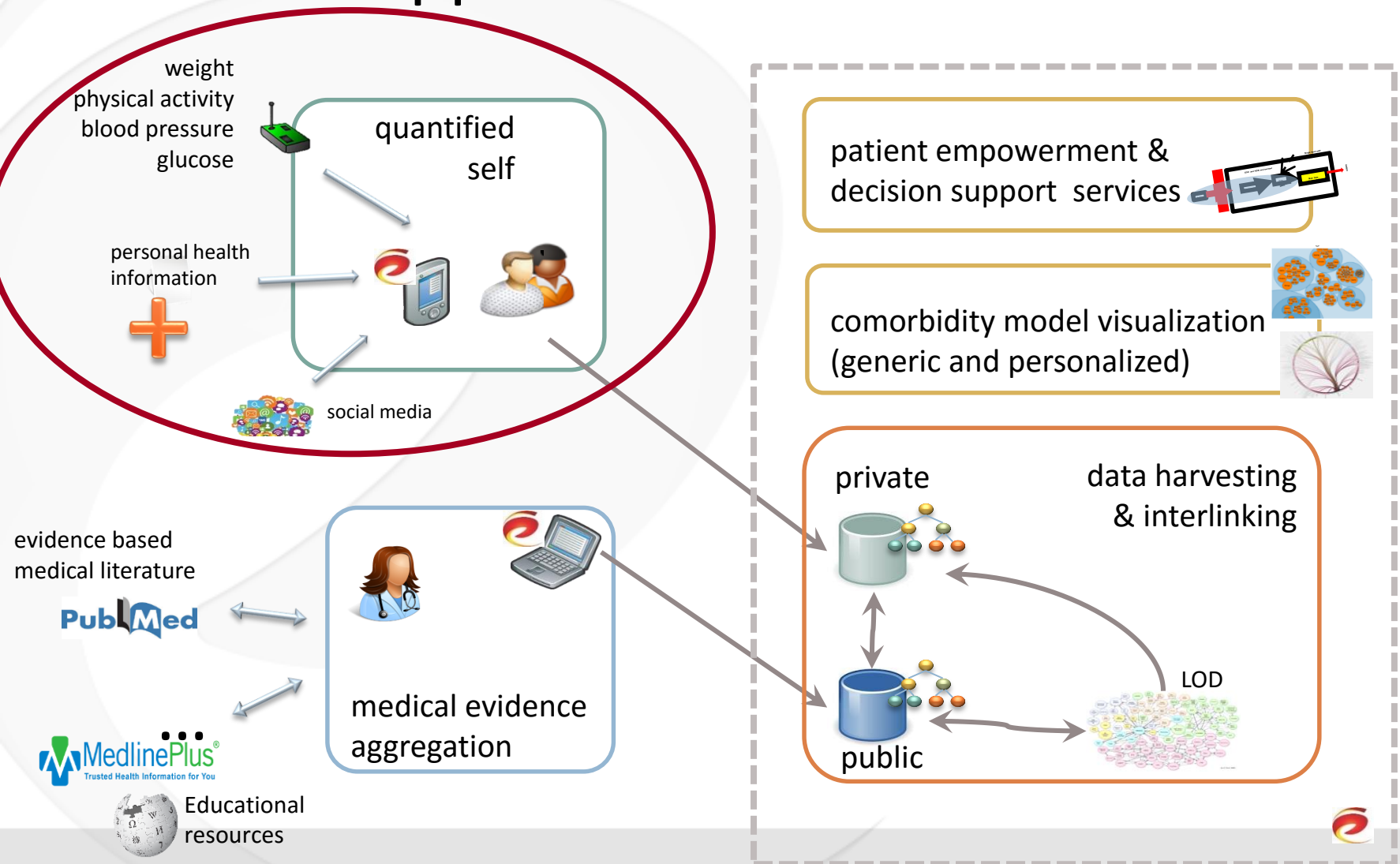








# CARRE approach



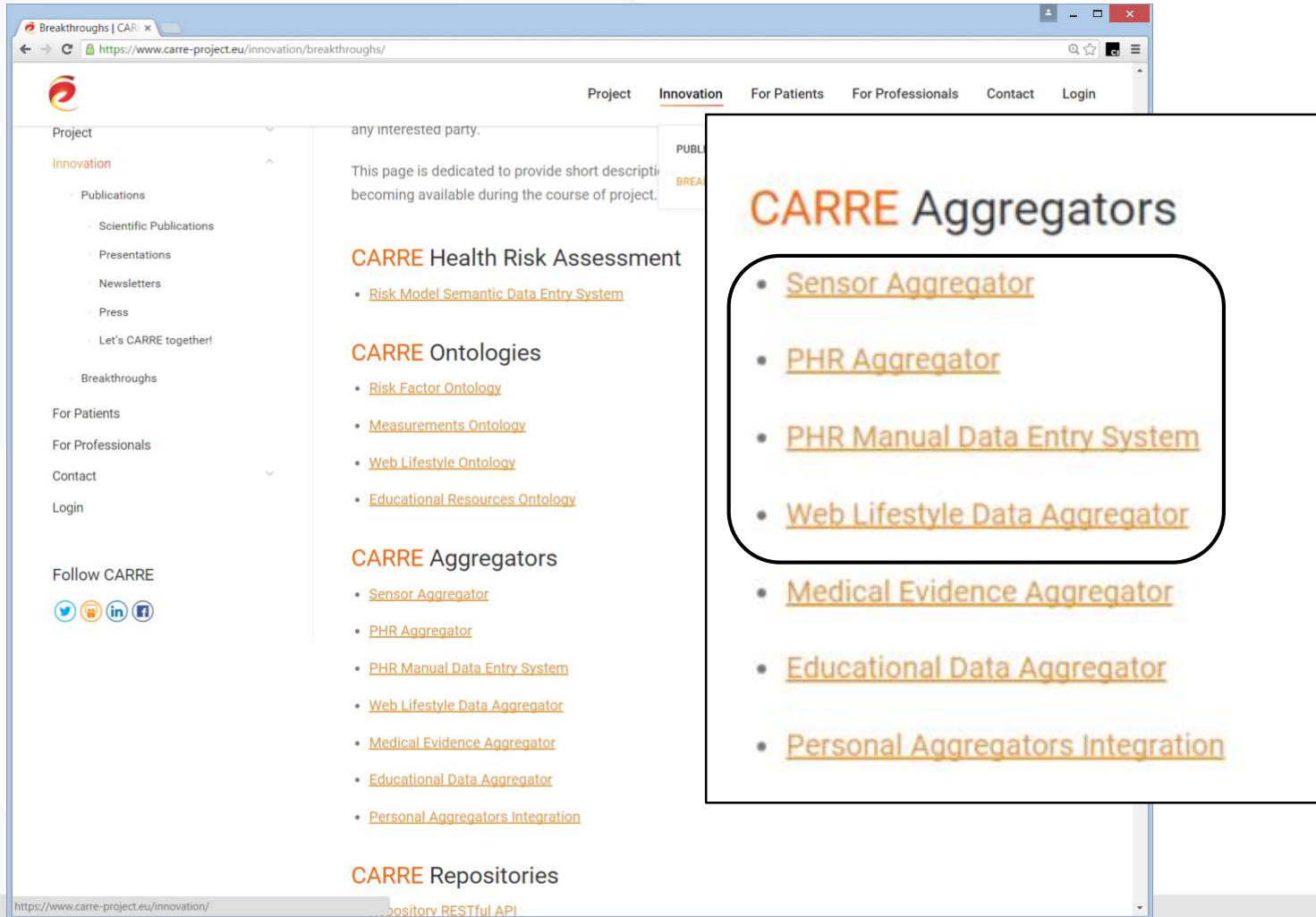
# personal data aggregators (WP3)

