Applicazioni di intelligenza Artificiale in un IRCCS

Emilio Meneschincheri – Giovanni Arcuri

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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

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In other words...

Information coming from diagnostic technology

Clinical interpretation

Diagnosis
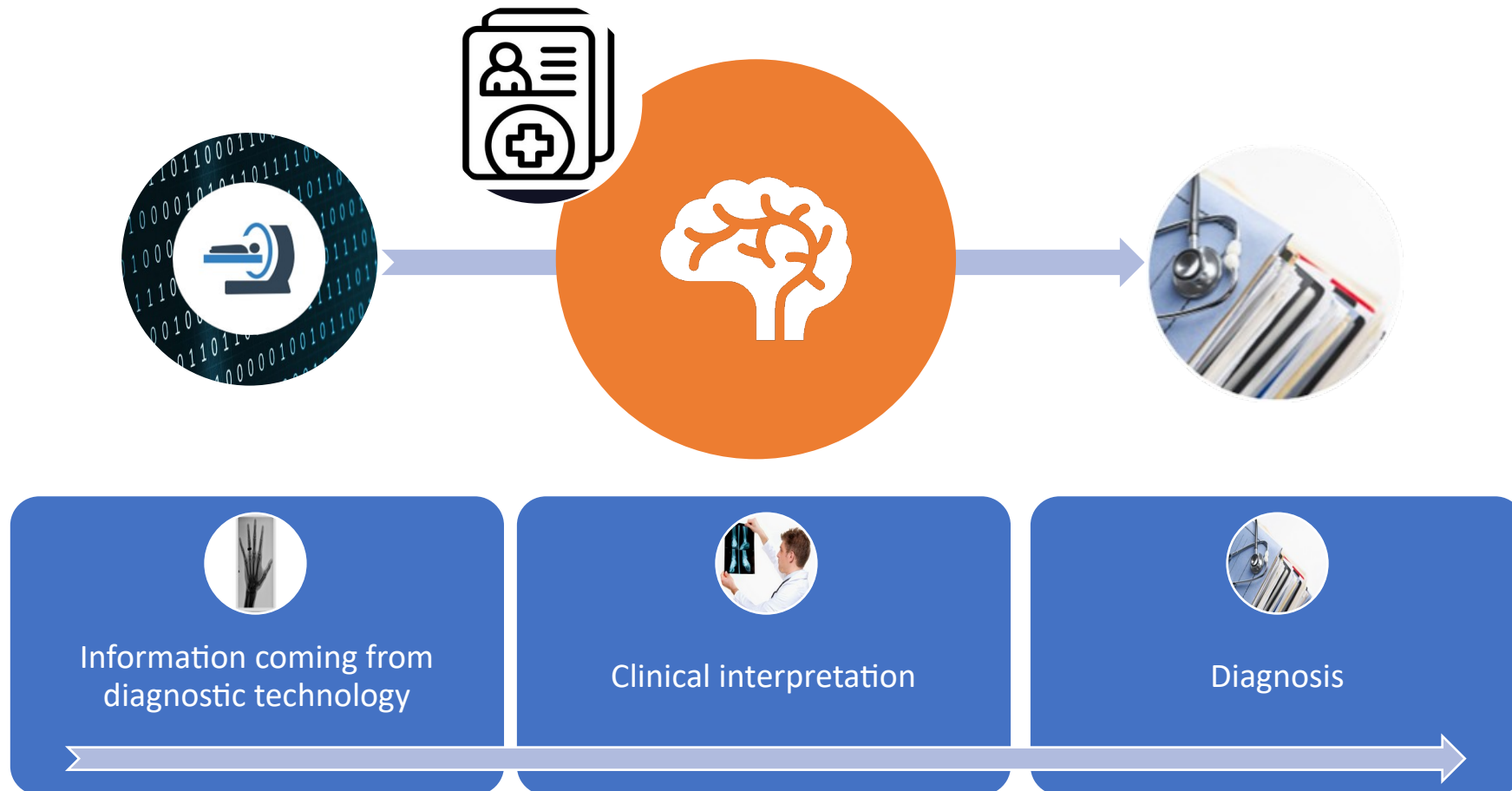
…and this is translated in technical architecture of an hospital
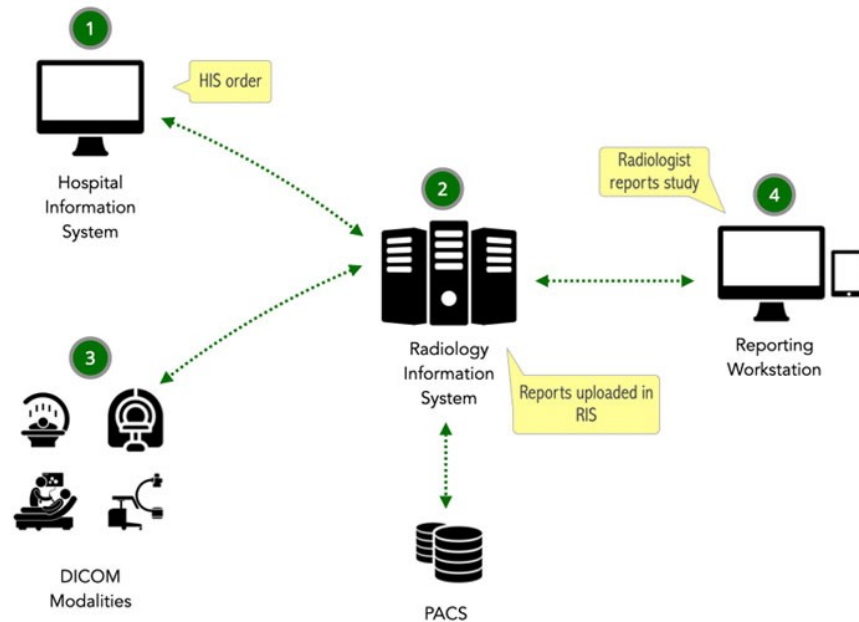
In terms of:

