

# AIIC2023

FORTEZZA DA BASSO

Firenze 10-13 maggio 2023



Convegno Nazionale  
Associazione Italiana Ingegneri Clinici

Innovazione e accessibilità:  
il governo delle tecnologie sanitarie come sfida sociale



IC



# Applicazioni di intelligenza Artificiale in un IRCCS

*Emilio Meneschincheri – Giovanni Arcuri*



## Il ruolo dell'IA in Sanità

- Miglioramento della diagnosi
- Personalizzazione dei trattamenti
- Ottimizzazione della gestione sanitaria
- Miglioramento dei servizi ai pazienti
- Accelerazione della ricerca clinica
- Digital Health e monitoraggio a distanza

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# **Building a radiomics hospital: design of technological evolution**

# Traditional Radiology Workflow



Information coming  
from diagnostic  
technology



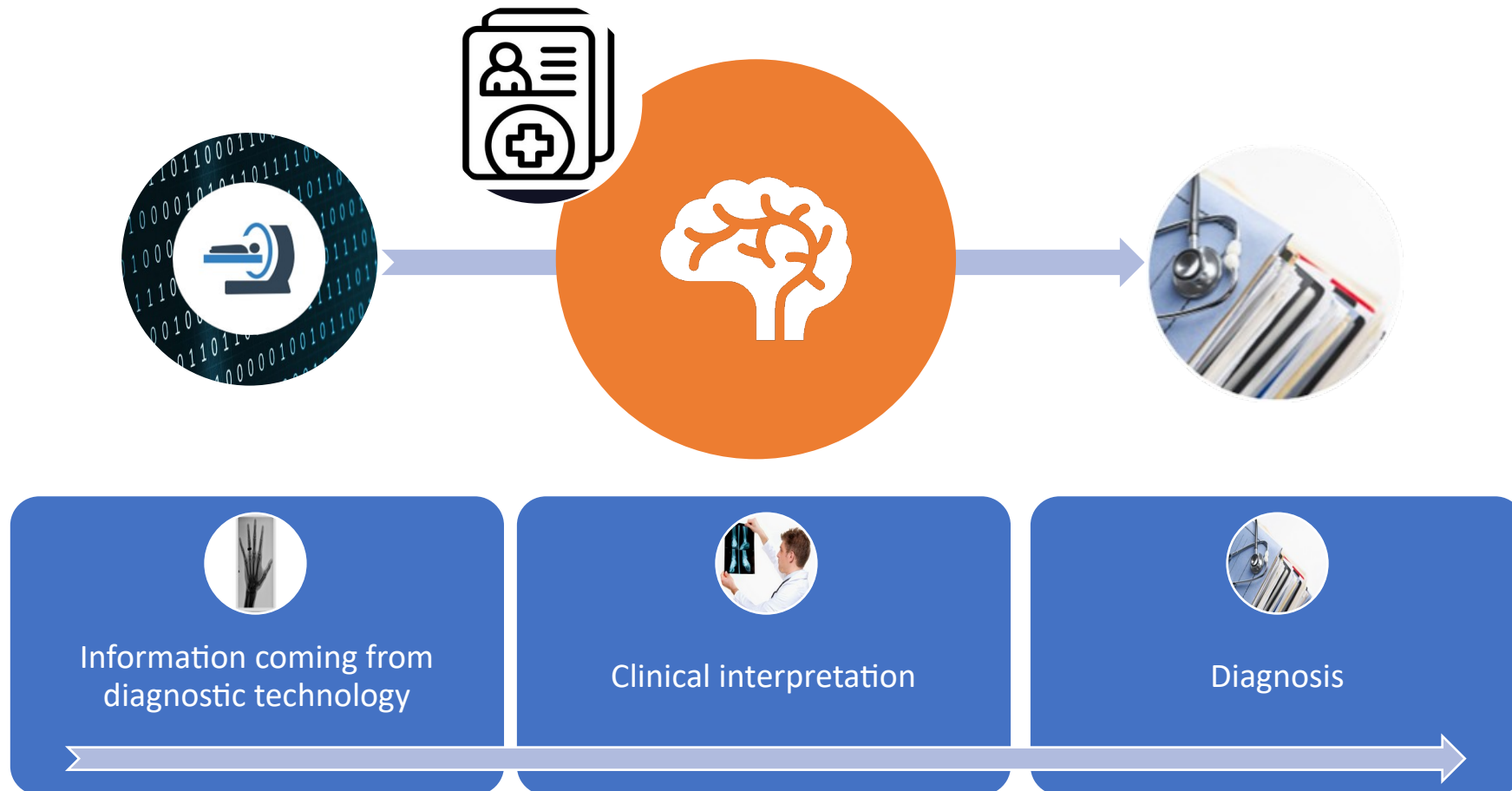
Clinical interpretation



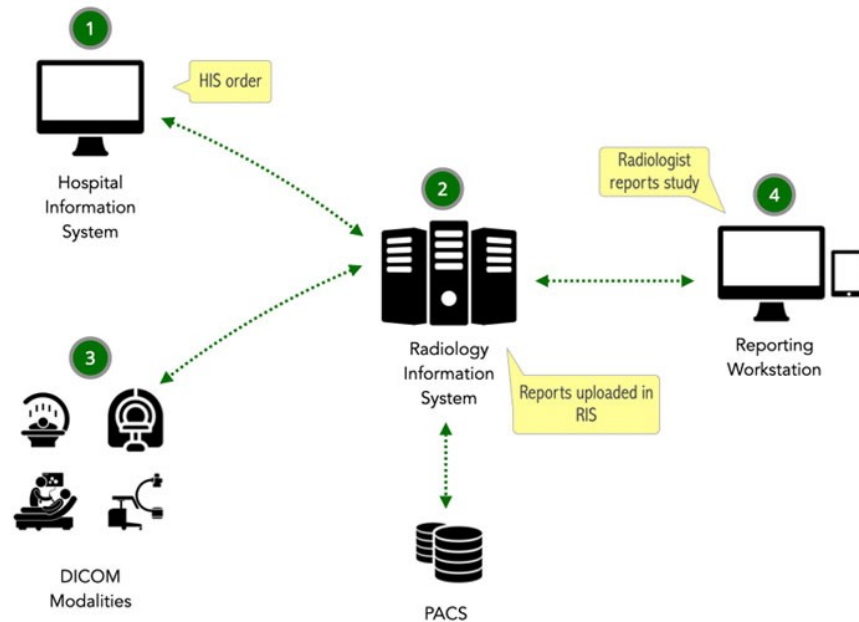
Diagnosis



# In other words...



## ...and this is translated in technical architecture of an hospital



In terms of:

- Archiving Capability
- Computational power
- Data structure and standards for communication
- Data integration
- Case selection
- ...