- **sensor** aggregators
- medical data aggregators from **personal health record**
- **manual entry** system for personal medical data
- **intention** extraction from **web** searches

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

project site → innovation → breakthroughs

<https://www.carre-project.eu/innovation/breakthroughs/>

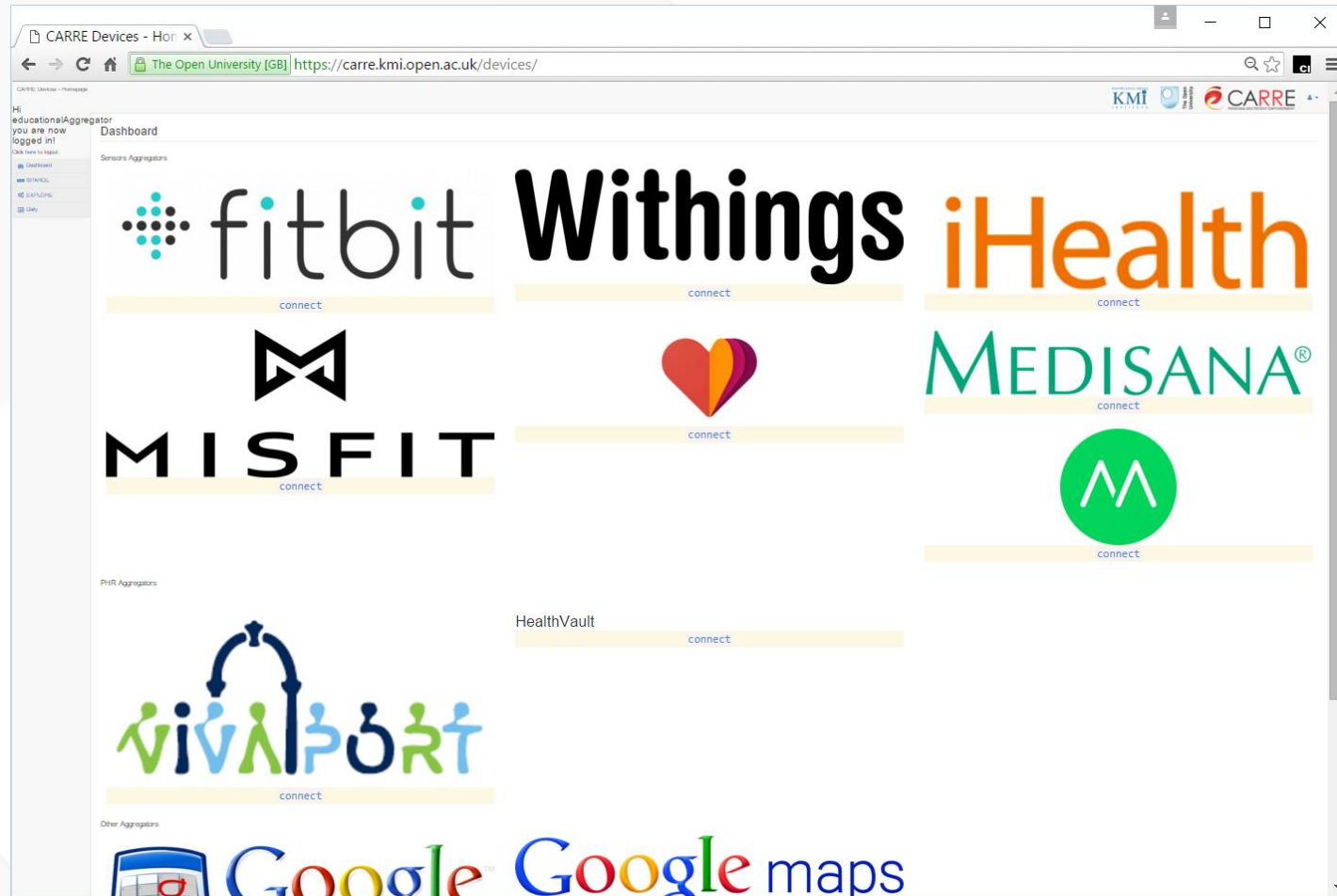


The screenshot shows the CARRE project website's 'Innovation' section. The left sidebar contains a navigation menu with 'Project', 'Innovation', 'For Patients', 'For Professionals', 'Contact', and 'Login'. The 'Innovation' menu is expanded, showing sub-items like 'Publications', 'Scientific Publications', 'Presentations', 'Newsletters', 'Press', 'Let's CARRE together!', 'Breakthroughs', 'For Patients', 'For Professionals', 'Contact', and 'Login'. The main content area is titled 'Breakthroughs' and lists several categories: 'CARRE Health Risk Assessment' (with a link to 'Risk Model Semantic Data Entry System'), 'CARRE Ontologies' (with links to 'Risk Factor Ontology', 'Measurements Ontology', 'Web Lifestyle Ontology', and 'Educational Resources Ontology'), 'CARRE Aggregators' (with links to 'Sensor Aggregator', 'PHR Aggregator', 'PHR Manual Data Entry System', 'Web Lifestyle Data Aggregator', 'Medical Evidence Aggregator', 'Educational Data Aggregator', and 'Personal Aggregators Integration'), and 'CARRE Repositories' (with a link to 'Repository RESTful API'). A black box highlights the 'CARRE Aggregators' section, listing the following items:

- [Sensor Aggregator](#)
- [PHR Aggregator](#)
- [PHR Manual Data Entry System](#)
- [Web Lifestyle Data Aggregator](#)
- [Medical Evidence Aggregator](#)
- [Educational Data Aggregator](#)
- [Personal Aggregators Integration](#)