- Archiving Capability

- Computational power

- Data structure and standards for communication

- Data integration

- Case selection

- …

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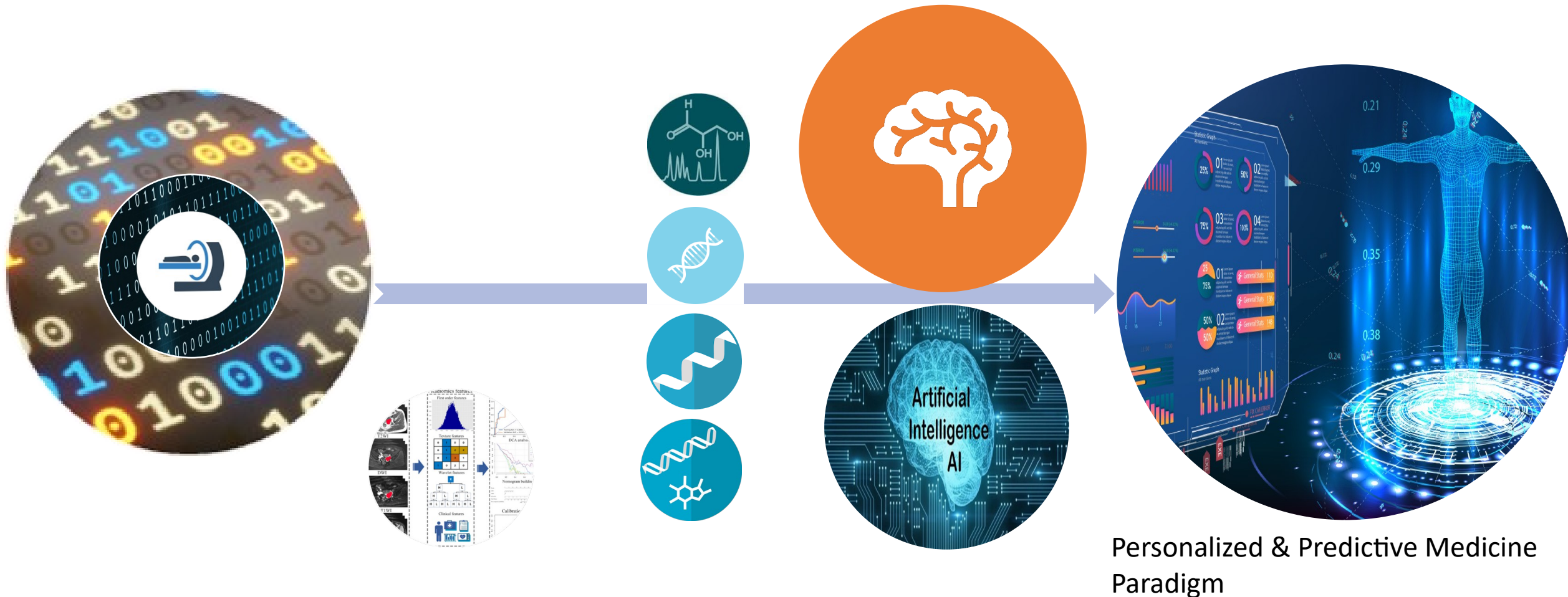Firenze 10-13 maggio 2023

