13 Years with an Integrated Clinical Information System at the Pompidou University Hospital

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HÔPITAUX UNIVERSITAIRES PARIS OUEST
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Inserm

UNIVERSITÉ PARIS DESCARTES

HEGP Background

Location

• Paris 15th district

Within AP-HP

• HEGP is the most recent acute care hospital within the 37 AP-HP hospitals

• HEGP meets the needs of the 600, 000 inhabitants of the Paris south-west

HEGP Background

Opening : July 2000-

Hôpital Laennec (1634)

Hôpital Boucicaut

Hôpital Broussais

HEGP Background

Transportation system: tubes and suitcases

Vacuum tubes (Intensive care, operating rooms)

Hidden in false ceilings different models of suitcases, simples or upholstered, transport…

… mail or paper documents as well as biological samples to the laboratories

Suitcases (Clinical units, ancillary departments, medical archives)

HEGP Background

Transportation system: robots (meals, clothing, etc.)

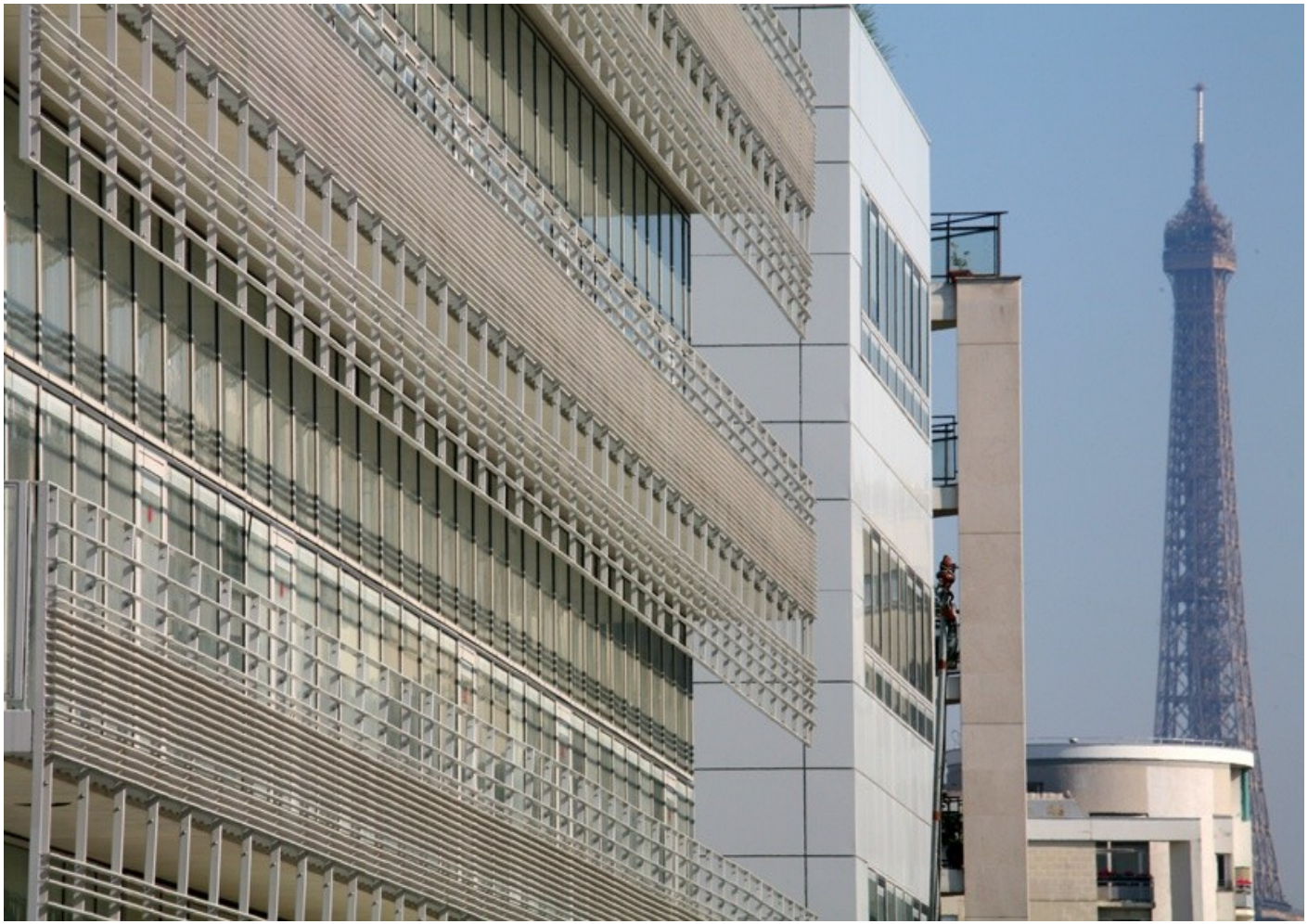
HEGP background

Shared Biobank (2008-)

Hôpital Européen Georges Pompidou

HEGP Background

HEGP Cardiovascular Translational Research Center (September 2009-)



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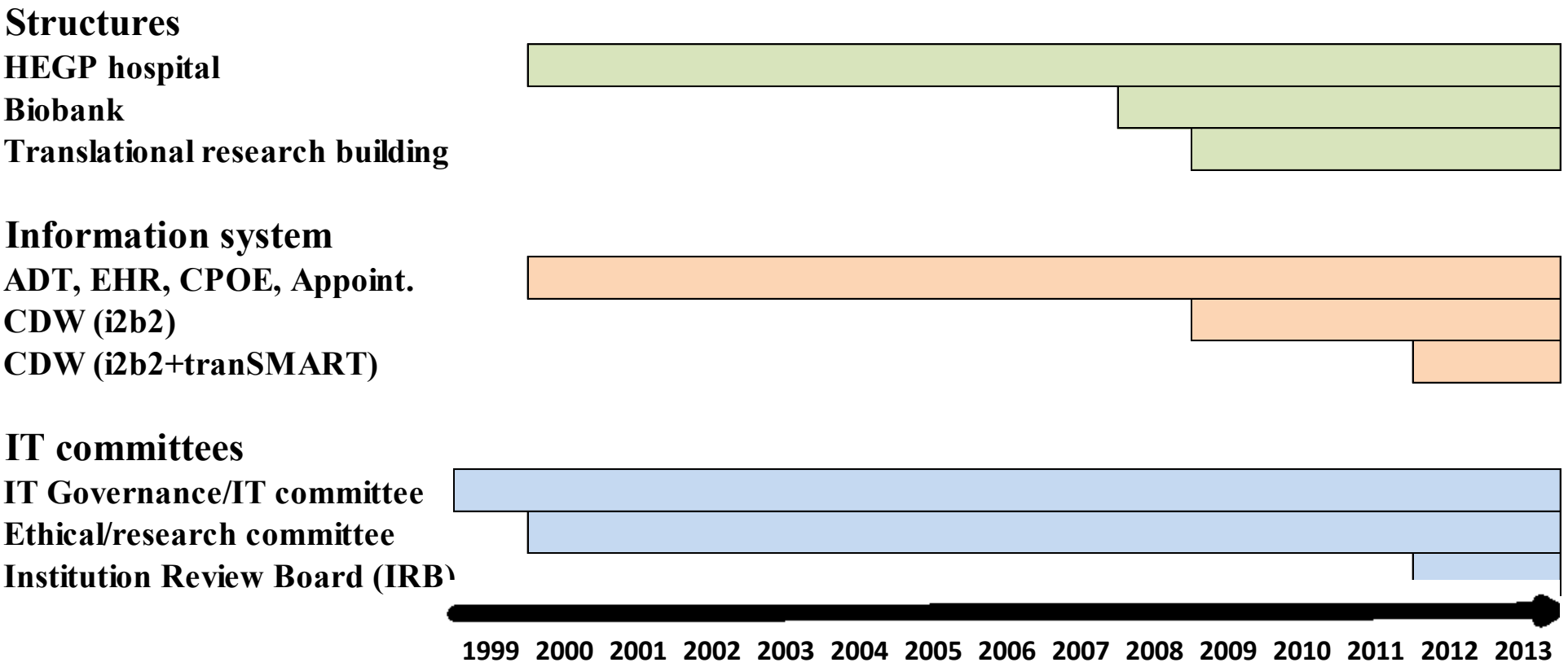

Structures
HEGP hospital
Biobank
Translational research building
Information system
ADT, EHR, CPOE, Appoint.
CDW (i2b2)
CDW (i2b2+tranSMART)
IT committees
IT Governance/IT committee
Ethical/research committee
Institution Review Board (IRB)
1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013

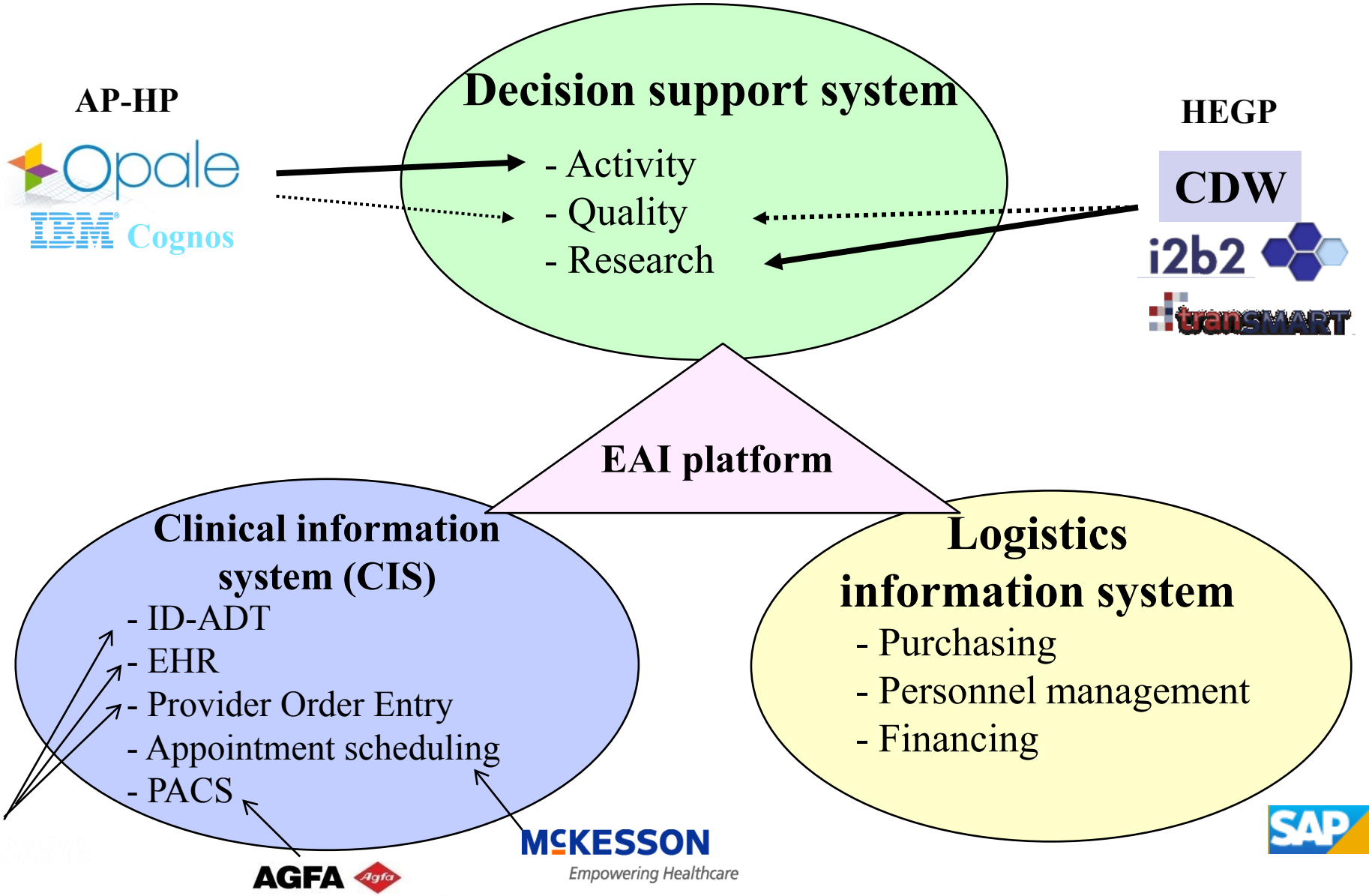
HEGP Background

Main figures (2013)