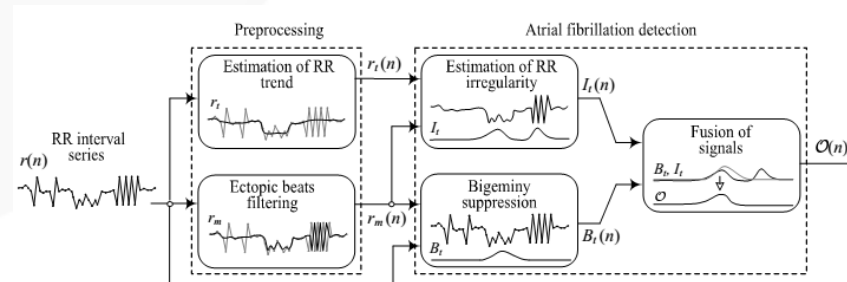
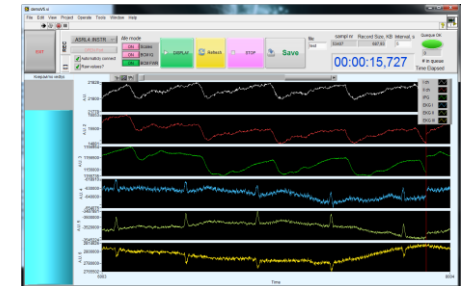
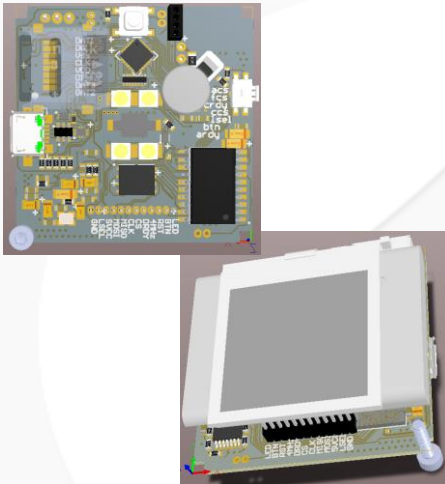
aggregator integration

<https://carre.kmi.open.ac.uk/devices/>



# CARRE sensor innovation

- multiparametric CARRE **Weight Scale** - body fluid balance monitoring, other parameters
- **ECG aggregator** – atrial **fibrillation** detection
- **CARRE Wristwatch** – heart arrhythmia detection, ...



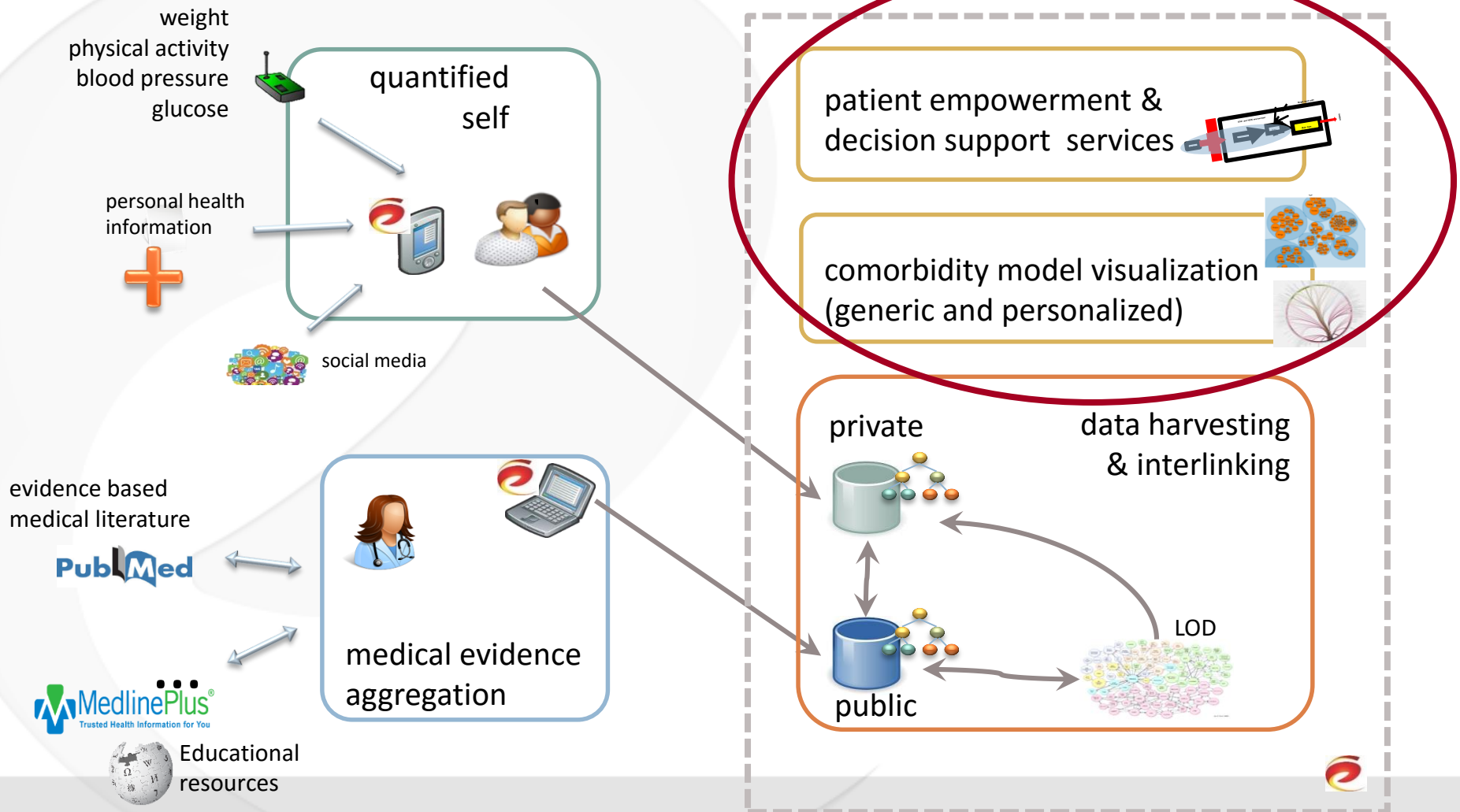
Paliakaite B., Daukantas S., Sakalauskas A., Marozas V., "Estimation of pulse arrival time using impedance plethysmogram from body composition scales," in *Sensors Applications Symposium (SAS), 2015 IEEE*, pp.1-4, 13-15 April 2015

Paliakaitė B., Daukantas S., Marozas V., Assessment of Pulse Arrival Time for Arterial Stiffness Monitoring on Body Composition Scales, *Computers in Biology and Medicine*, submitted to special issue: Self-monitoring systems for personalized health-care and lifestyle surveillance, 05/10/2015.

Petrenas, V. Marozas, L. Sörnmo, Low-complexity detection of atrial fibrillation in continuous long-term monitoring, *Computers in Biology and Medicine*, vol. 35, iss. 47, pp. 3365-3376, 2015.

Stankevicius et al. „Photoplethysmography based system for atrial fibrillation detection during hemodialysis“, submitted to *Medicon* 2016