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But the reality is now different...

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

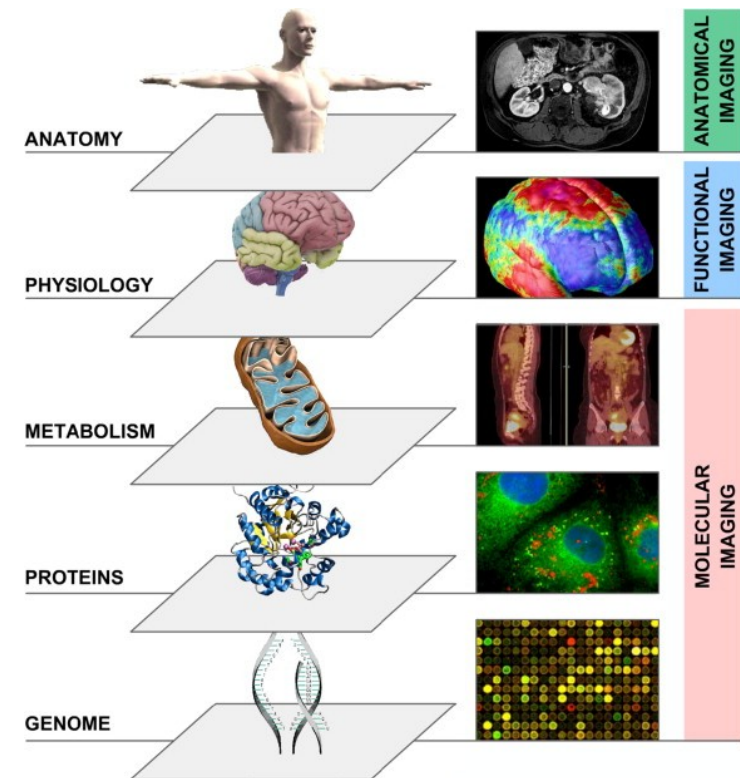Diagnostic technologies provide information NOT PERCEPTABLE TO THE HUMAN EYE

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

Personalized & Predictive Medicine Paradigm

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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
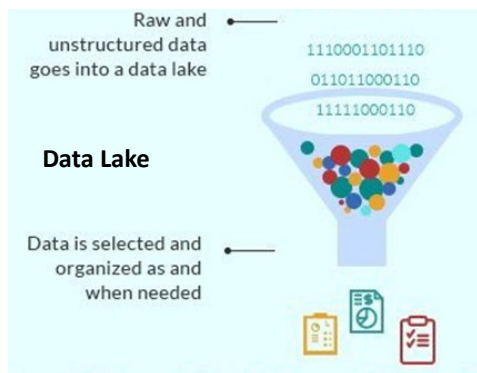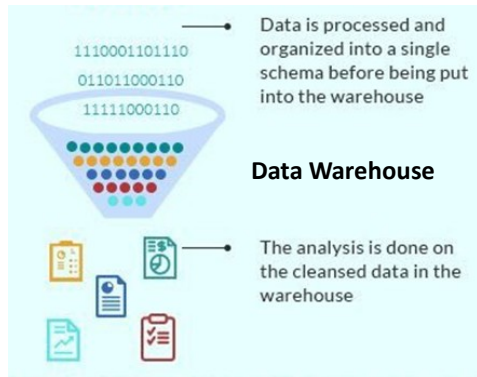- Different Clinical workflow & New Facilities