# But the reality is now different...

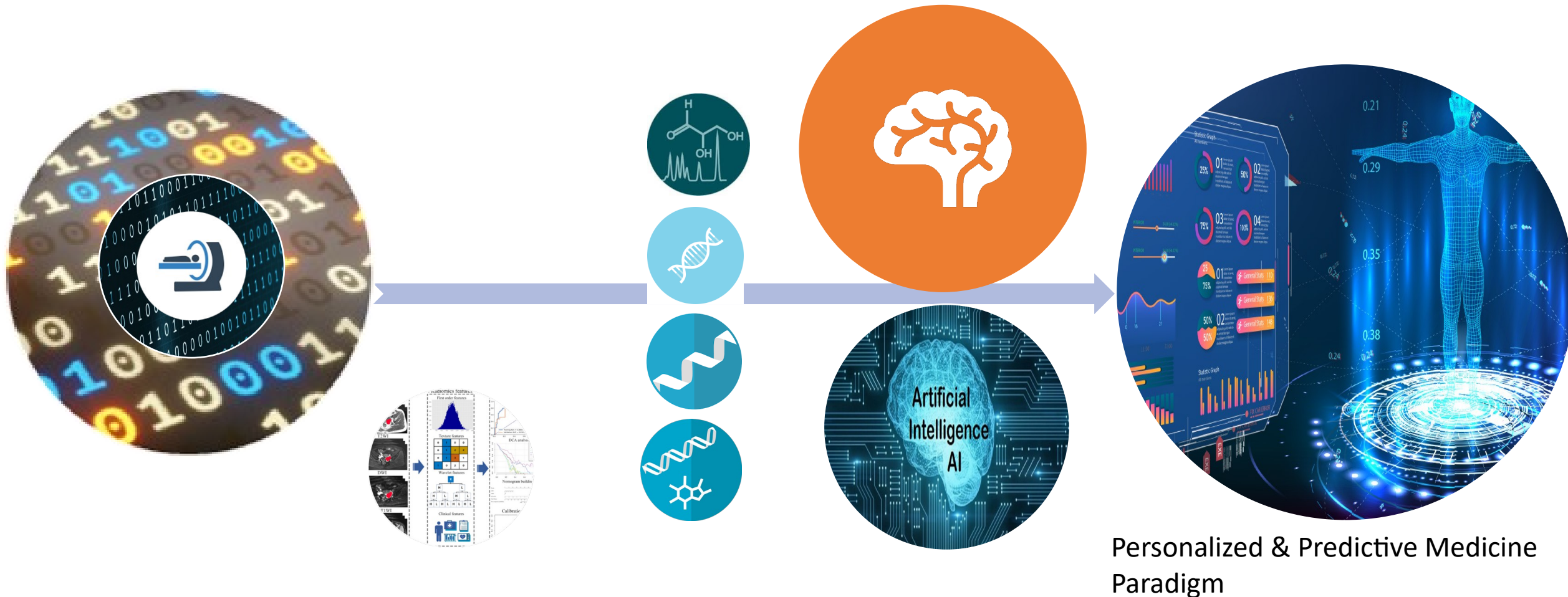
Radiomics performs a sw based analysis of extraction of features NOT PERCEPTABLE TO THE HUMAN EYE



Diagnostic technologies provide information NOT PERCEPTABLE TO THE HUMAN EYE



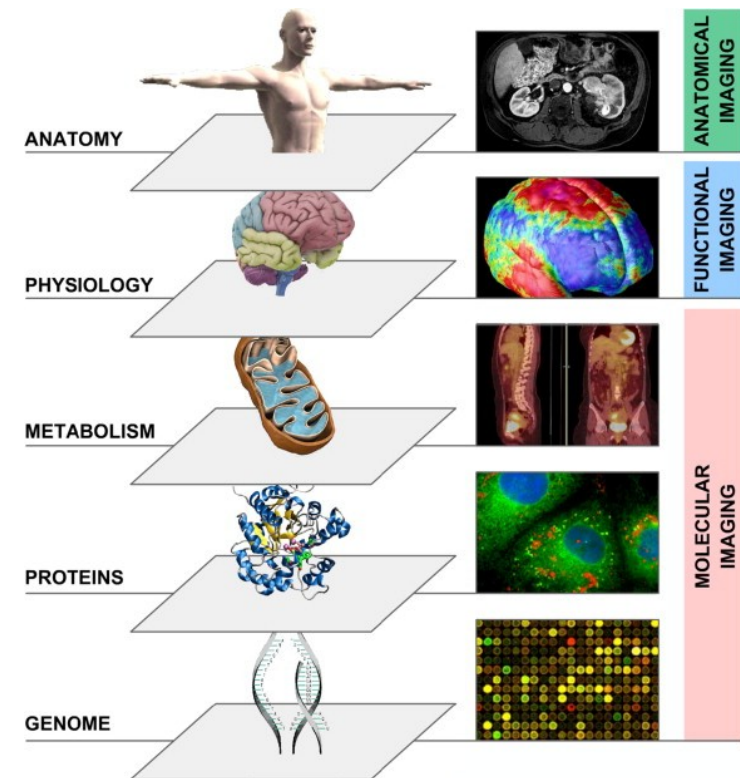
# ... and beyond: Rediogenomics & «omics» integration