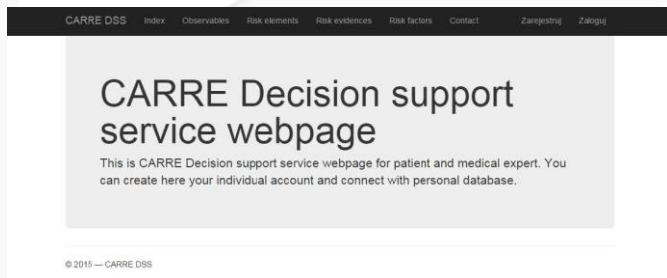
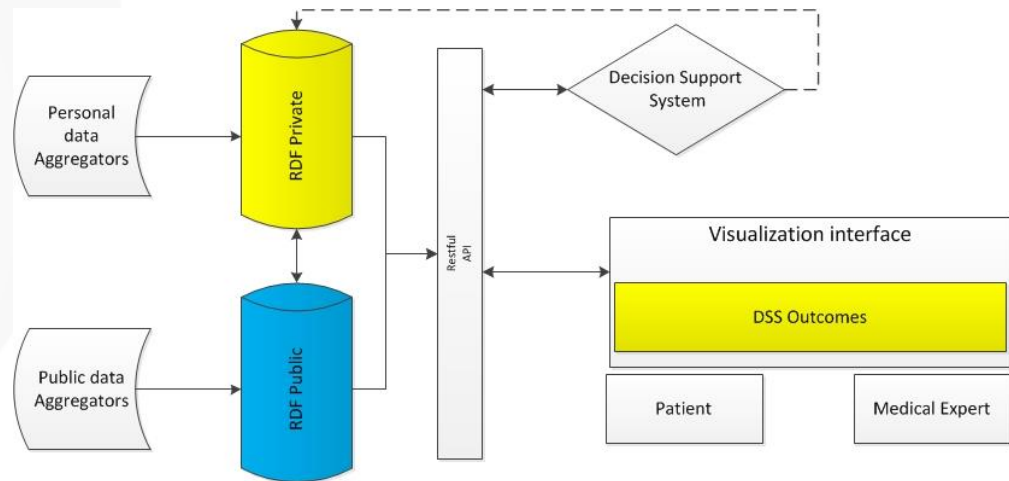
# CARRE approach



# decision support services

interlace **personal data** and **medical evidence** for personalized services to

- plan
- monitor
- alert
- educate



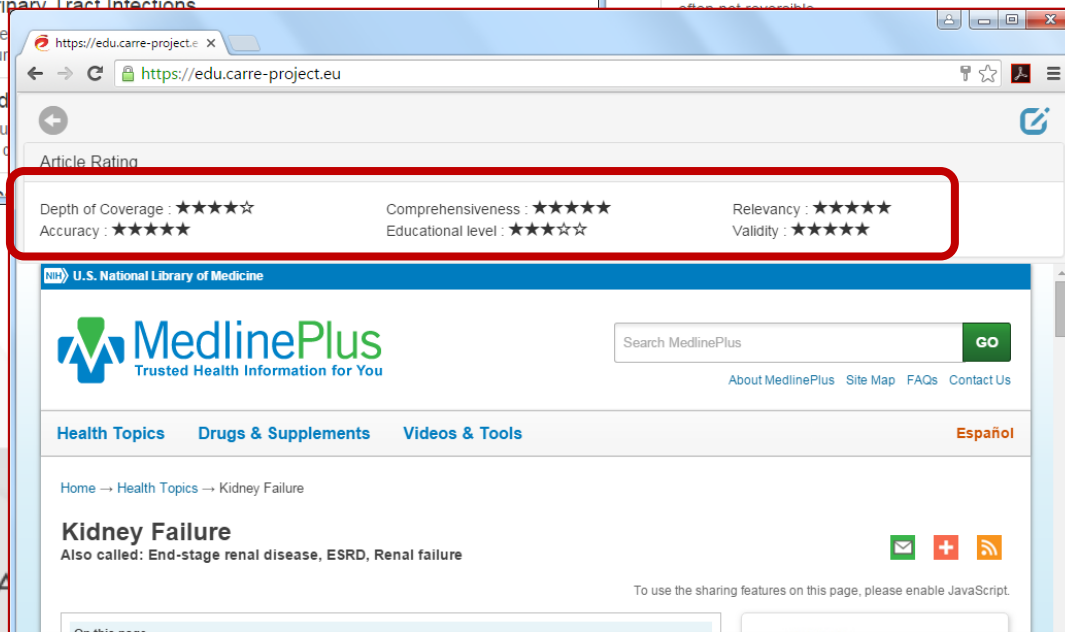
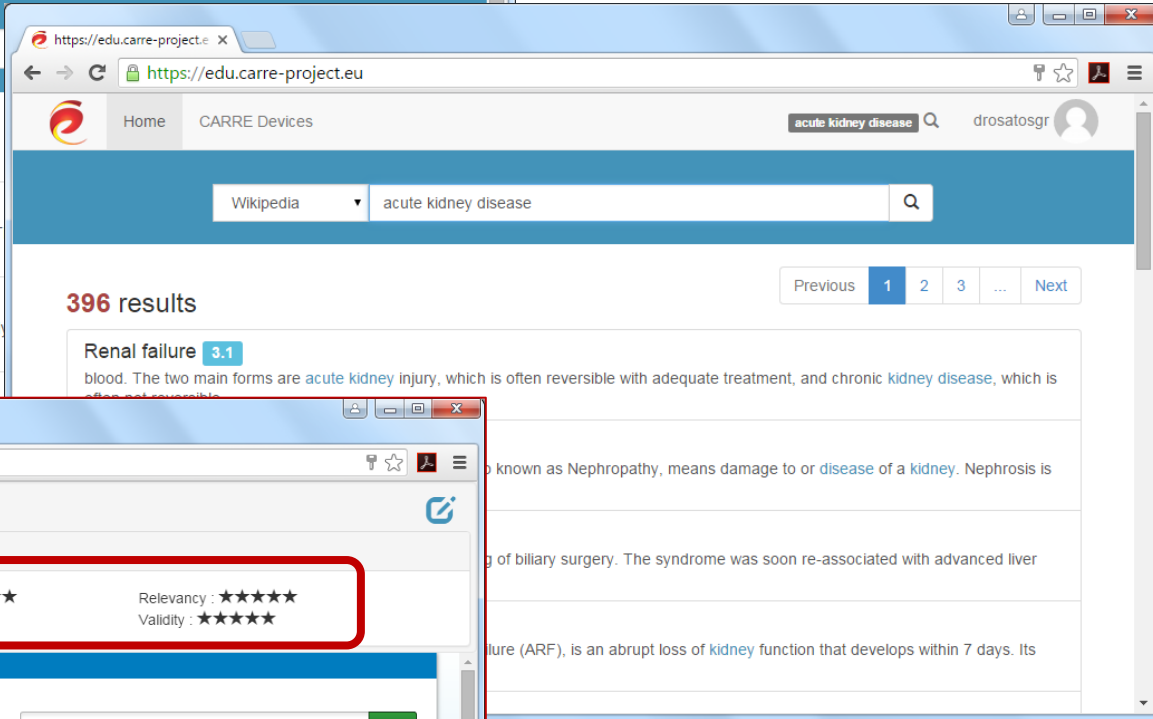
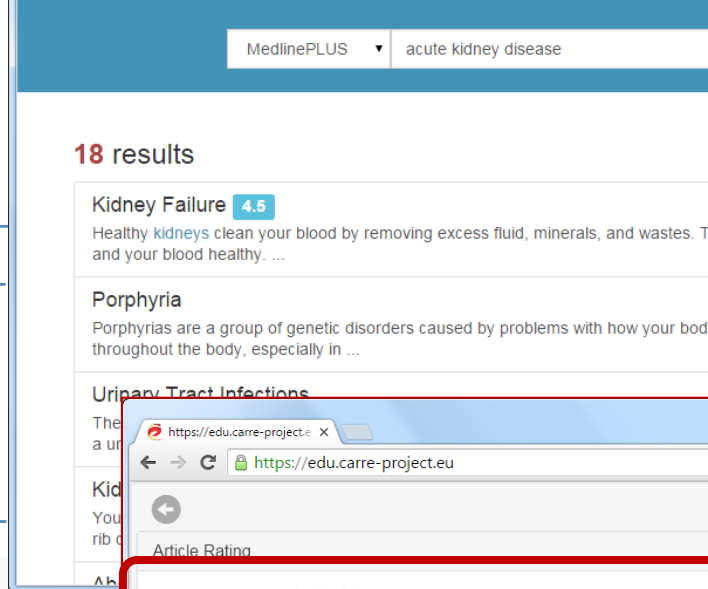
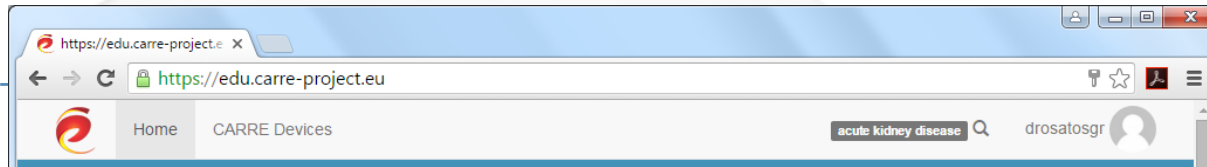
CARRE D.6.2 & D.6.3, 2016 (in progress)