Omic – From Sample to Data
The Cognitive Platform
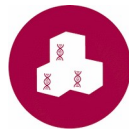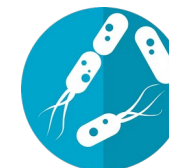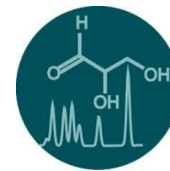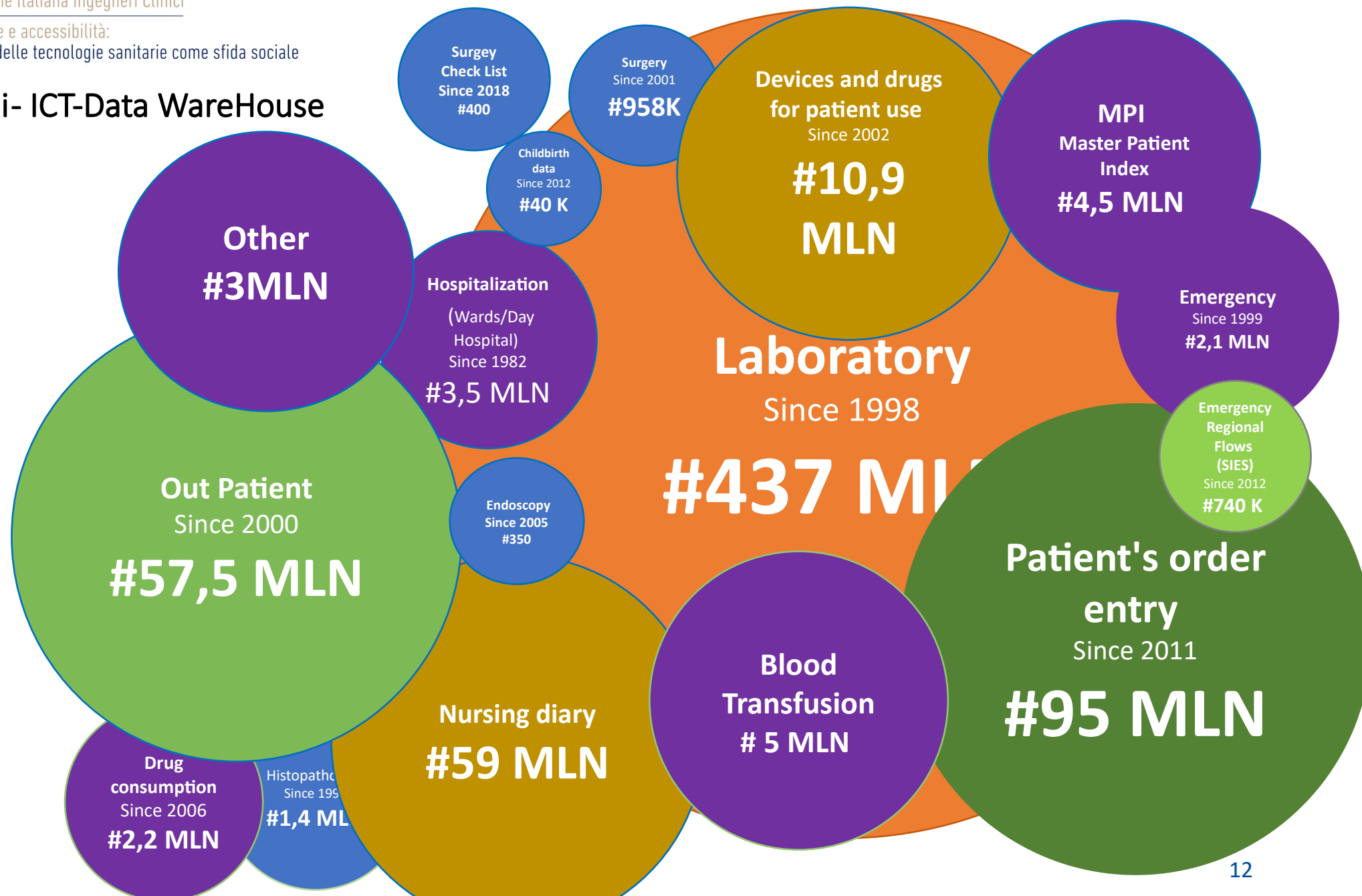
Design of technological evolution