Personalized & Predictive Medicine  
Paradigm



# Design of technological evolution



More data integration

Different kind of data

Different workflow

Different networking architecture

Collaborative Platform – Collaborating Centers

High Computational Power

High Data Storage Capability

Different Clinical workflow & New Facilities

# Omic – From Sample to Data The Cognitive Platform

## Repository

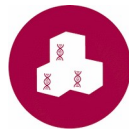


PACS



Biobank

## Sample



Imaging



Blood



Feces



Urine



Tumour Biopsy



Tissue Biopsy

## Data



Radiomics



Genomics



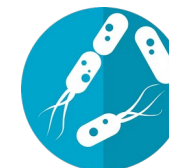
Proteomics



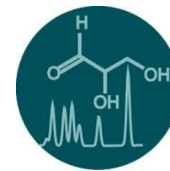
Trascriptomics



MetaProteomics



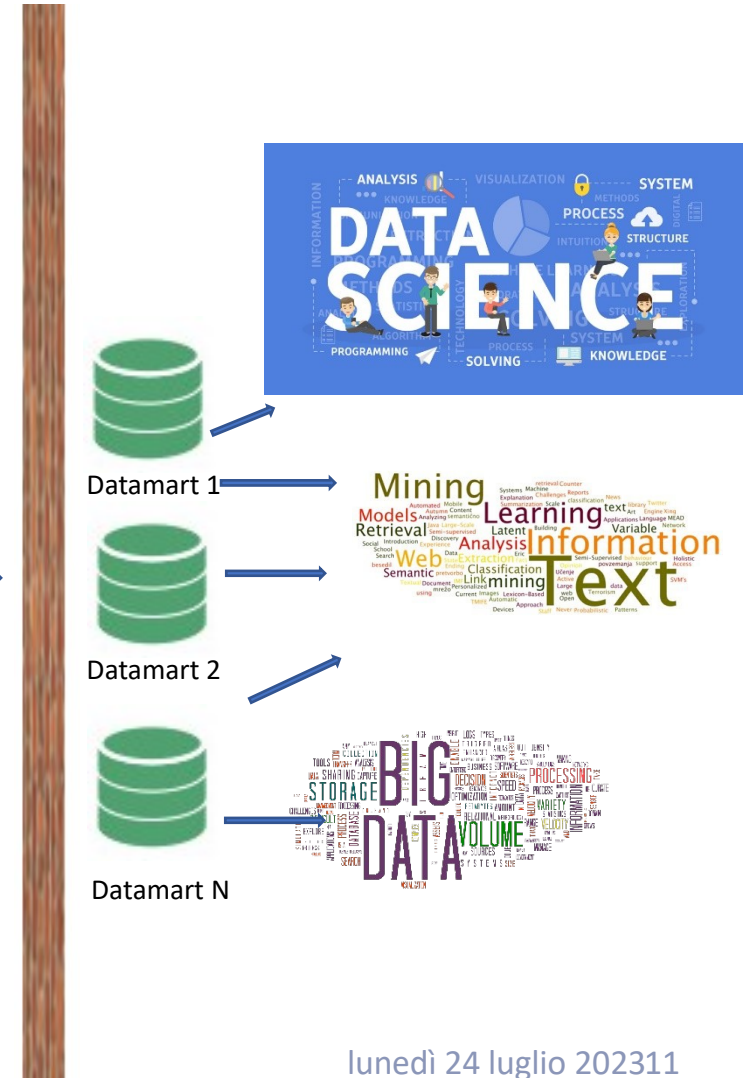
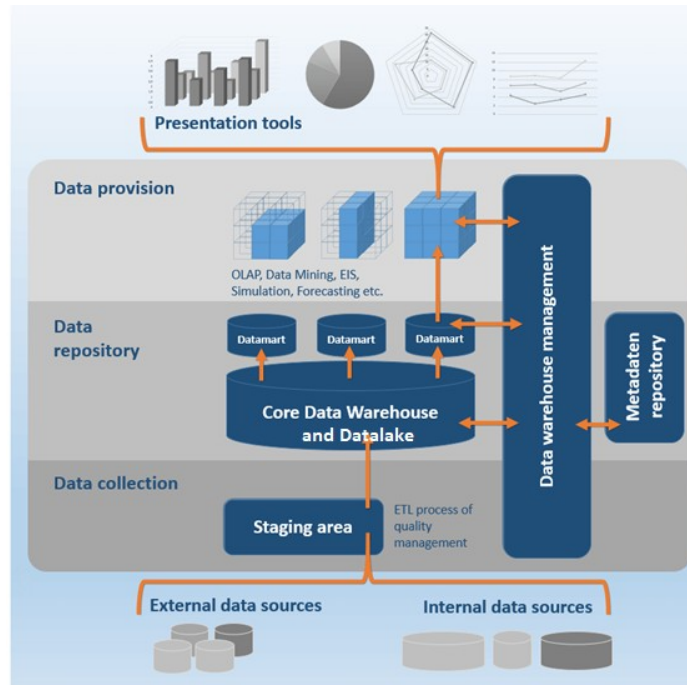
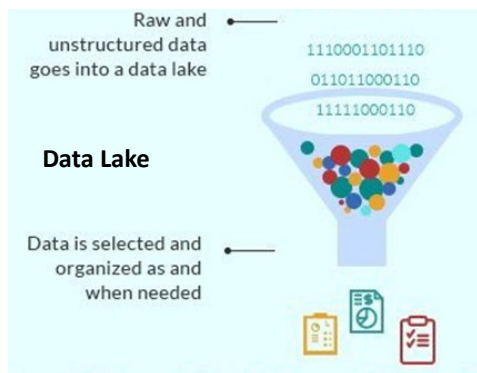
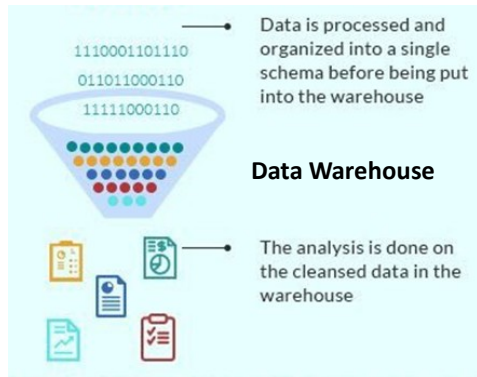
Microbiomics