	No
Number of active beds (Inpatient + One day care)	800
Number of operating rooms	24
Total number of employees	3 100
- Nb. of physicians (FTE)	400
Mean number of inpatient admissions/month	4 600
One day hospital care (% of admissions)	61%
Number outpatients visits/month	21 000
Nb. visits at the emergency department/day	130
Nb. PC/light terminals	2 600
Nb. wireless portables computers	200
Nb. simultaneous users (at 11:00 am)	1 200

HEGP HIS

Sub-systems



HEGP CIS

Use of the provider order entry functions

	2002	2003	2005	2013
Laboratory orders - Direct entry by physicians	65%	73%	96%	95%
Imaging orders - Direct entry by physicians	57%	65%	68%	70%
Drug orders* -Direct entry by physicians		100%	100%	100%

* 35% of beds in 2003 and 85% of beds in 2013

HEGP CDW

Why : Objectives

1. **EHR driven research (EHR data reuse)**
   - Patient selection for CR studies (e.g., EHR4CR)
   - In-silico evaluation of clinical decision rules
   - Phenotypic augmentation (e.g., reuse of EHR data to feed a CR study)
2. **Genotype/Phenotype integration**
   - Biomarker research (e.g., GeWAS/PheWAS studies)
   - Personalized medicine

- Prokosch HU, Ganslandt T. Perspectives for medical informatics. Reusing the electronic medical record for clinical research. *Methods Inf Med*. 2009; 48(1): 38-44.
- Kohane IS. Using electronic health records to drive discovery in disease genomics. *Nat Rev Genet*. 2011; 12(6): 417-28.
- Jensen PB, Jensen LJ, Brunak S. Mining electronic health records: towards better research applications and clinical care. Nat Rev Genet. 2012; 13(6): 395-405.

HEGP CDW

Access rights

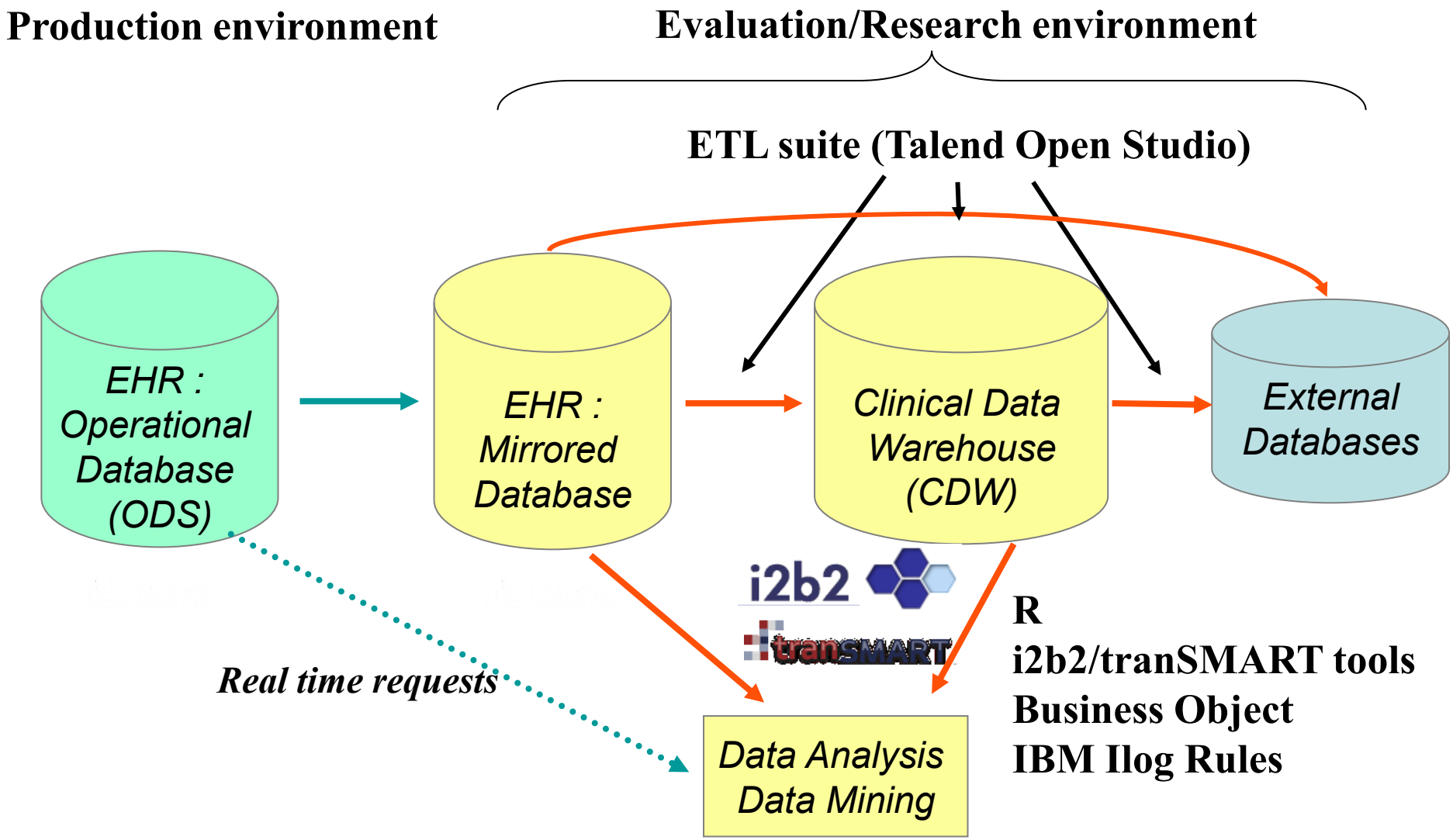
- **Type 1 studies : aggregated data (e.g. potential trial recruitment)**
  - Free access for all HEGP health professionals

- **Type 2 studies :anonymized patient data**
  - Structured written project
  - Validation by the HEGP ethical/research committee
  - Transmission to the regional IRB committee

- **Type 3 studies : de-anonymized patient data**
  - Written project
  - Patient consent
  - Validation by the regional IRB committee