ICT-Data Warehouse , DataLake and Datamart for Research
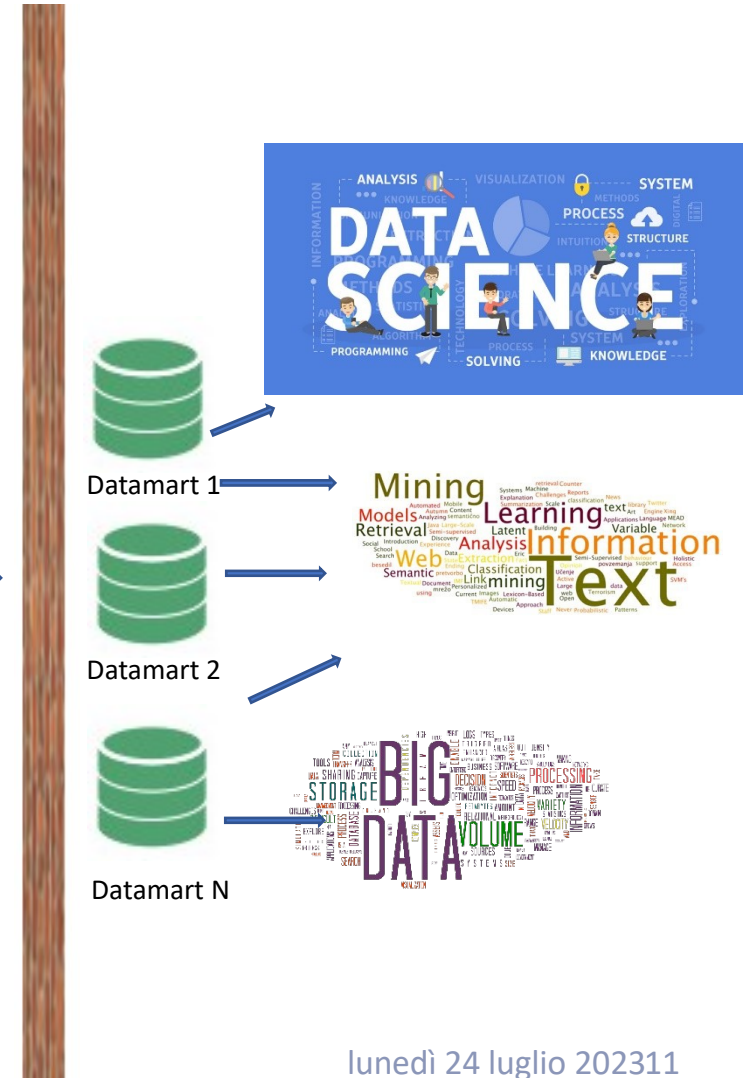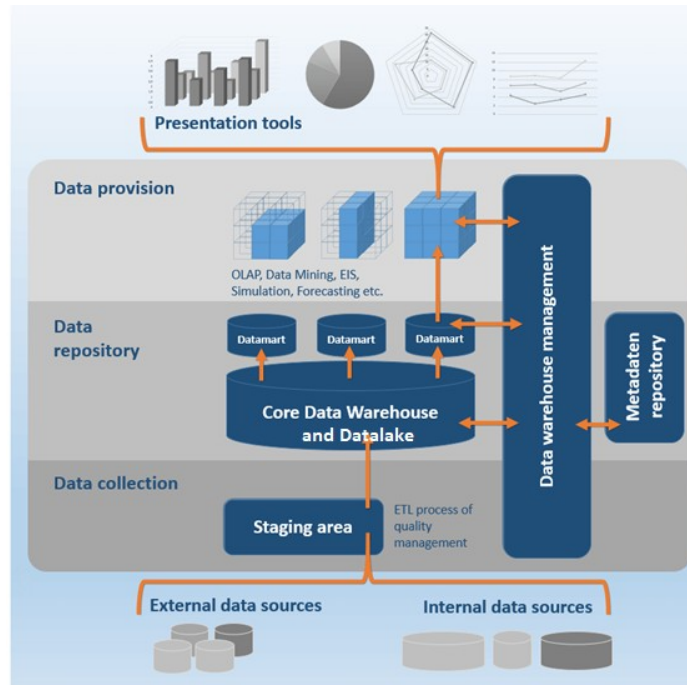
Policlinico Gemelli- ICT-Data WareHouse