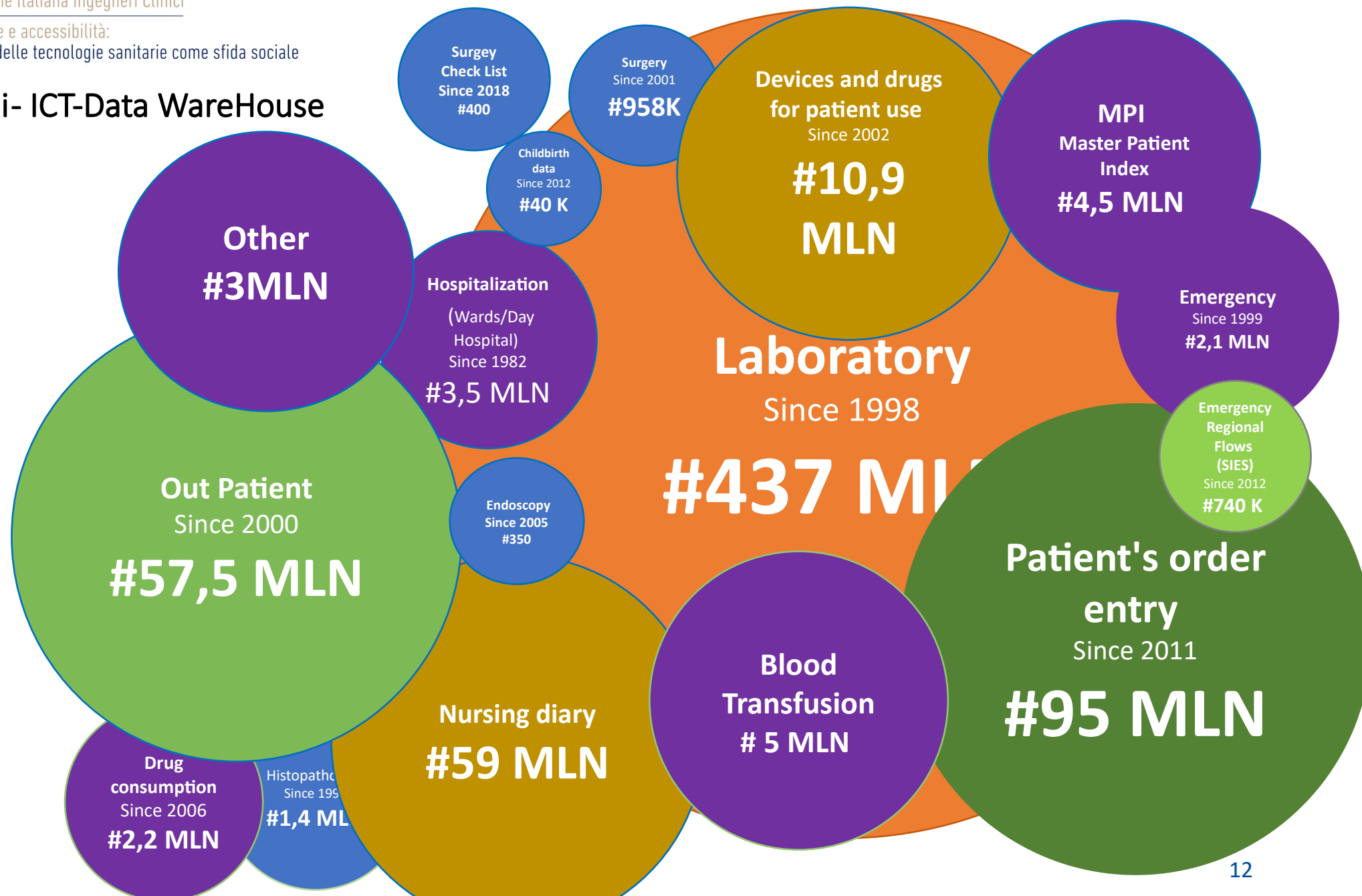
Metabolomics

# Design of technological evolution

## ICT-Data Warehouse , DataLake and Datamart for Research



# Policlinico Gemelli- ICT-Data Warehouse

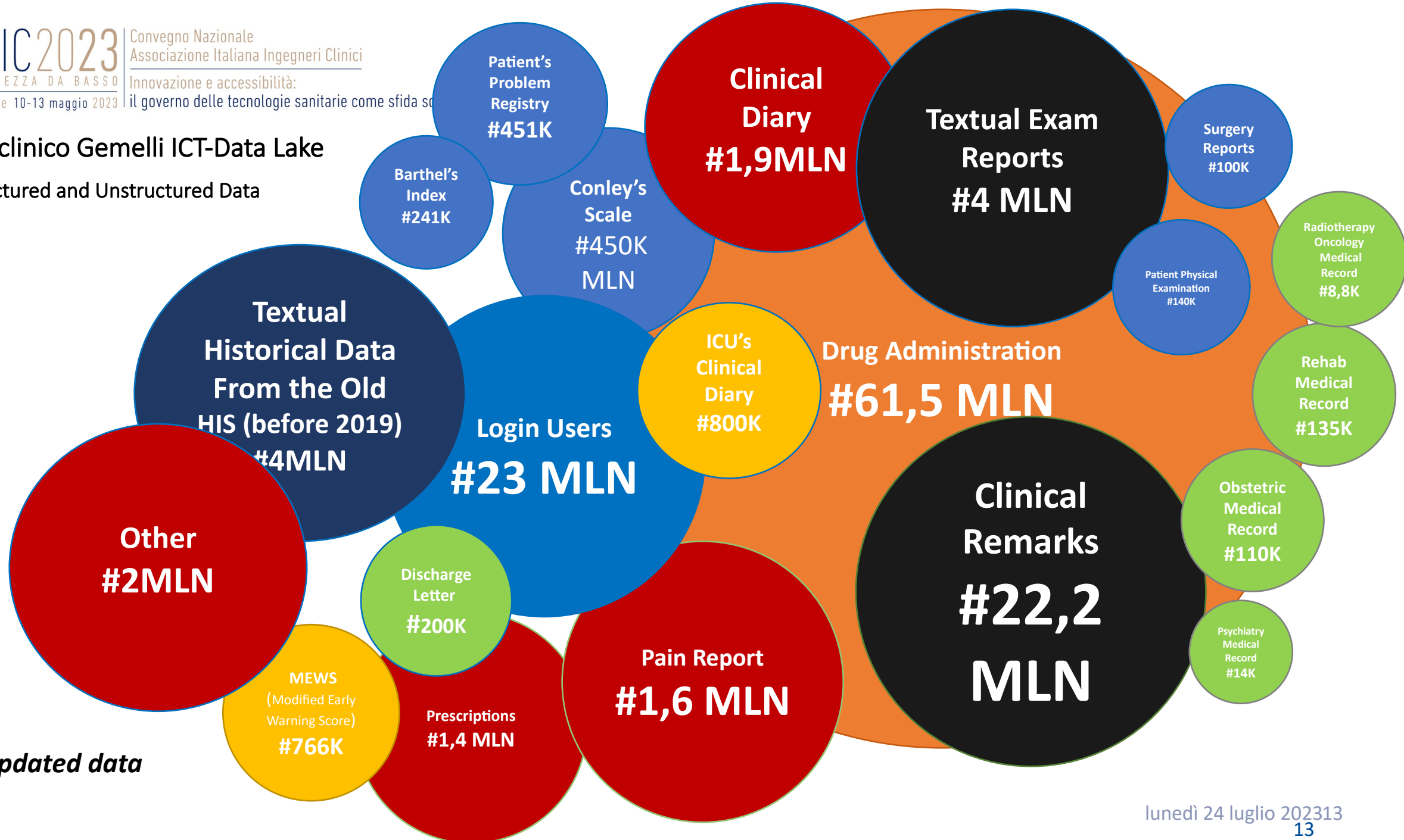


Daily updated data



## Policlinico Gemelli ICT-Data Lake

Structured and Unstructured Data



Daily updated data

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## CASO 1 - DATA MART / POC PREDITTORI SCOMPENSO CARDIACO



## A WORLDWIDE MEDICAL AND ECONOMIC BURDEN

### USE CASE: HEART FAILURE

**3/1000**

**1-2%**

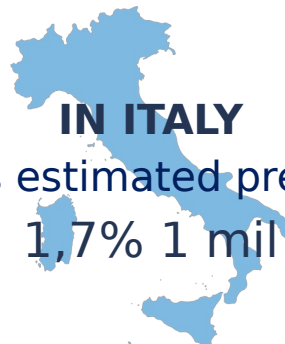
prevalence and incidence in Europe

**53%**

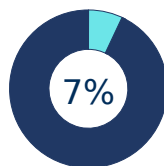
of patients die within 5 years from diagnosis

**1.3**

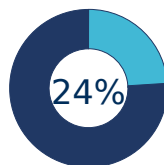
per person /year rate of readmission