# educational aggregator

<https://edu.carre-project.eu/>

educational repositories

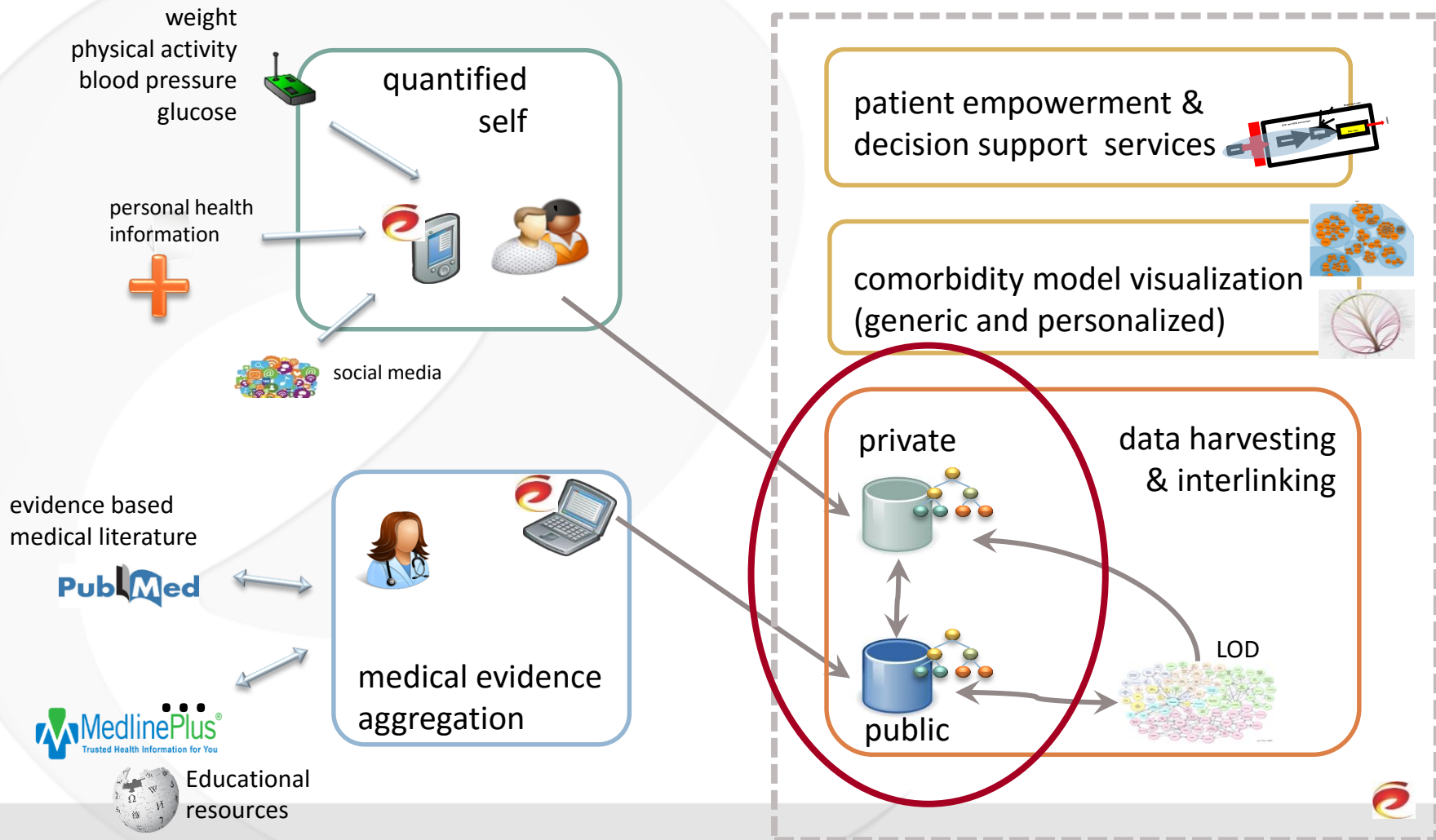
semantic web



CARRE D.3.4, 2015

E. Kaldoudi

# CARRE approach



project site → innovation → breakthroughs

<https://www.carre-project.eu/innovation/breakthroughs/>

The screenshot shows the CARRE Project website. The top navigation bar includes links for Project, Innovation (selected), For Patients, For Professionals, Contact, and Login. The left sidebar has a menu with Project, Innovation (selected), For Patients, For Professionals, Contact, and Login. The main content area is titled 'Breakthroughs' and contains a list of links under the heading 'CARRE Breakthroughs'. The links are: CARRE Health Risk Assessment (with sub-link Risk Model Semantic Data Entry System), CARRE Ontologies (with sub-links Risk Factor Ontology, Measurements Ontology, Web Lifestyle Ontology, and Educational Resources Ontology), CARRE Aggregators (with sub-links Sensor Aggregator, PHR Aggregator, PHR Manual Data Entry System, Web Lifestyle Data Aggregator, Medical Evidence Aggregator, Educational Data Aggregator, and Personal Aggregators Integration), and CARRE Repositories (with sub-link Repository RESTful API).