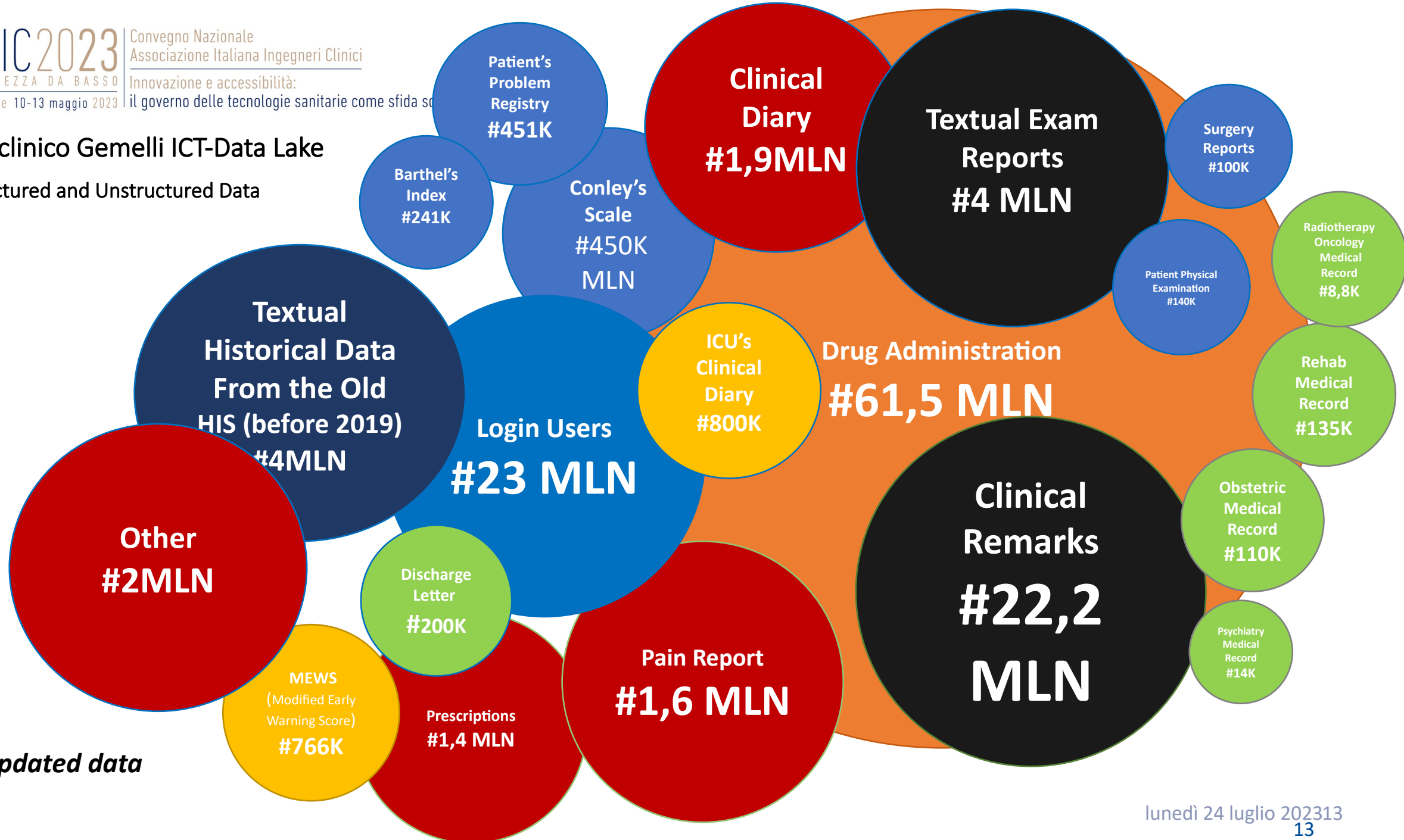*Daily updated data*

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Policlinico Gemelli ICT-Data Lake