HEGP CDW

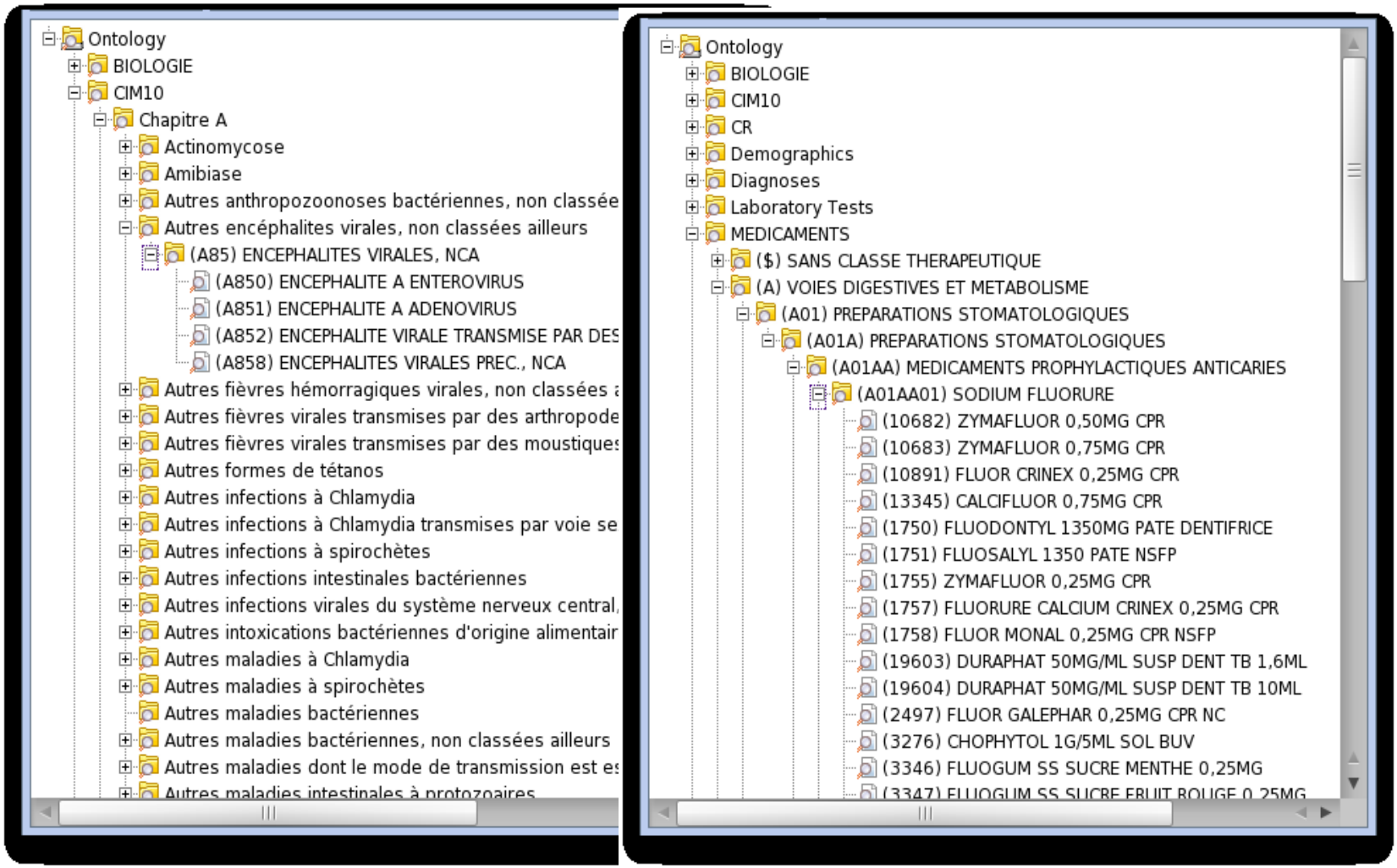
How : EHR/CDW integration



HEGP CDW

EHR/CDW integration : concept dimension

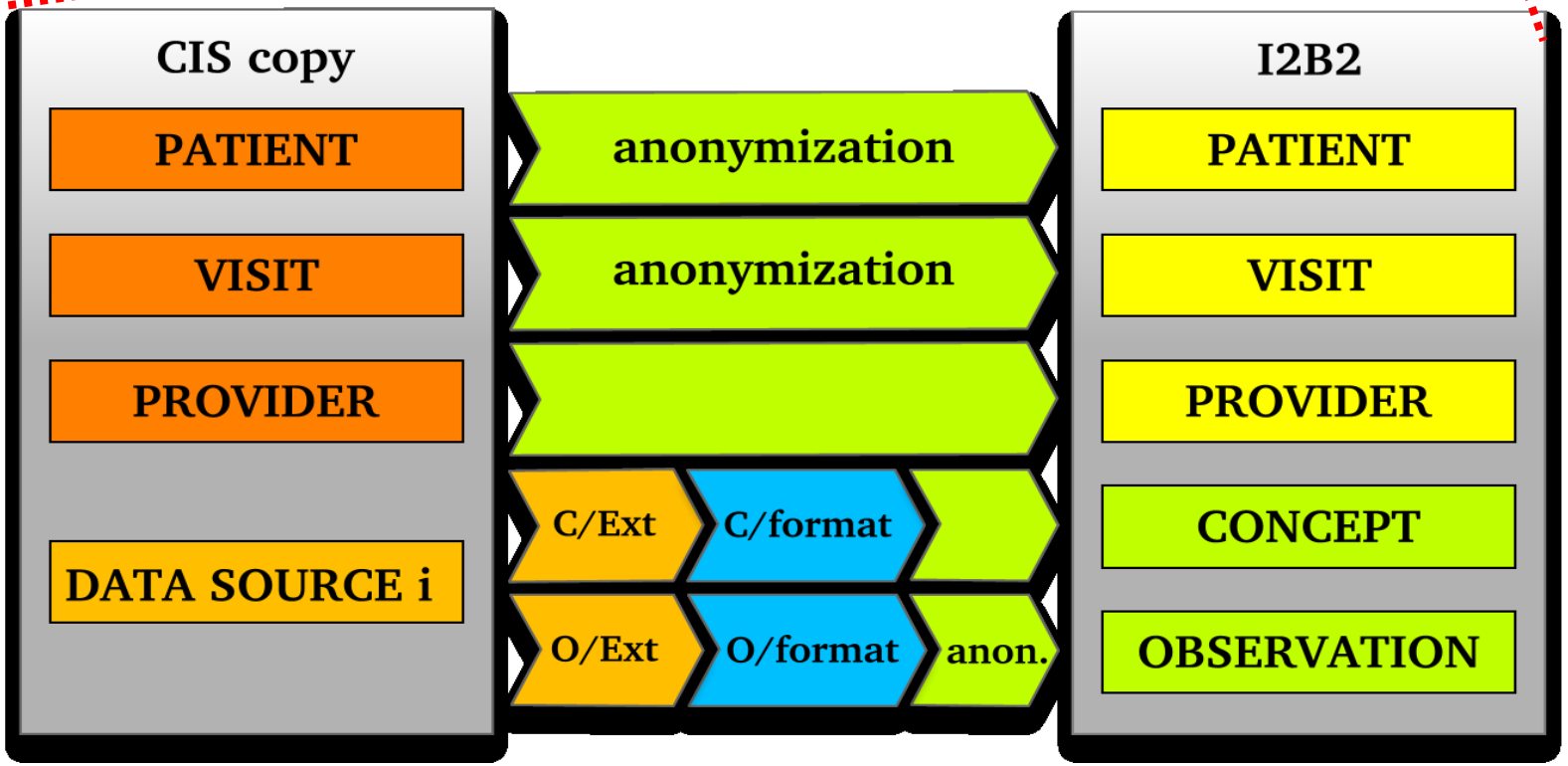
CIS Reference manager —*ETL tools*→ **I2B2 Concept dimension**



HEGP CDW

Data sources mapping to CDW

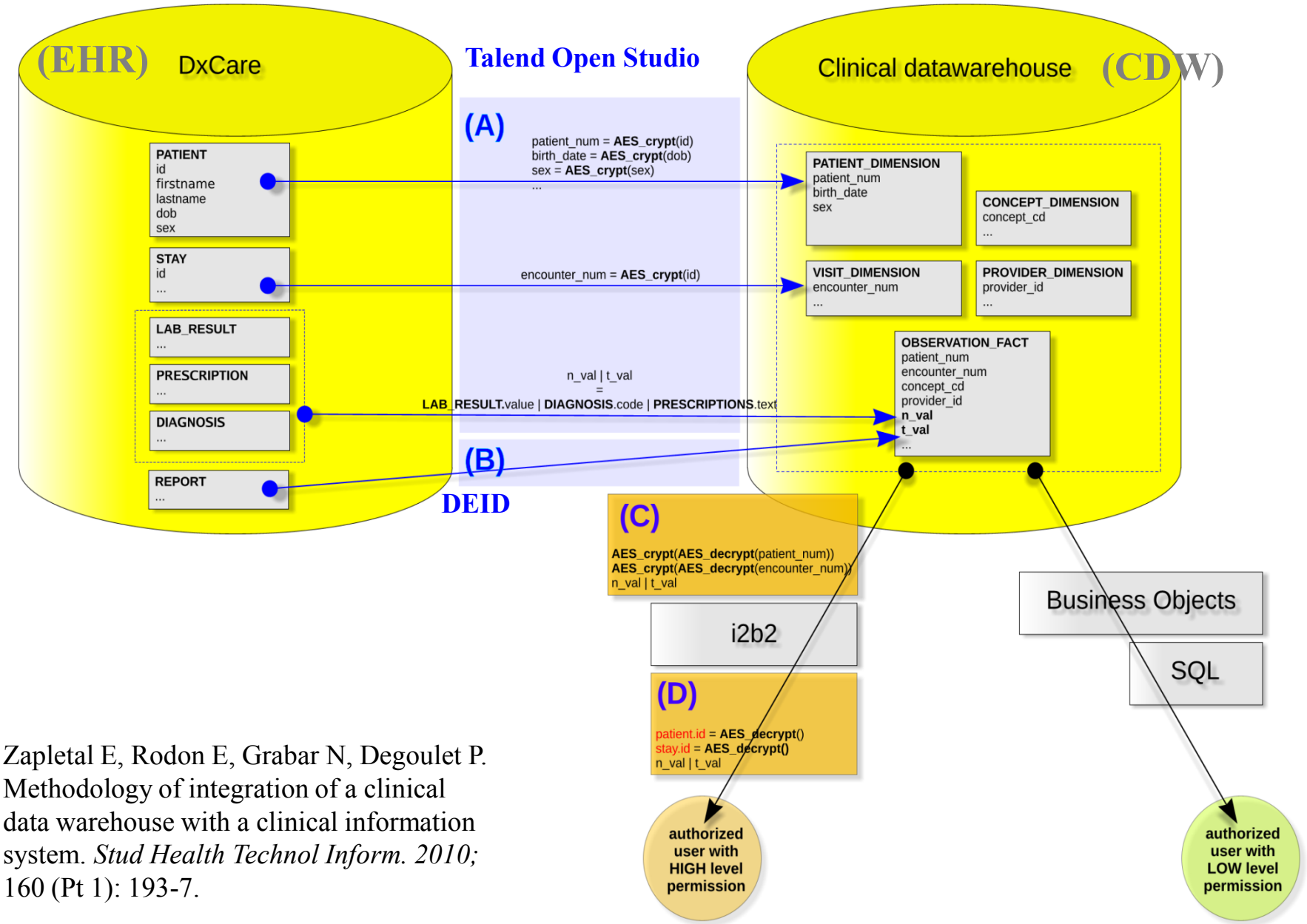
	Technological framework		
Administration	Help desk system		
Restitution	Business intelligence solutions	Enterprise content management	Ad-hoc tools
Data	Database model navigation, Business layers analysis	Data sources mapping CIS/CDW	Datamart creation
Technical	French security body, strong reversible encryption, NLP	Open source software Developments	Database mirroring



Zapletal E, Rodon E, Grabar N, Degoulet P. Methodology of integration of a clinical data warehouse with a clinical information system. *Stud Health Technol Inform. 2010;* 160 (Pt 1): 193-7.

HEGP CDW

EHR/CDW integration : anonymization



Zapletal E, Rodon E, Grabar N, Degoulet P. Methodology of integration of a clinical data warehouse with a clinical information system. *Stud Health Technol Inform. 2010;* 160 (Pt 1): 193-7.

CDW content

i2b2 CDW content (December 2012)

Dimensions	Categories	Numbers
Patient		606 524
Concept dimension	ICD10 classification	21 356
	Laboratory results classification	8 272
	Drug classification (ATC)	33 612
	EHR forms concepts	5 950
Observation facts	ICD10 Diagnosis	2 626 792
	Laboratory results	88 607 301
	Drug prescriptions	2 612 742
	EHR forms items	46 506 217
	Text reports	1 961 985

HEGP CDW

Use

1. **EHR driven research (EHR data reuse)**
   - Patient selection for CR studies (e.g., EHR4CR)
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In vivo evaluation of decision rules (EHR)

Rate of inappropriate prescriptions

6 alternating 2-month phases: control vs. intervention (Aug. 2006- Aug. 2007)

Physicians	Alerting off	Alerting on	p
Junior	21.5%	16.3%	
Senior	20.9%	29.3%	
p	p=0.88	p=0.01	
Total	21.3%	19.9%	0.63 (NS)

Sellier E et al. Effect of alerts for drug dosage adjustments in inpatients with renal insufficiency. *JAMIA 2009; 16:203-10.*