- [Medical Evidence Aggregator](#)
- [Educational Data Aggregator](#)
- [Personal Aggregators Integration](#)

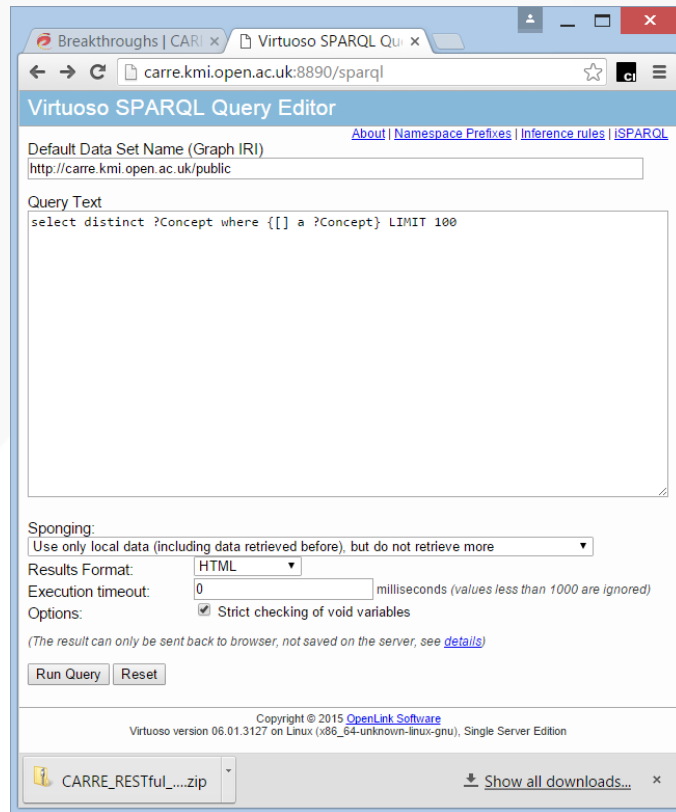
## CARRE Repositories

- [Repository RESTful API](#)
- [Risk Model SPARQL Endpoint](#)

## CARRE Visualizations

- [Interactive Visual Interface](#)

# public RDF SPARQL endpoint



## Virtuoso SPARQL Query Editor

Default Data Set Name (Graph IRI)

Query Text

```
select * where {  
  ?s a <http://carre.kmi.open.ac.uk/ontology/educational.owl#object> .  
  ?s ?p ?o .  
} LIMIT 100
```

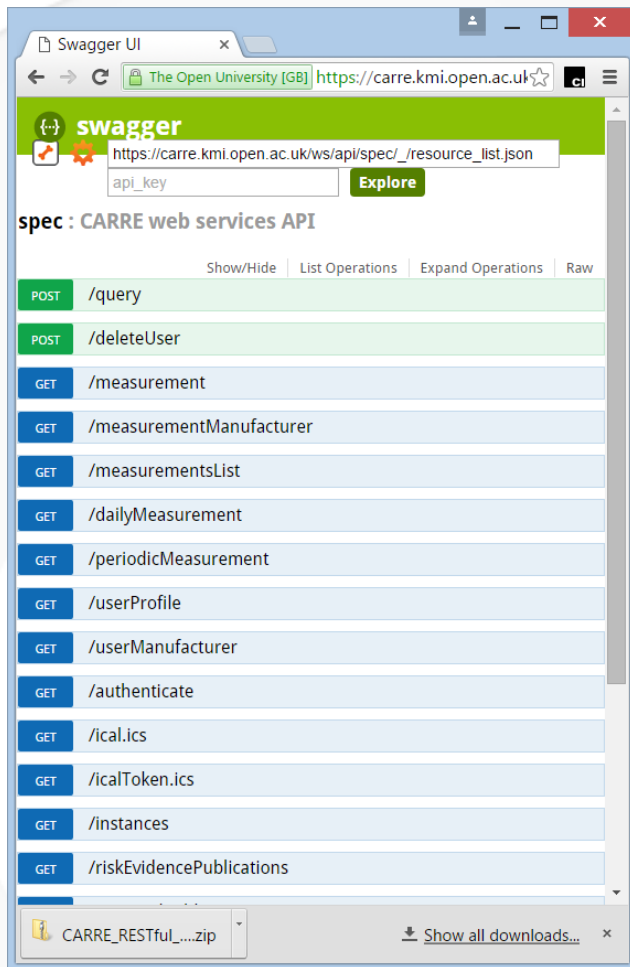
a SPARQL query to retrieve RDF  
triples about educational objects