Structured and Unstructured Data

Patient's Problem Registry #451K

Clinical Diary #1,9MLN

Textual Exam Reports #4 MLN

Surgery Reports #100K

Barthel's Index #241K

Conley's Scale #450K MLN

Radiotherapy Oncology Medical Record #8,8K

Patient Physical Examination #140K

Textual Historical Data From the Old HIS (before 2019) #4MLN

ICU's Clinical Diary #800K

Drug Administration #61,5 MLN

Rehab Medical Record #135K

Login Users #23 MLN

Obstetric Medical Record #110K

Other #2MLN

Discharge Letter #200K

Clinical Remarks #22,2 MLN

Psychiatry Medical Record #14K

MEWS (Modified Early Warning Score) #766K

Prescriptions #1,4 MLN

Pain Report #1,6 MLN

Daily updated data

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CASO 1 - DATA MART / POC PREDITTORI SCOMPENSO CARDIACO

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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
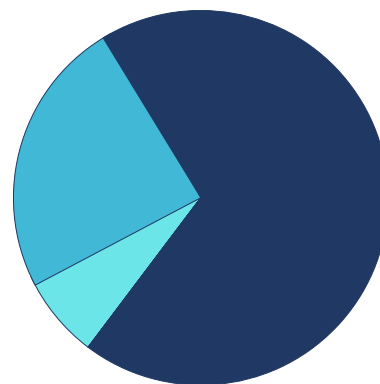diagnosis
1.3
per person /year
rate of readmission

IN ITALY
Patients estimated prevalence
1,7% 1 mil

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
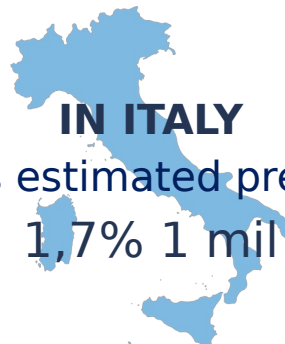
High mortality rate

7%
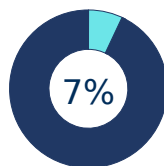
PATIENTS DIED DURING
THE FIRST HOSPITAL
ADMISSION

24%
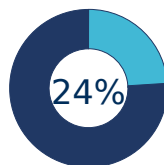
PATIENTS DIED WITHIN 1 YEAR
FROM HOSPITAL DISCHARGE

GENERATOR PROCEDURES
SEARCH ENGINES, DATA COLLECTION / PROCESSING

HEART FAILURE DATAMART
PATIENT-CENTERED VIEW

DATALAKE
SOURCE: GEMELLI IT SYSTEMS

CONTACTS

CARDIOLOGY CONSULTANCIES

PRIMARY DIAGNOSES

ECO CARDIO MEASURES

LABORATORY EXAMS

DRUGS

NURSE DIARIES

HOSPITALIZATION

ER / ACUTE EVENTS

AUTOMATED STRUCTURED DATA ETL
(real time, continuous ingestion)
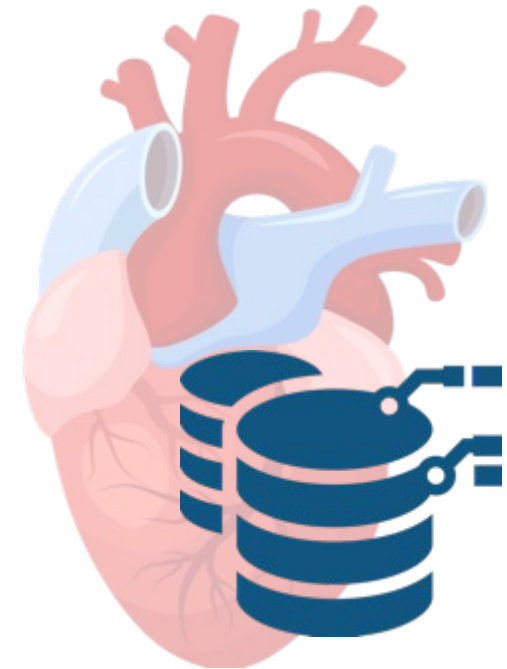
ANONYMIZATION