CDW use

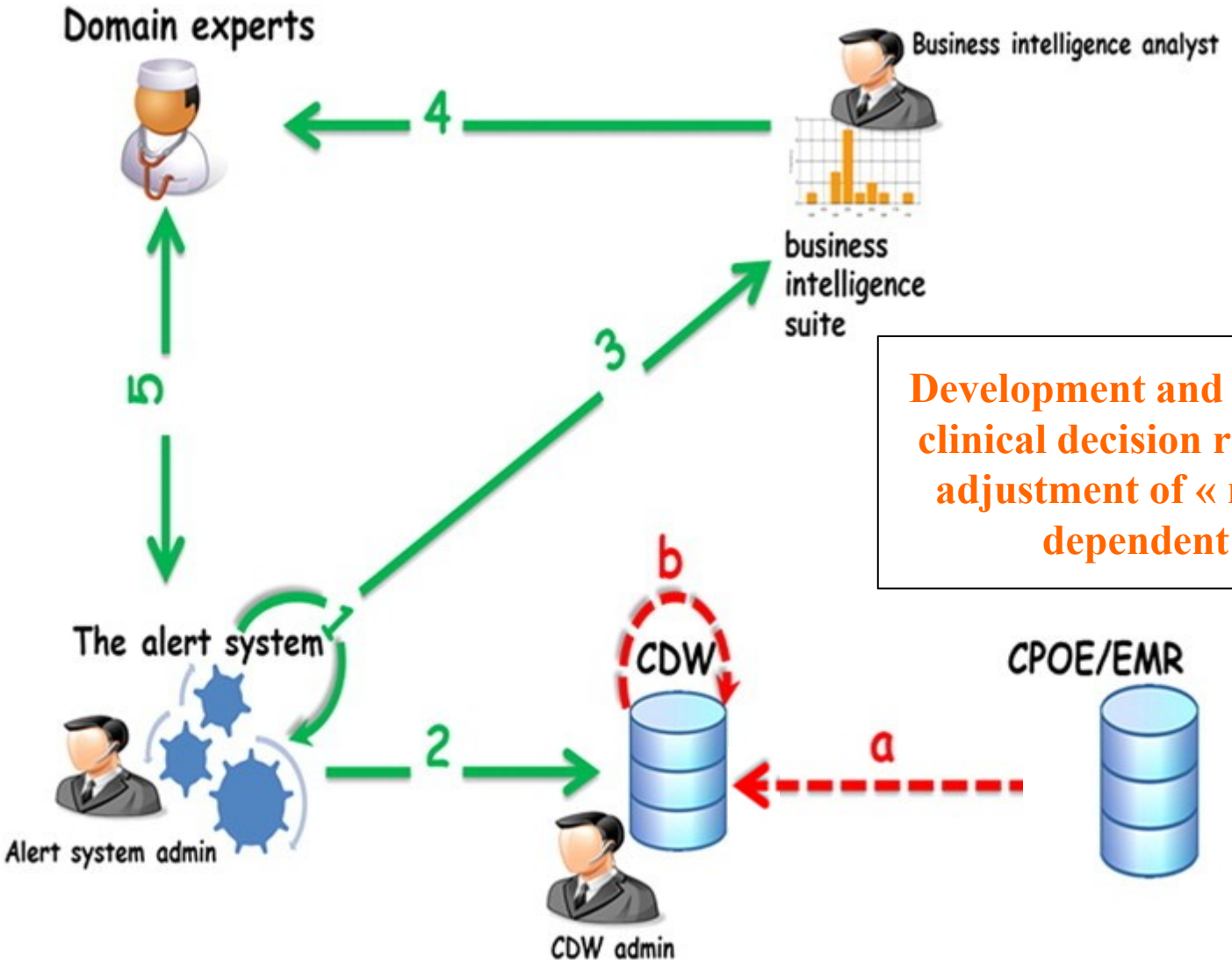
In-silico evaluation of decision rules (EHR)

Medical/Pharmaceutical validation of drug prescriptions

- Data initial source (CIS) =
  - DxCare physicians' drug prescriptions
  - DxCare pharmacists' validation of physicians' prescriptions
- Concepts (CIS/CDW) =
  - ATC drug classification (n= 33,000 concepts)
  - Local classification of pharmaceutical validation codes
- Observations (CDW) =
  - drug prescriptions and pharmaceutical validations

CDW use

In silico evaluation of decision rules

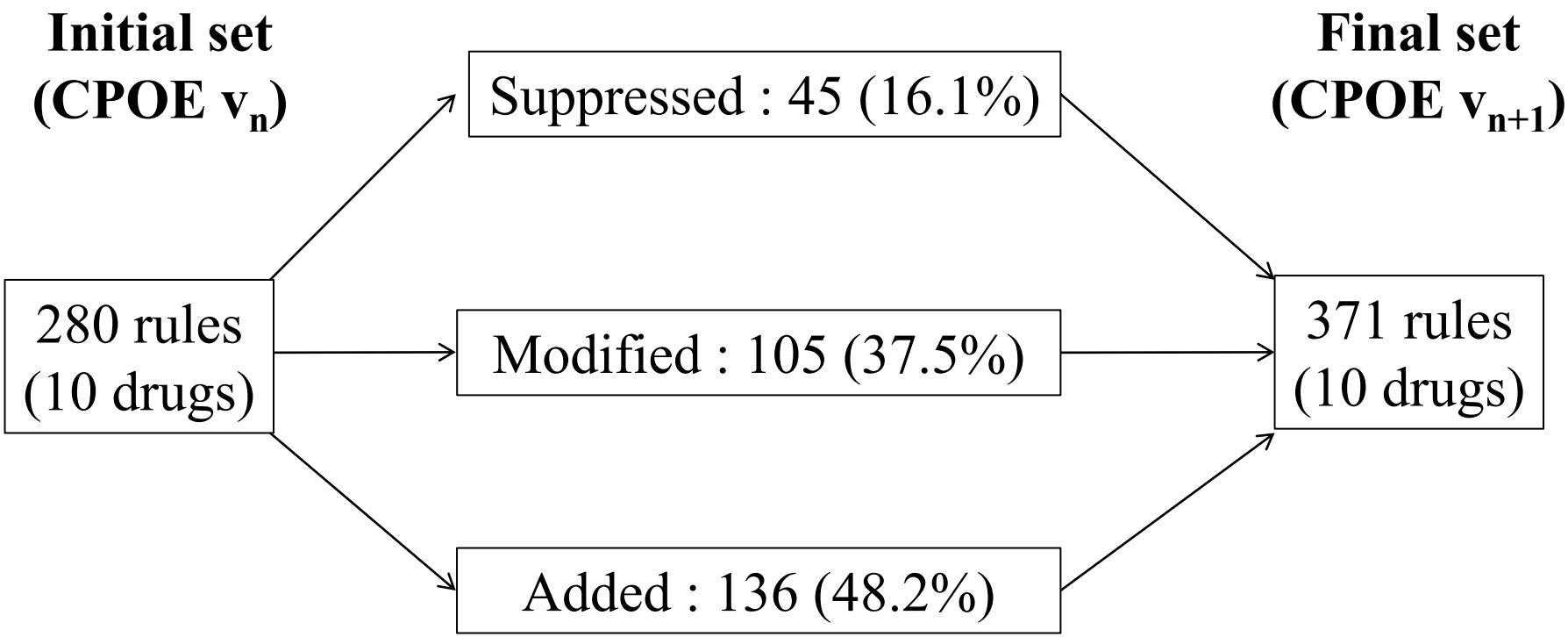


Development and optimization of clinical decision rules for dosage adjustment of « renal function dependent » drugs

Boussadi A, Caruba T, Zapletal E, Sabatier B, Durieux P, Degoulet P. A clinical data warehouse–based process for refining medication orders alerts. **J Am Med Inform Assoc 2012**; 19(5): 782-5

CDW use

In-silico evaluation of decision rules (CDW)



Boussadi A, Caruba T, Zapletal E, Sabatier B, Durieux P, Degoulet P. A clinical data warehouse–based process for refining medication orders alerts. **J Am Med Inform Assoc 2012**; 19(5): 782-5

Applications

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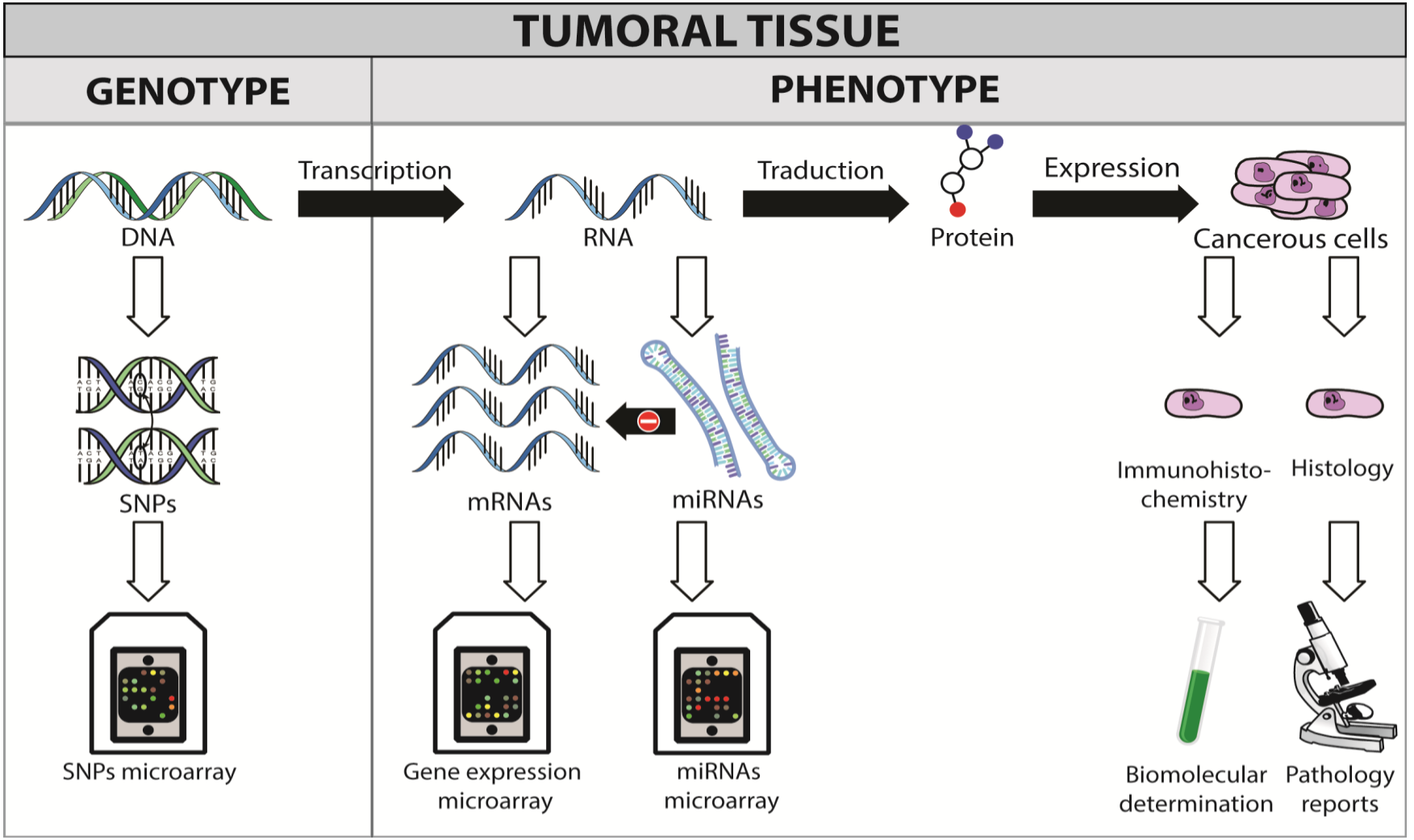
2. **Genotype/Phenotype integration**
   - Biomarker search
   - Genome/Phenome Wide Association Studies (GeWAS/PheWAS)
   - Personalized medicine

Biomarkers in oncology



- Feero WG, Guttmacher AE, Collins FS. Genomic medicine--an updated primer. N. Engl. J. Med. 2010 May 27;362(21):2001–11.
- Pasquinelli AE. MicroRNAs and their targets: recognition, regulation and an emerging reciprocal relationship. Nat. Rev. Genet. 2012 Apr;13(4):271–82.