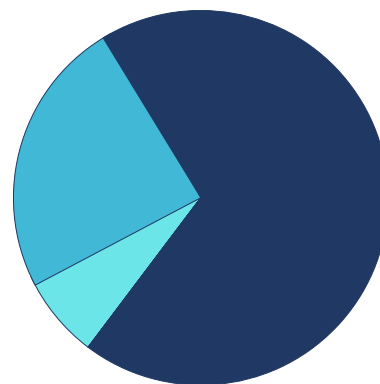
#### High mortality rate



PATIENTS DIED DURING THE FIRST HOSPITAL ADMISSION



PATIENTS DIED WITHIN 1 YEAR FROM HOSPITAL DISCHARGE



#### High direct costs

**84,6%**

Hospital admissions

**8,9%**

Other medications

**5,3%**

Specialist examinations and diagnostic procedures

**11.864 €**

Average annual cost of a patient with HF = ~2% of total SSN budget

**1,2%**

HF medications



## DATALAKE

SOURCE: GEMELLI IT SYSTEMS



CONTACTS



CARDIOLOGY  
CONSULTANCIES



PRIMARY  
DIAGNOSES



ECO CARDIO  
MEASURES



LABORATORY  
EXAMS



DRUGS



NURSE DIARIES



HOSPITALIZATION



ER / ACUTE EVENTS

## GENERATOR PROCEDURES

SEARCH ENGINES, DATA  
COLLECTION / PROCESSING



AUTOMATED STRUCTURED DATA ETL  
(real time, continuous ingestion)