*A. Third et al, CARRE D.4.1 & D.4.2, 2015*

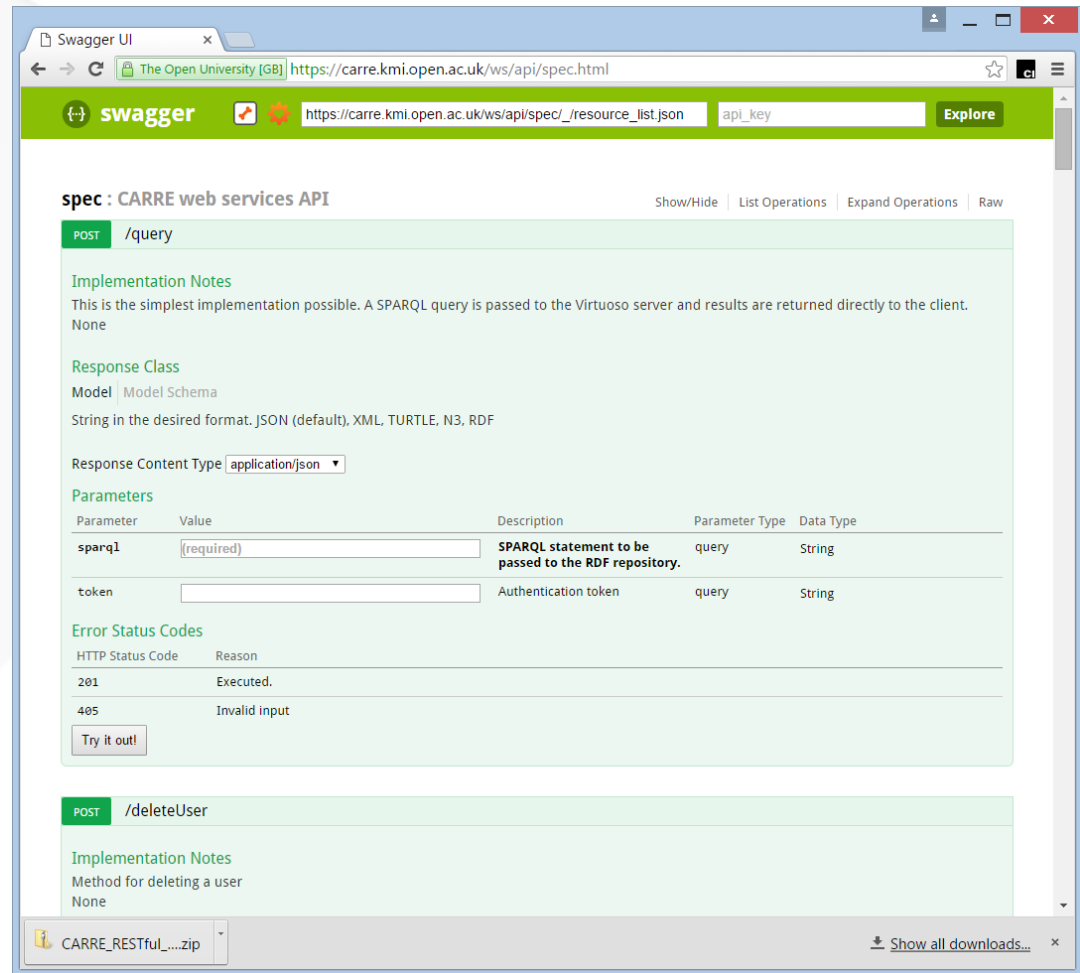
# triples about educational objects

<a href="http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140">http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140</a>	<a href="http://carre.kmi.open.ac.uk/ontology/educational.owl#url">http://carre.kmi.open.ac.uk/ontology/educational.owl#url</a>	<a href="http://en.wikipedia.org/wiki/Metabolic_syndrome">http://en.wikipedia.org/wiki/Metabolic_syndrome</a>
<a href="http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140">http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140</a>	<a href="http://carre.kmi.open.ac.uk/ontology/educational.owl#title">http://carre.kmi.open.ac.uk/ontology/educational.owl#title</a>	"Metabolic syndrome"^^<http://www.w3.org/2001/XMLSchema#stri
<a href="http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140">http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140</a>	<a href="http://carre.kmi.open.ac.uk/ontology/educational.owl#views">http://carre.kmi.open.ac.uk/ontology/educational.owl#views</a>	2
<a href="http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140">http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140</a>	<a href="http://carre.kmi.open.ac.uk/ontology/educational.owl#date_accepted">http://carre.kmi.open.ac.uk/ontology/educational.owl#date_accepted</a>	2015-04-26
<a href="http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140">http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140</a>	<a href="http://carre.kmi.open.ac.uk/ontology/educational.owl#snippet">http://carre.kmi.open.ac.uk/ontology/educational.owl#snippet</a>	"tissue, ultimately promoting visceral adiposity, insulin resistance, dy effects on the bone, causing &quot;low turnover&quot;"^^<http://ww
<a href="http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140">http://carre.kmi.open.ac.uk/beta/educational/dcb53878-7a19-4897-9d7c-cfc69bd16140</a>	<a href="http://carre.kmi.open.ac.uk/ontology/educational.owl#language">http://carre.kmi.open.ac.uk/ontology/educational.owl#language</a>	"English"^^<http://www.w3.org/2001/XMLSchema#string>
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<a href="http://carre.kmi.open.ac.uk/beta/educational/bedc4c16-ad7e-4052-bf69-156dfd60e136">http://carre.kmi.open.ac.uk/beta/educational/bedc4c16-ad7e-4052-bf69-156dfd60e136</a>	<a href="http://carre.kmi.open.ac.uk/ontology/educational.owl#date_accepted">http://carre.kmi.open.ac.uk/ontology/educational.owl#date_accepted</a>	2015-03-03
<a href="http://carre.kmi.open.ac.uk/beta/educational/bedc4c16-ad7e-4052-bf69-156dfd60e136">http://carre.kmi.open.ac.uk/beta/educational/bedc4c16-ad7e-4052-bf69-156dfd60e136</a>		"Angina is chest pain or discomfort you feel when there is not enough heart muscle needs the oxygen that the blood carries. Angina may fee chest. It may feel like indigestion. You may also feel pain in your shou a symptom of coronary artery disease (CAD), the most common heart 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 happ

# restful API



A. Third et al, CARRE D.4.1 & D.4.2, 2015



# evaluation framework & plan\*

	CARRE system functions	Human perspectives			Context and Environment
		Experts	Patients	Admins	
Structure	aggregators and interfaces functioning	changes to working conditions and practices; new skills, & abilities	new skills, and abilities		
Process	service operation correct & valid	induced changes in function and satisfaction	Induced changes in self-management & satisfaction		
Outcome	service usable and reliable	effectiveness	perceived quality of care and life	improving specific clinical parameters	potential to improve the health status and quality of life

\* based on the model proposed by Cornford, T., Doukidis, G.I., and Forster, D., *Int. J. Manag. Science*, 22(5), 491-504, 1994

1: component testing

2: service testing & understanding

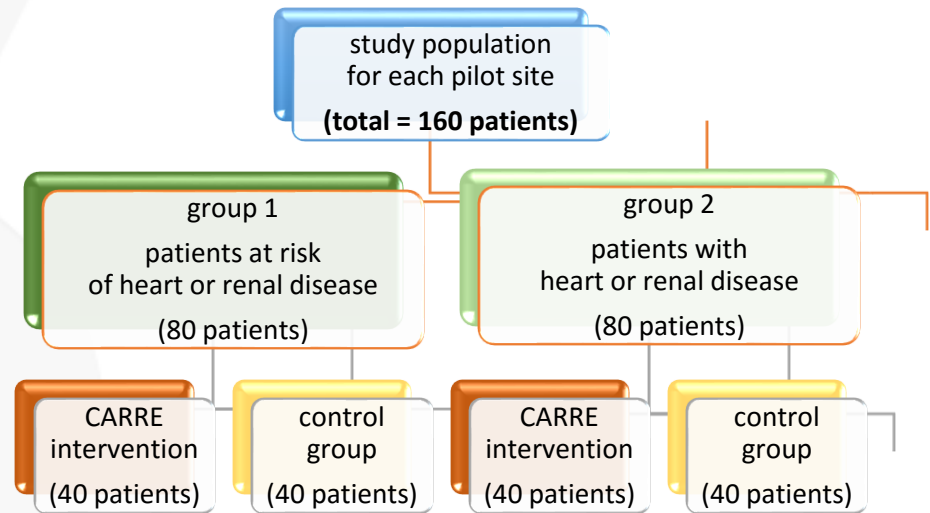
3: service evaluation

# evaluation

- 2 center  
randomized control trial

- primary objectives

- primary
  - 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 (*biomarkers & disease prevalence*)
- secondary
  - 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



CARRE D.7.4, 2016 (in progress)

## what?

**CARRE**

EU FP7-ICT-2013-611140

3.2M, 2013-2016

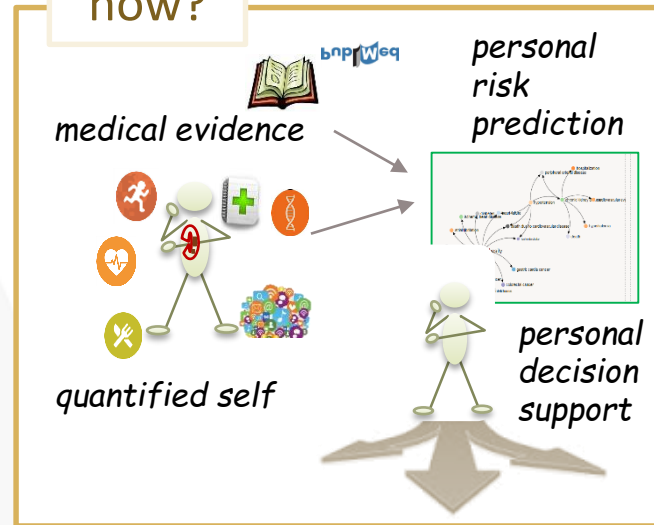
DUTH, OU, BED, VULSK, KTU, PIAP

## why?

cardiorenal disease

chronic, common, dangerous,  
expensive, with many causing  
factors and complex progression

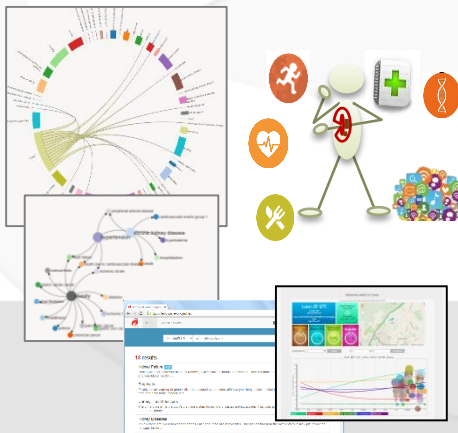
## how?