CDW use

Pilot Study (i2b2 + transSMART

VOLUME 27 · NUMBER 35 · DECEMBER 10 2009

JOURNAL OF CLINICAL ONCOLOGY

ORIGINAL REPORT

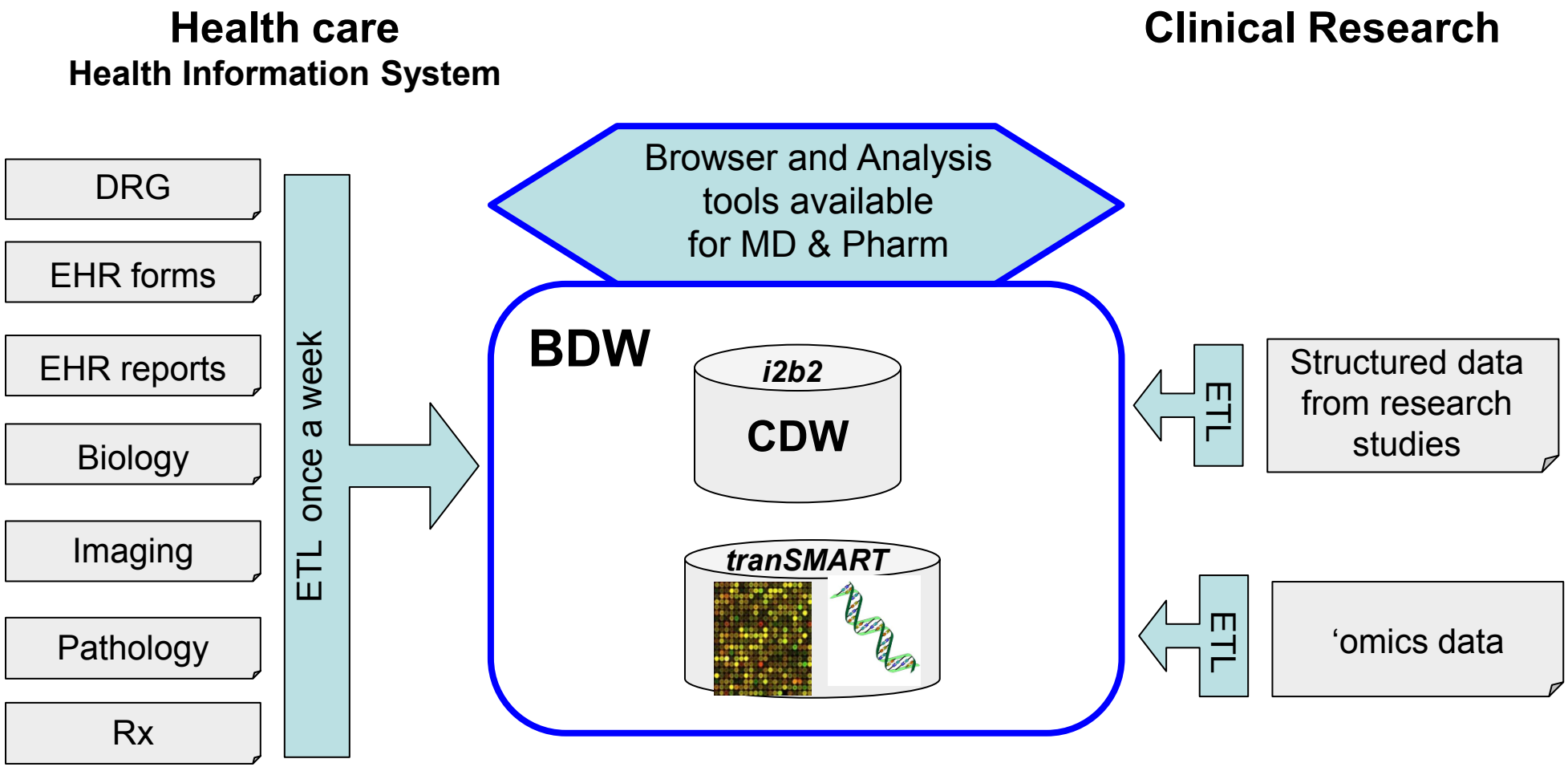
Analysis of *PTEN*, *BRAF*, and *EGFR* Status in Determining Benefit From Cetuximab Therapy in Wild-Type *KRAS* Metastatic Colon Cancer

Pierre Laurent-Puig, Anne Cayre, Gilles Manceau, Emmanuel Buc, Jean-Baptiste Bachet, Thierry Lecomte, Philippe Rougier, Astrid Lievre, Bruno Landi, Valérie Boige, Michel Ducreux, Marc Ychou, Fréderic Bibeau, Olivier Bouché, Julia Reid, Steven Stone, and Frédérique Penault-Llorca

- Laurent-Puig P, Cayre A, Manceau G, Buc E, Bachet J-B, Lecomte T, et al. Analysis of PTEN, BRAF, and EGFR status in determining benefit from cetuximab therapy in wild-type KRAS metastatic colon cancer. J. Clin. Oncol. 2009 Dec 10;27(35):5924–30.

HEGP BDW

I2b2 + tranSMART data sources



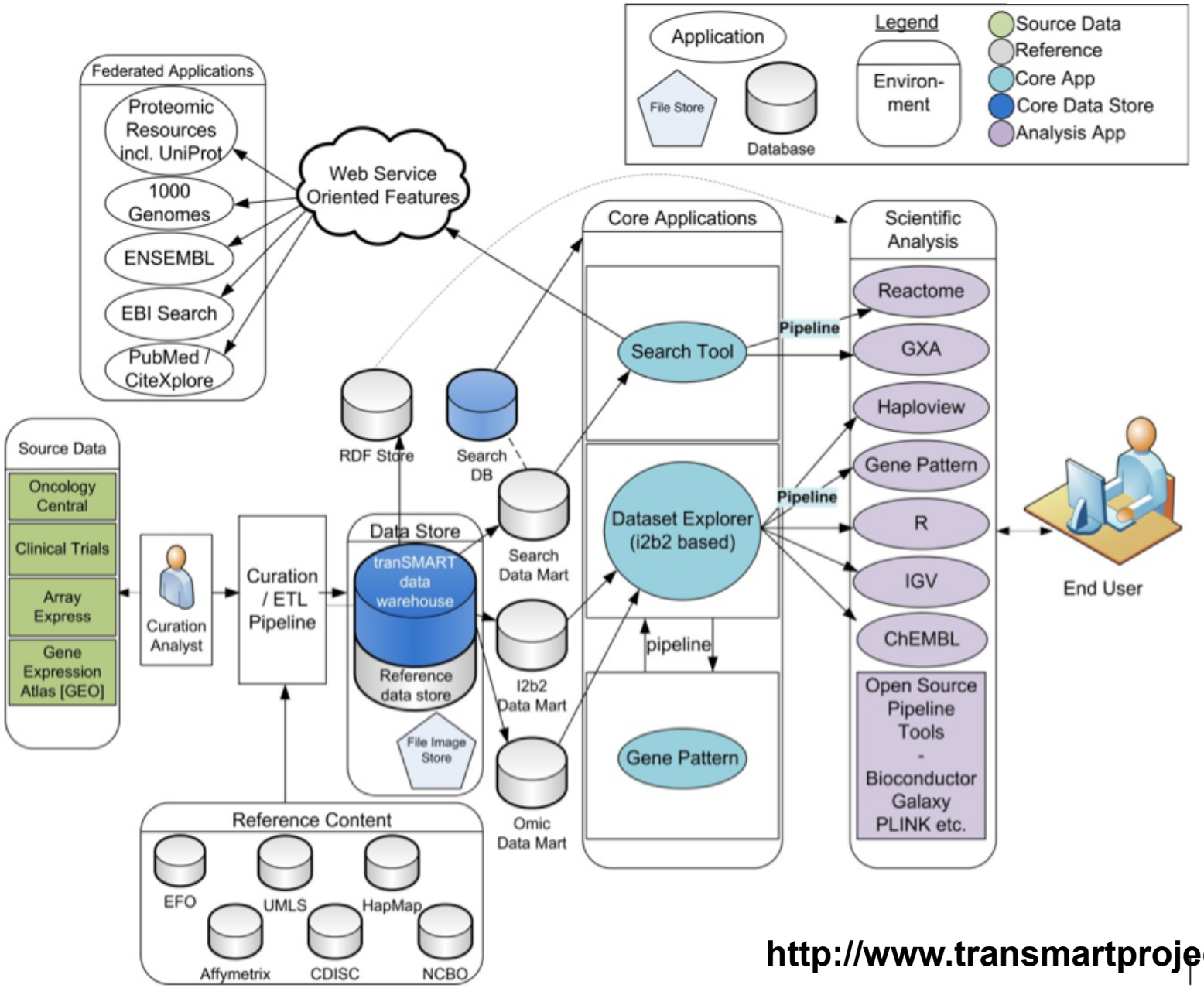
HEGP BDW

- Integrated platform to support translational researc
- Initiated by Johnson & Johnson et Recombinant 5 years ago
- Open-source since January 2012
- Installe at HEGP in June, 2012

- tranSMART [Internet]. [cited 2013 Jan 16]. Available from: http://www.transmartproject.org/
- Szalma S, Koka V, Khasanova T, Perakslis ED. Effective knowledge management in translational medicine. J Transl Med. 2010; 8:68.