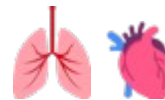
ANONYMIZATION



LAB MEASURES BOT



DIAGNOSIS BOT



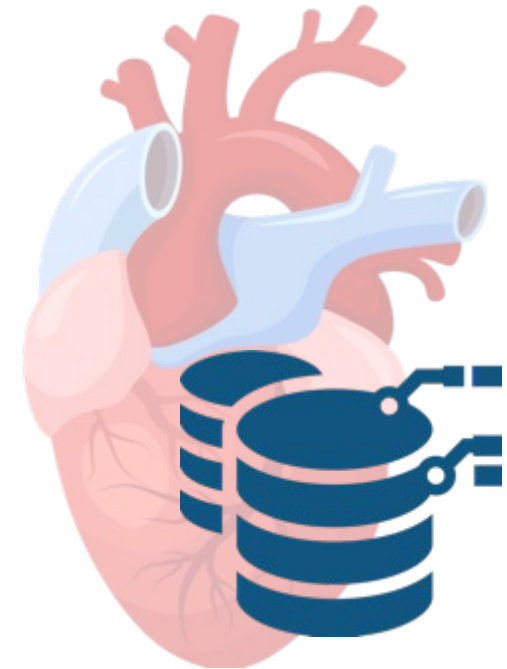
COMORBIDITIES BOT



DRUGS BOT

## HEART FAILURE DATAMART

PATIENT-CENTERED VIEW

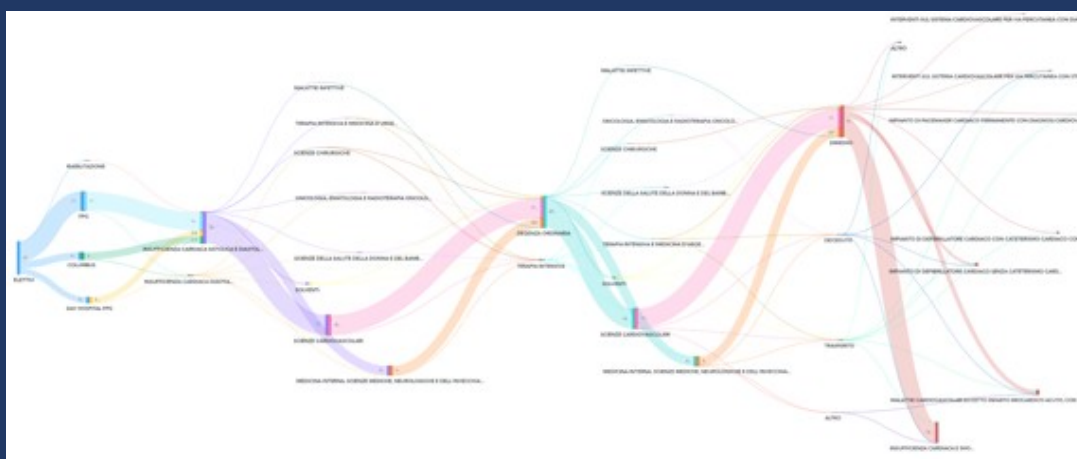


**3000 PTS (DIAGNOSED)**  
**10000 PTS (PRE-CLINICAL)**

### GENERATOR HEART FAILURE DataMart: an integrated framework for heart failure research (in press)

Domenico D'Amario, Renzo Laborante, Agni Delvinoti, Jacopo Lenkowicz, Chiara Iacomini, Carlotta Masciocchi, Alice Luraschi, Andrea Damiani, Daniele Rodolico, Attilio Restivo, Giuseppe Ciliberti, Donato Antonio Paglianiti, Francesco Canonico, Stefano Paternello, Alfredo Cesario, Vincenzo Valentini, Giovanni Scambia and

Principal Investigator: Prof. D. D'Amario



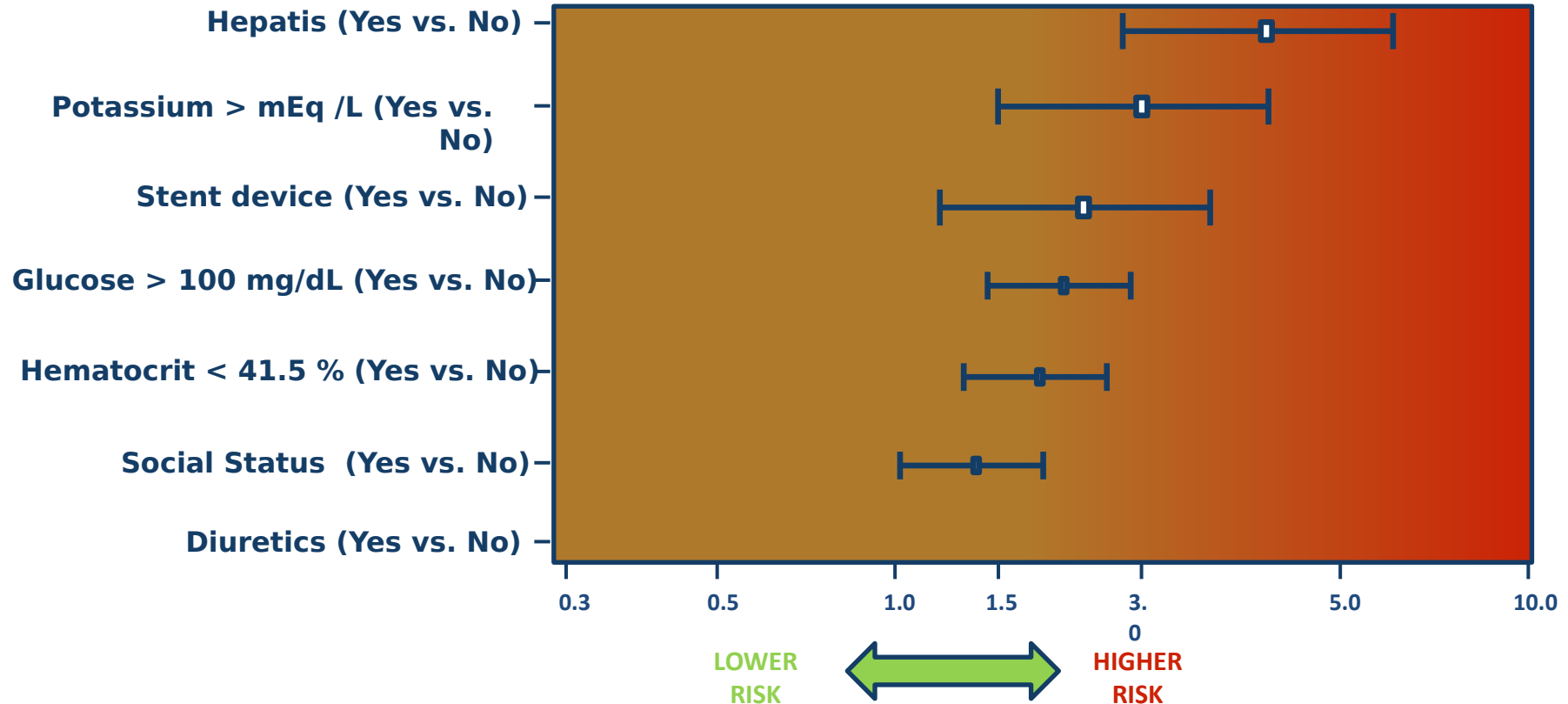
**INCLUSION CRITERIA - 465 PATIENTS, 2019-21, REDUCED EJECTION FRACTION**

**PREDICTIVE MODELS  
DEVELOPMENT FOR EARLY  
IDENTIFICATION OF  
ADVERSE EVENTS**



**USE CASE:  
RISK OF RE-  
HOSPITALIZATION**

- ALGORITHM: FEATURE SELECTION BASED ON MULTIVARIATE COX
- TRAINING SET: 644 PATIENTS
- TESTING SET: 161 PATIENTS



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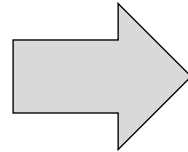
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## CASO 2 - CONTINUITÀ ASSISTENZIALE / GESTIONE LUNGODEGENTI