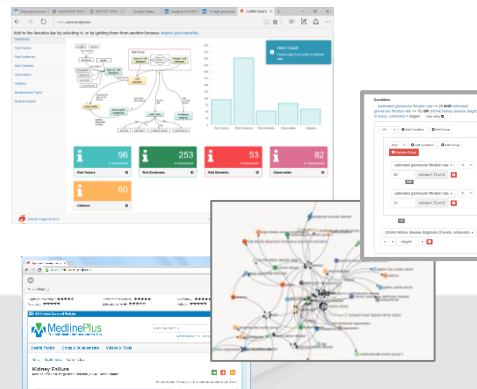
Personalized patient empowerment and shared decision  
support for cardiorenal disease and co\morbidity

<http://carre-project.eu>

### for the patient



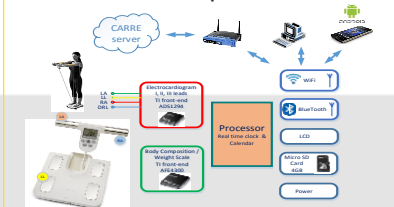
### for the medical expert



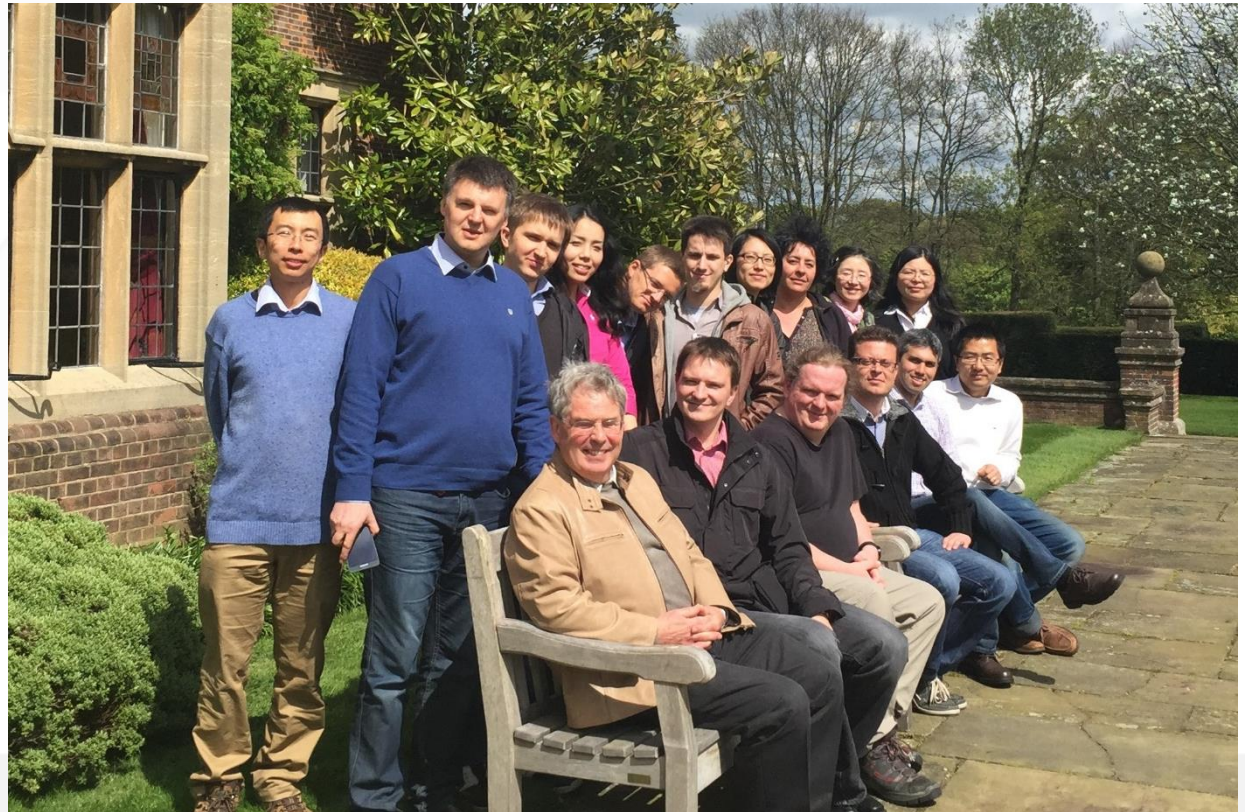
### for the ICT expert



### sensor developments



*thank you !!!*



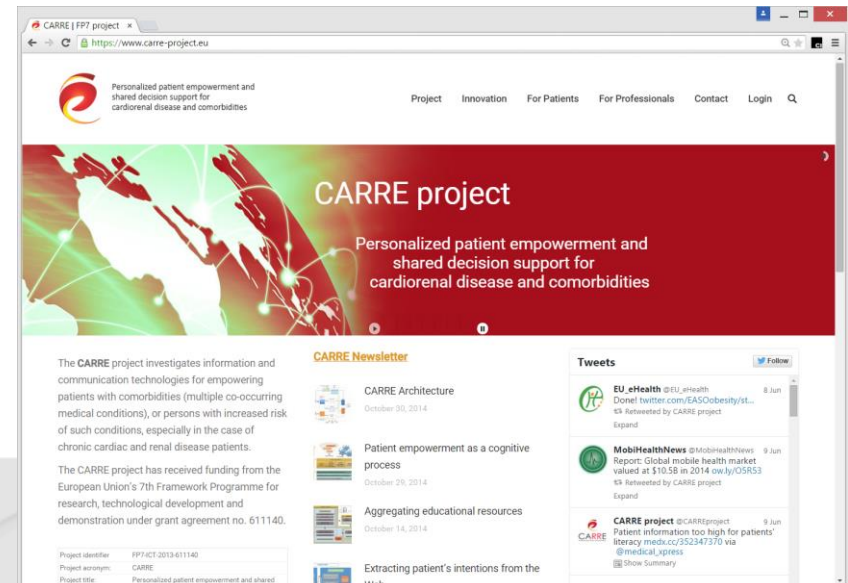
# acknowledgment

work funded under project CARRE

co-funded by the  
European Commission under the  
Information and Communication Technologies (ICT)  
7<sup>th</sup> Framework Programme  
Contract No. FP7-ICT-2013-611140

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

<http://www.carre-project.eu/>



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## Cite as

Eleni Kaldoudi

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

Presentation & Demo

HealthInf 2016: 9th International Conference  
on Health Informatics, part of BIOSTEC,  
Rome, Italy, 21-23 February, 2016

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## Contact

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Tel: +30 6937124358

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Email: [carre@med.duth.gr](mailto:carre@med.duth.gr)