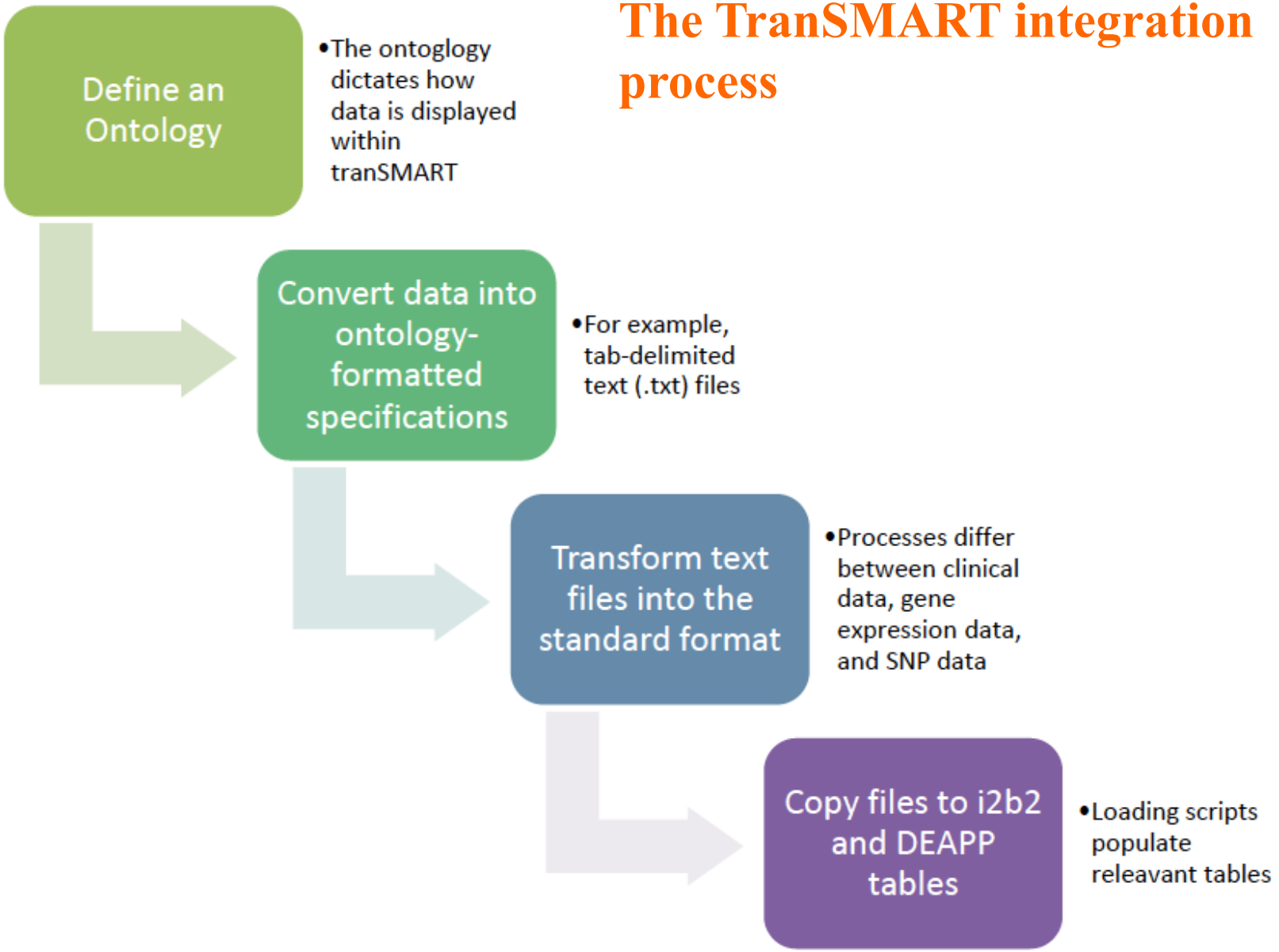
BDW content

“Omics” data integration



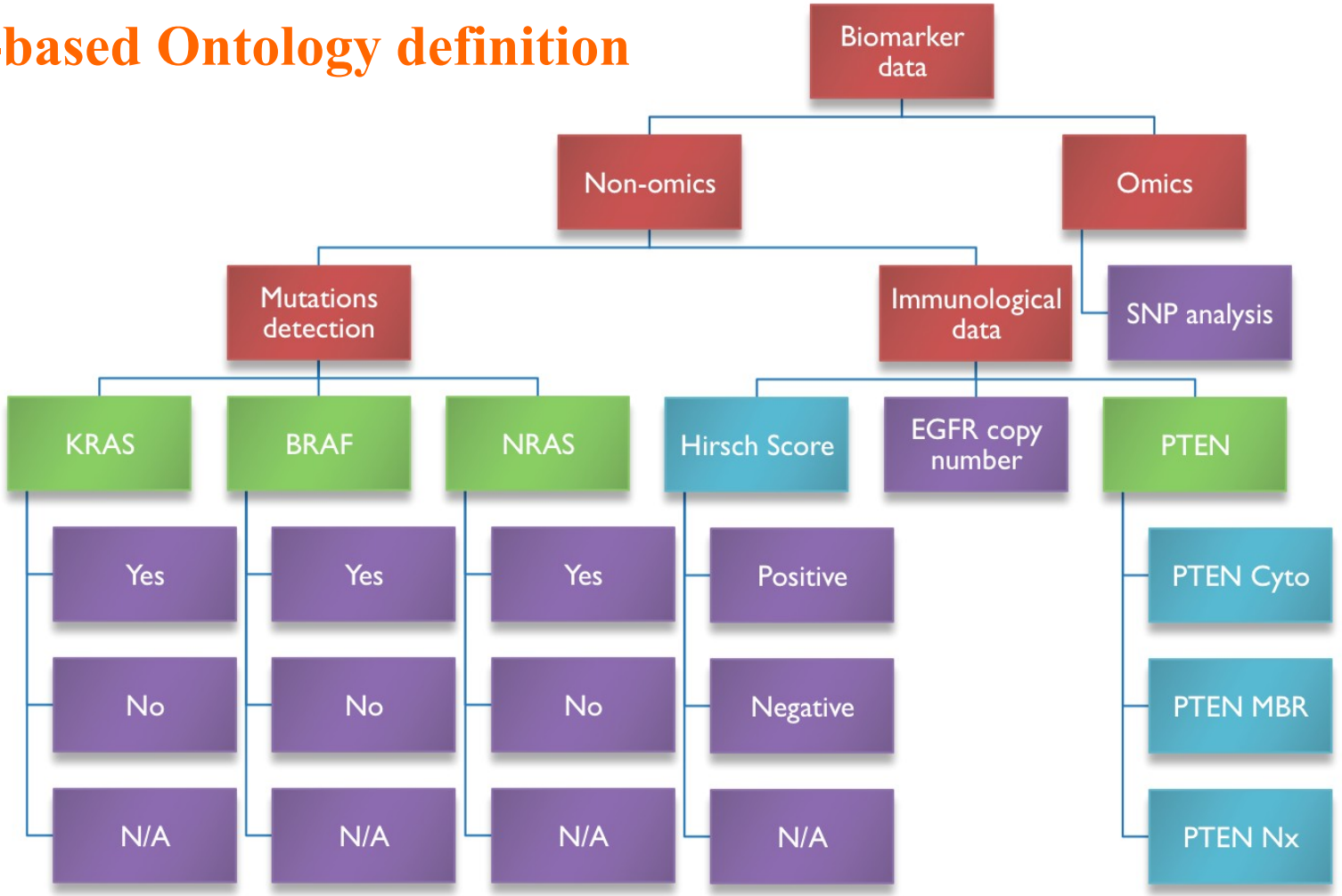
http://www.transmartproject.org

The TranSMART integration process



http://www.transmartproject.org

TranSMART-based Ontology definition



Category Code

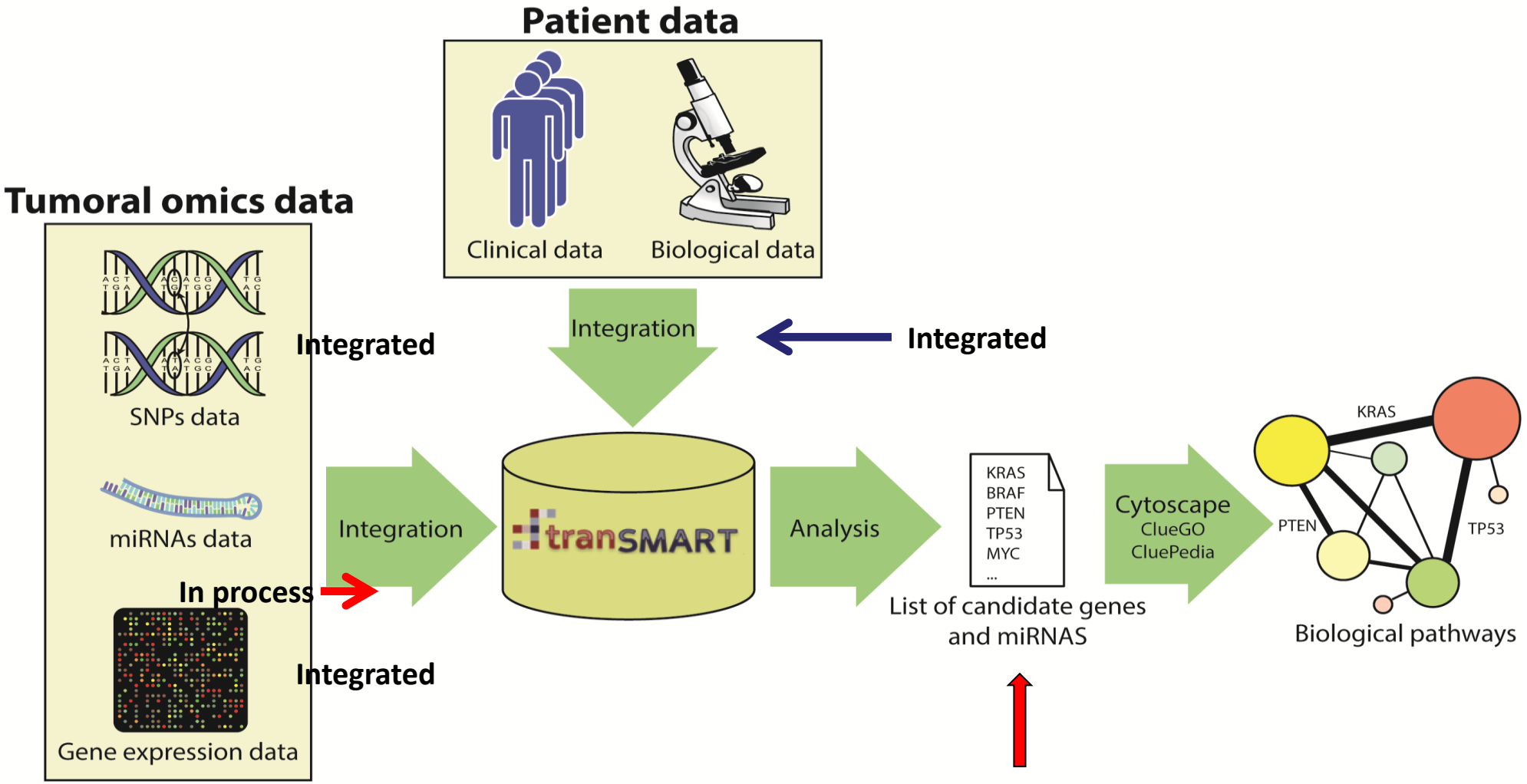
Data Label

Data Value

Concept inexistant dans une terminologie contrôlée

Kevin Zarka, 2012

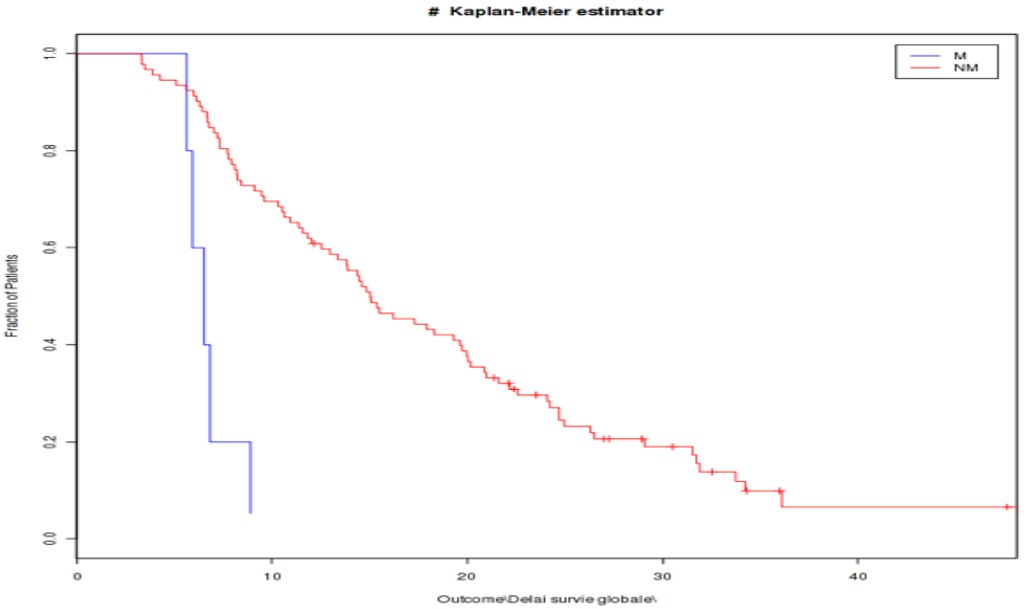
Iéb2/TranSMART data integration process



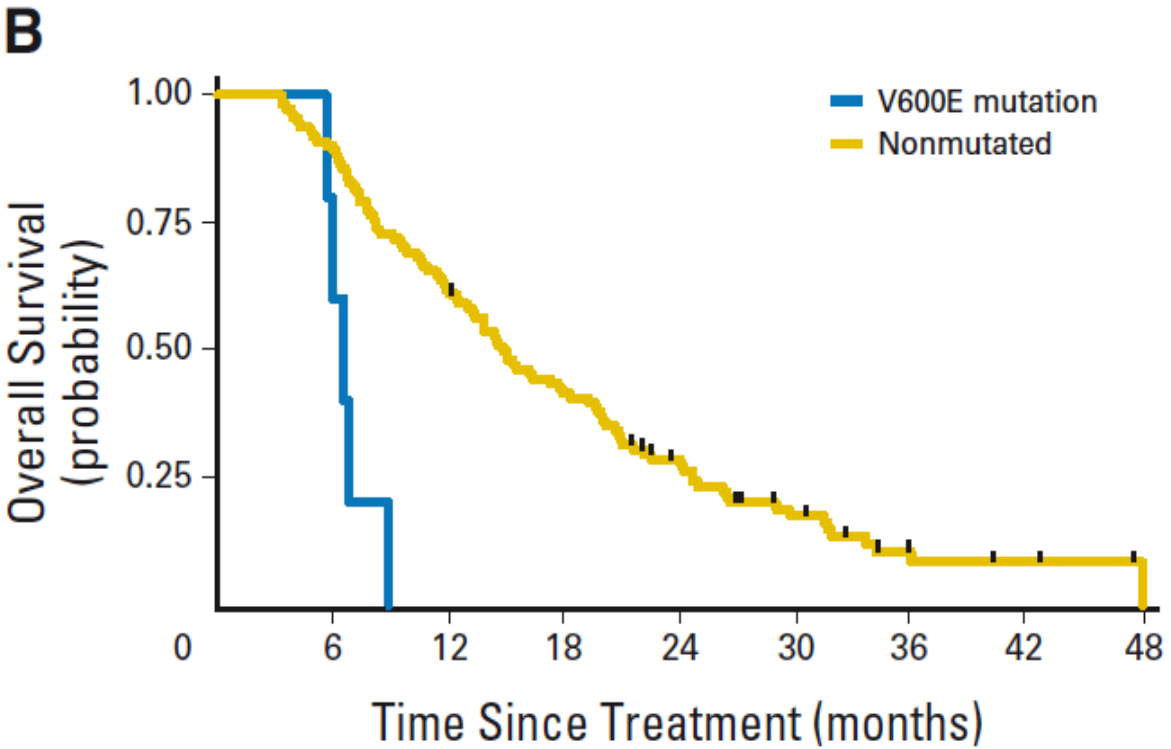