# Use case: long term patient management (centrale di continuità assistenziale)

AUTOMATED SYSTEM  
FOR MONITORING, PROCESS  
CONTROL, DECISION SUPPORT  
FOR LONG TERM PATIENT  
MANAGEMENT (**CCA**)



- **Automate data collection:** engagement, onboarding, management of long-term patients (high complexity, multicomorbidities, fragility, geriatric ...)
- **Integration of multiple data sources** (eHR; LIMS; Nurse Information System) → **unified patient view vista unica paziente CCA**
- Verify **process conformance** and **impact of non-compliance** with ward-specific focus
- Identify **critical factors** and **root cause analysis** impacting length of stay and differentiate analysis for disease domains
- Build **predictive tools** that enable **early identification** of most critical cases to take **preventive actions**





# Use case: long term patient management (centrale)

CCA Monitor



dashboard

Date:

2022-07-15

days-window

26

Pazienti CCA:

All

Pazienti PS:

All

Gruppo:

MED

Stato paziente:

Dimessi

BRASS:

All

Reparti Stats

Legenda

Show 10 entries

Search:

ID	CCA	PS	frail	mBRd	d.B-O	d.C-O	dataRicovero	desc.reparto	classe	dataIN	dataOUT	ggReparto	StatoPaz	dataBRASS	deltaBRASS	maxBrass	mBRr	pat.ID
2848	X					2	2022-08-02	UNITA COGN.-FUNZ.	MED	2022-08-02	2022-08-12	10	D	2022-08-02	0	23		5749635.922011471703
2854	X	X				5	2022-08-09	UNITA COGN.-FUNZ.	MED	2022-08-10	2022-08-22	12	D	2022-08-10	0	29		6086813.922011494879
2865	X				1	0	2022-08-03	MED. GENERALE	MED	2022-08-03	2022-09-11	39	DD	2022-08-03	0	26		6963177.922011472206
2873	X	X				1	2022-07-14	MED. INTERNA E GASTR.	MED	2022-07-19	2022-07-22	3	D	2022-07-19	0	8		8547929.922011449196
2878	X	X			0	3	2022-07-19	CARDIO. INTENS.	MED	2022-07-20	2022-07-29	9	D	2022-07-20	0	12		8659112.922011459138
2879	X	X			0	3	2022-07-19	CARDIO. SUB-INTENS.	MED	2022-07-29	2022-08-04	6	D	2022-07-29	0	24		8659112.922011459138
2880	X	X			0	3	2022-07-19	UNITA COGN.-FUNZ.	MED	2022-08-04	2022-08-05	1	DD		1			8659112.922011459138
2895	X	X				1	2022-07-30	MED. D'URG.	MED	2022-08-01	2022-08-04	3	D	2022-08-03	2	3		9974437.922011478252
2896	X	X				1	2022-07-30	MED. INTERNA GER.	MED	2022-08-04	2022-08-22	18	DD	2022-08-10	6	21		9974437.922011478252

Showing 181 to 189 of 189 entries

Previous 1 ... 15 16 17 18 19 Next

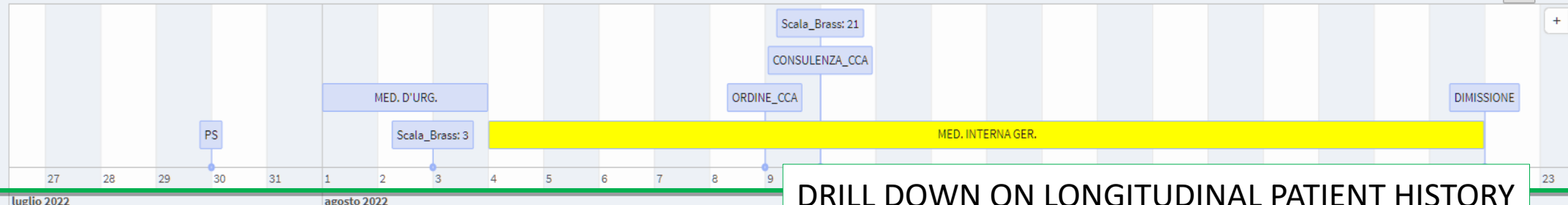
Show 10 entries

Search:

ID	CCA	PS	frail	mBRd	d.B-O	d.C-O	dataRicovero	desc.reparto	classe	dataIN	dataOUT	ggReparto	StatoPaz	dataBRASS	deltaBRASS	maxBrass	mBRr	pat.ID
2895	X	X				1	2022-07-30	MED. D'URG.	MED	2022-08-01	2022-08-04	3	D	2022-08-03	2	3		9974437.922011478252
2896	X	X				1	2022-07-30	MED. INTERNA GER.	MED	2022-08-04	2022-08-22	18	DD	2022-08-10	6	21		9974437.922011478252

Showing 1 to 2 of 2 entries

Previous 1 Next



DRILL DOWN ON LONGITUDINAL PATIENT HISTORY

## CASO 3 - SISTEMI DI PATIENT IDENTIFICATION PER DISEGNO CLINICAL TRIAL

## FOCUS: patient identification and selection criteria

Step 1: automated procedures to filter patients on first-level inclusion / exclusion criteria



Step 2: AI-based rules for composite clinical parameters (example: subtype)



Step 3: provide clinical research team with actionable information

### TECHNICAL SOLUTION

- Specialized AI engines (“SEARCH” BOTs) that automatically crawl into the different domains of Breast DATA MART