Vincent Canuel, Paul Avillach 2013

Proof of concept

- R module in tranSMART



- Published figure in JCO



HEGP CDW

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   - Personalized medicine

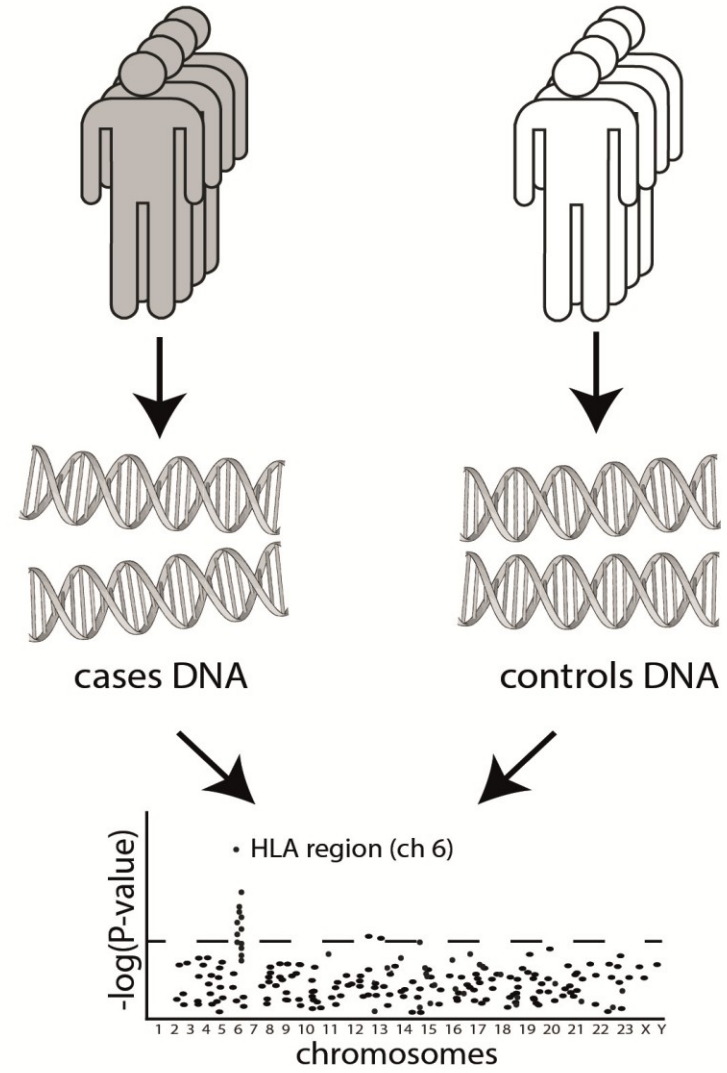
Genome Wide Association Study

(1 Phenotype compared to ALL SNPs)

cases

(ex: systemic sclerosis)

controls



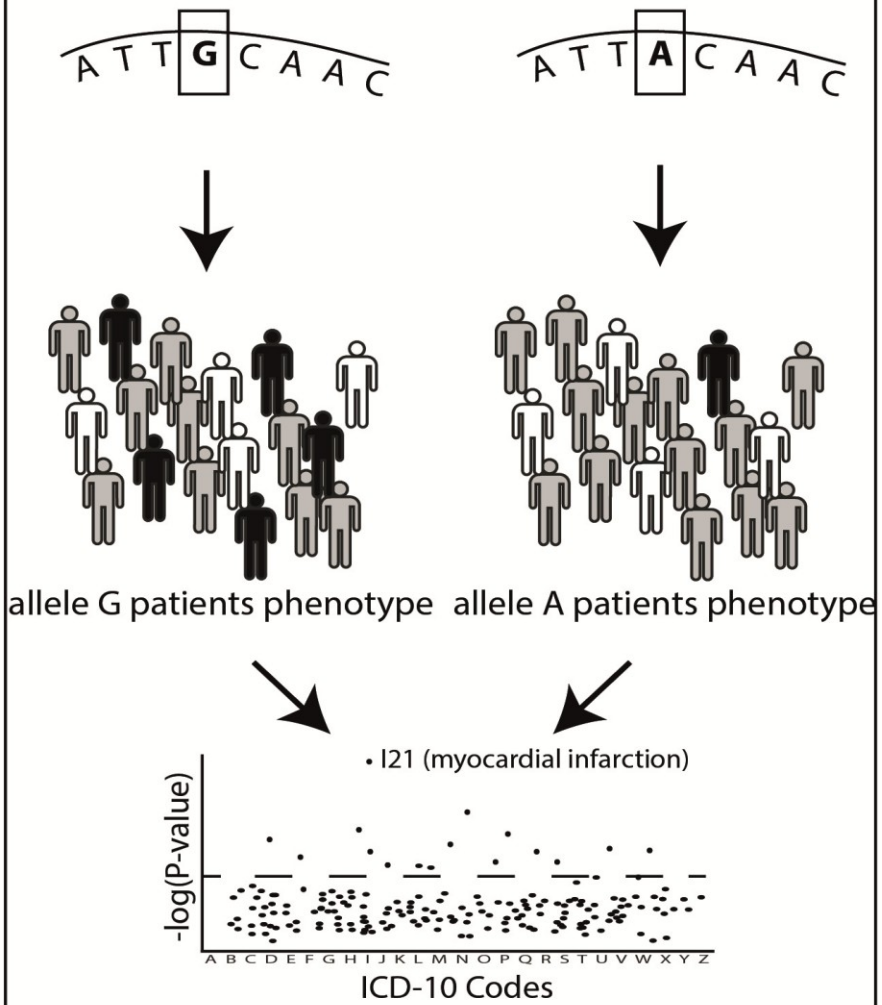
compare ALL SNPs to find differences between cases and controls

Phenome Wide Association Study

(1 SNP compared to ALL Phenotypes)

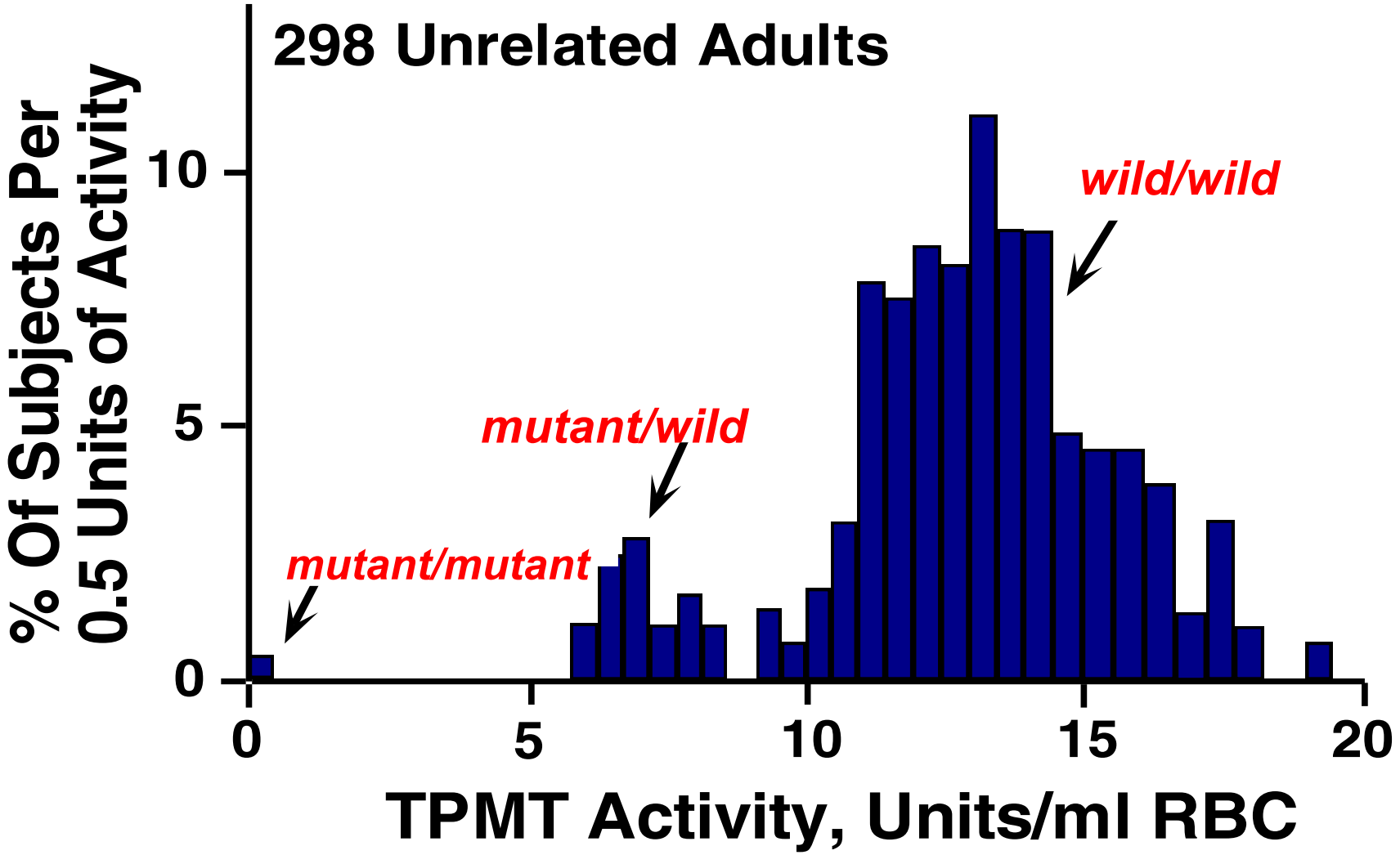
allele G patients group

allele A patients group

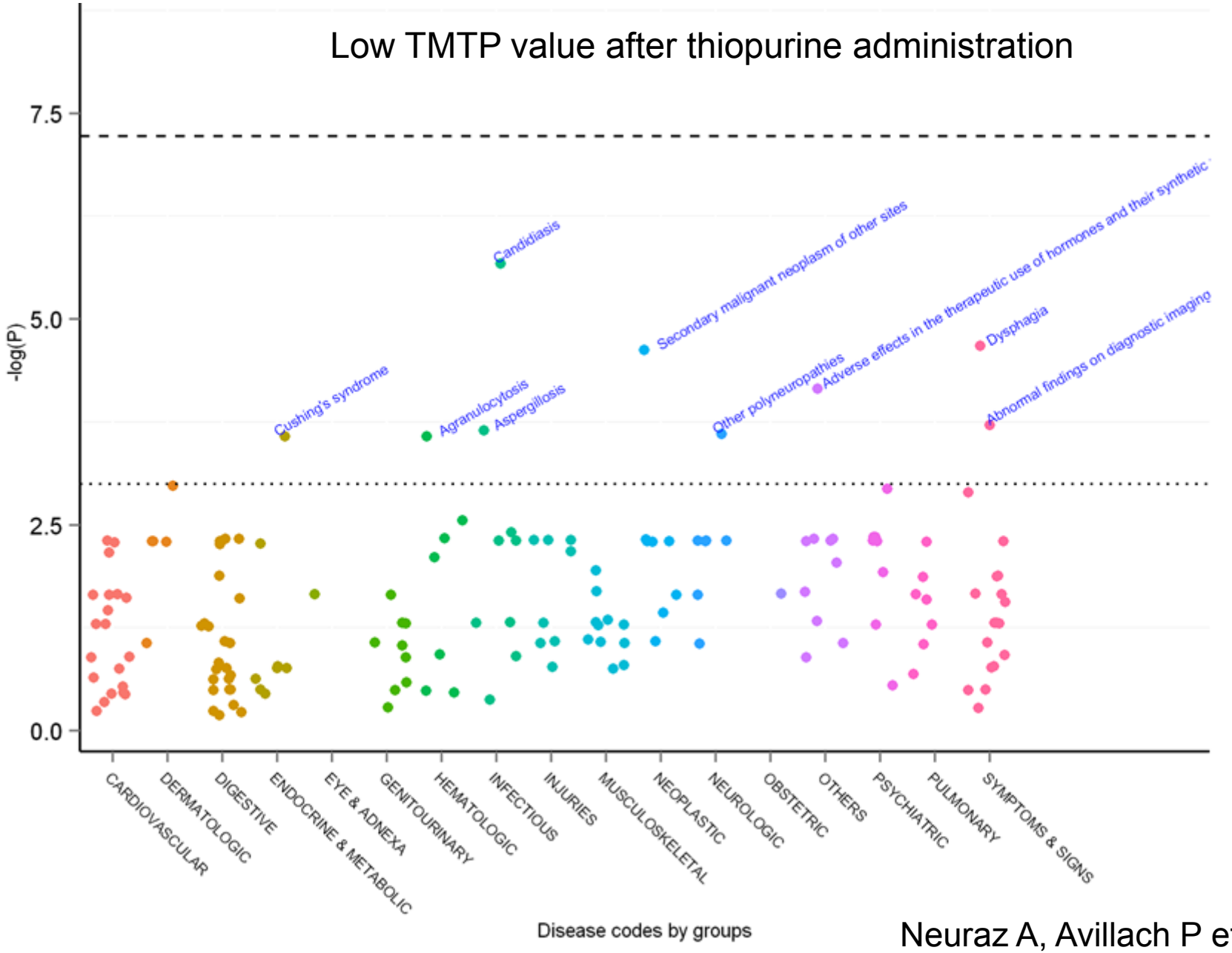


compare ALL DIAGNOSIS to find differences between cases and controls

TPMT: activity distribution (genetically dependent trait)



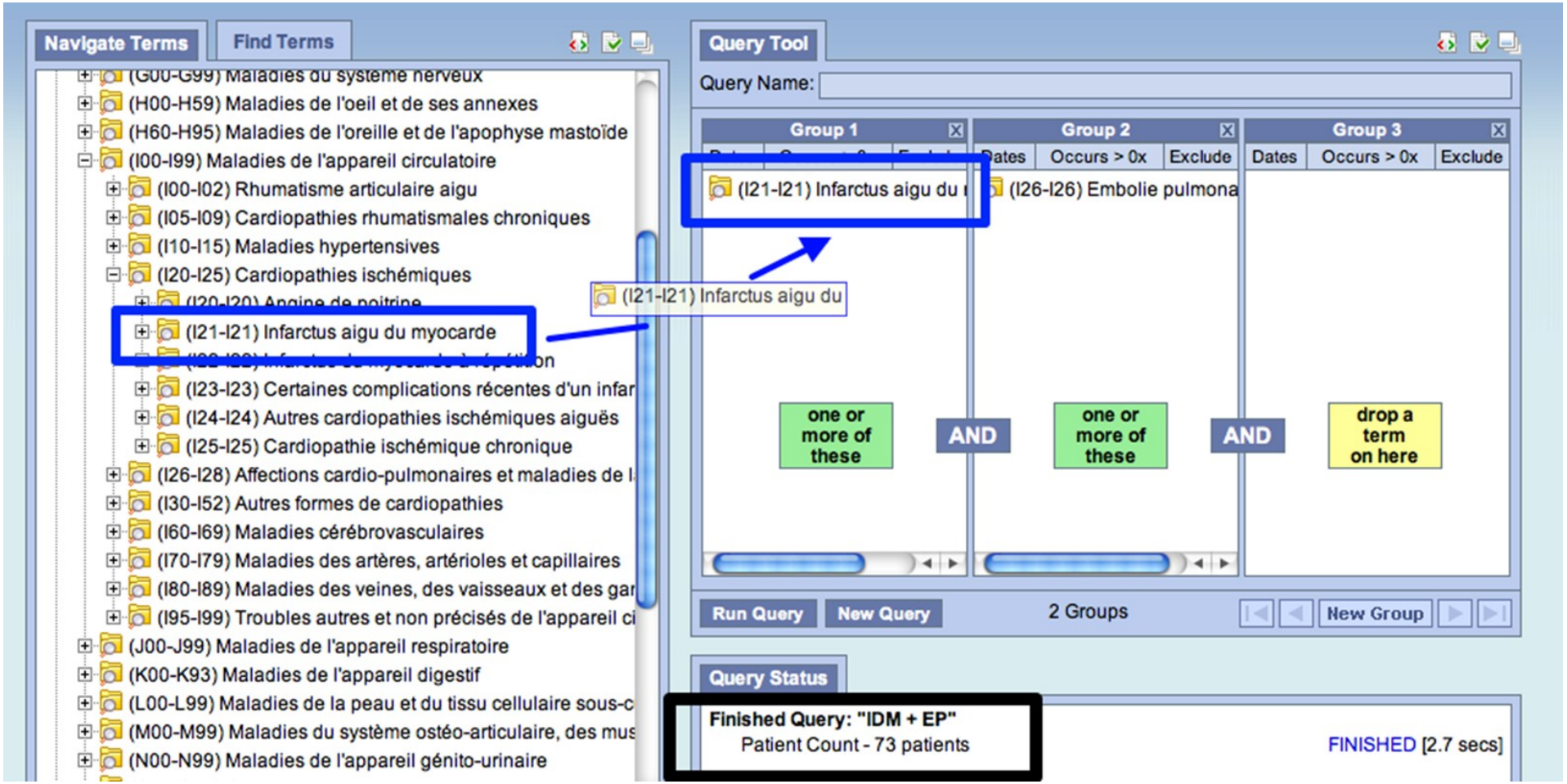
Lennard, Therapeutic drug monitoring of antimetabolic cytothoxic drugs, British journal of Clinical Pharmacology 2001



Neuraz A, Avillach P et al.

CDW use

i2b2 CDW queries (Jan. 2011-Dec. 2012)



- **170 MD + Pharmacists trained**
- **1864 type 1 requests**

CDW use

Type 2/3 project (Jan. 2011-Dec. 2012)

- **i2b2 projects**
  - 39 submitted projects
  - 19 accepted projects
- **i2b2 + tranSMART**
  - 3 submitted projects
  - 3 accepted projects

Conclusion (1)

Achievements

- A methodology to export concepts and data from an integrated CIS to an i2b2 CDW (2009-)
- An operational CDW directly used by MD and Pharm (2011-)
- Installation & evaluation of a tranSMART platform to augment clinical data with omic information (2012-)

Benefits of the approach

- Availability of clinical data has generated a virtuous cycle at the HEGP end-user level (e.g., improved standardized questionnaires)
- tranSMART as a superset of i2b2 could facilitate “omics” data integration

Conclusion (2)

Limits of the approach

- Lack of semantic integration tools to merge i2b2-tranSMART concepts
- i2b2-tranSMART data model heterogeneity

Perspectives

- Semantic integration within the i2b2-tranSMART platform to facilitate:
  1) meta-analysis from multiple cohorts
  2) phenotypic augmentation in “omics” driven research

Acknowledgments

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Vincent Canuel, MD

Pharmacy
Pr. Patrice Prognon
Brigitte Sabatier

www.i2b2.org

www.transmartproject.org

www.recomdata.com

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