Diagnosis BOT



Comorbidities BOT



Drug Therapy BOT



Radiology BOT

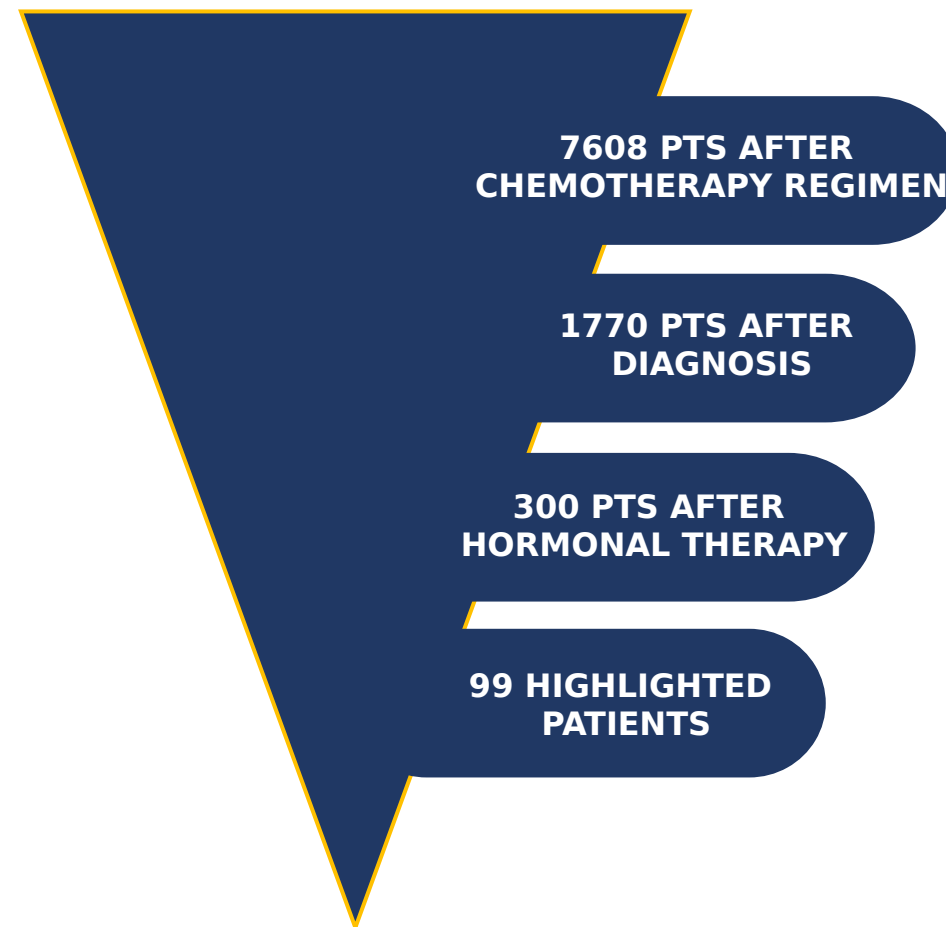


- Natural language understanding on free text medical reports + rule engines co-designed with clinical team
- User-oriented data visualization and drill-down tools to analyze patient history in depth

## FOCUS: patient identification and selection criteria

### Key Inclusion/Exclusion Criteria

- History of low HER2 expression
- Refractory endocrine therapy (HR+HR - Cohort)
- Has been treated with at least 1 or most 2 prior lines of chemotherapy in current or metastatic setting
- Never previously treated with anti-HER2 therapy (never previously HER2-positive)
- Presence of at least 1 measurable lesion according to m RECIST v1.1
- No history of myocardial infection in the last 6 months
- No history of interstitial lung disease
- No clinically active central nervous system metastases



Recruitment timeline **2 years / 1 patient selected**  
Screening based on AI-tool: **4 weeks**

## FOCUS: patient identification and selection criteria



### Temporal Filter

Recent Patients

MISSING NON APPLICABLE TRIPLE NEGATIVE

	ER	PR	Ki67	HER2
	90	5	65	1
	90	90	65	0
09/03/2020	85	30	40	0
12/02/2020	90	90	40	2
12/02/2020	90	30	2	1
30/01/2020	99	70	30	3
28/01/2020	75	65	25	2
24/01/2020	50	50	20	0
13/01/2020	95	40	70	0
08/12/2019	85	55	65	2
03/12/2019	90	1	65	0
28/11/2019	5	30	30	1
08/11/2019	99	50	15	2
31/10/2019	-	-	15	-
30/10/2019	2	3	40	0
09/10/2019	55	40	40	2
26/09/2019	1	0	25	0
19/09/2019	2	0	60	1
09/09/2019	0	0	20	0
06/09/2019	5	5	-	-
23/08/2019	50	80	40	3
18/08/2019	99	90	15	0
14/08/2019	90	10	25	1

### Color-coding

- Patient matching

### Drill-down

- In depth medical report

### Histological Sample Origin

BIOPSIA CITOLOGICO FISH IMMUNOISTOCHEMICA

Date	Data Origin	Text Type	Text
04/12/2013	BIOPSIA	NOTE_ESAME	REFERATO AGGIUNTIVO (E6) E-CADERINA:NEGATIVA (COMPATIBILE CON TIPO LOBULARE)
02/02/2017	BIOPSIA	DIAGNOSI	FRUSTOLO AGIOBIPTICO DELLA LUNGHEZZA DI CIRCA CM 2.4 ESTESAMENTE SEDE DI INFILTRAZIONE CARCINOMATOSA AD OPERA DI ELEMENTI DI PICCOLA TAGLIA CON ASPETTO MORFOLOGICO E PATTERN DI CRESCITA NON CONTRASTANTE CON ISTOTIPO LOBULARE (VEDASI NS PRECEDENTI ESAMI N°13-B-27370 E 13-B-27369). GLI ELEMENTI NEOPLASTICI SONO RISULTATI CK7 ED ER POSITIVI. NEGATIVE LE IMMUNOCOLORAZIONI PER MAMMOGLOBINA, GCDFFP15, PR ED HER2. FOCALE POSITIVITA PER ANDROGENO RECETTORE. SI RIMANDA AD ESAME N° 2017-P-0155 PER CARATTERIZZAZIONE BIOPATOLOGICA.
12/12/2013	IMMUNOISTOCHEMICA	DIAGNOSI	GIUNGONO N° 1 FETTE IN BIANCO SU COLLA PER DETERMINAZIONI IMMUNISTOCHEMICHE INDICATE IN GESTIONE COLORAZIONI. A, C, D. TESSUTI ESENTI DA LOCALIZZAZIONE NEOPLASTICA. B. MASTOPATIA FIBROSA CON



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Thanks for your attention