LAB MEASURES BOT

DIAGNOSIS BOT

COMORBIDITIES BOT

DRUGS BOT

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

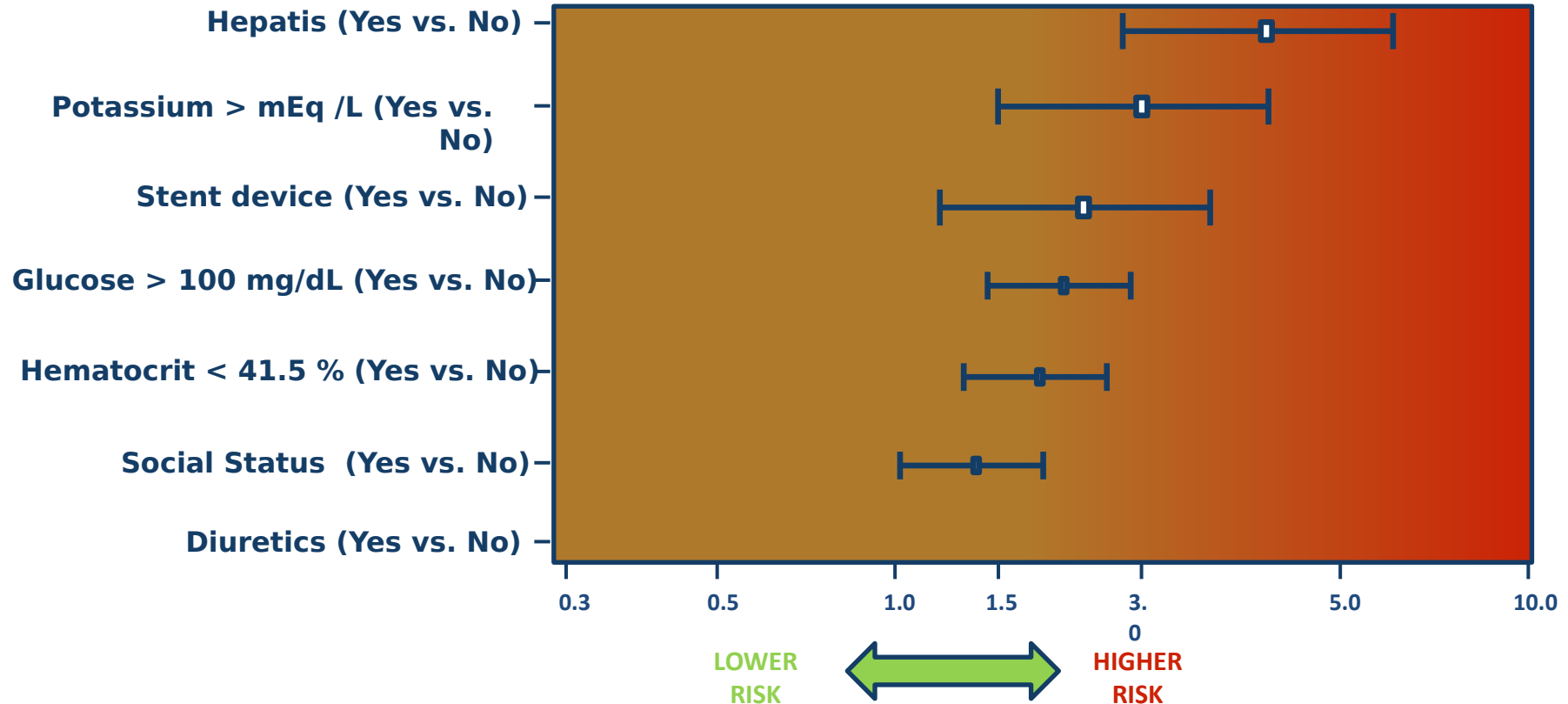Principal Investigator: Prof. D. D'Amario

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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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CASO 2 - CONTINUITÀ ASSISTENZIALE / GESTIONE LUNGODEGENTI

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

AUTOMATED SYSTEM
FOR MONITORING, PROCESS
CONTROL, DECISION SUPPORT
FOR LONG TERM PATIENT
MANAGEMENT **(CCA)**
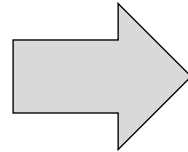
- **Automate data collection:** engagement, onboarding, management of long-term patients (high complexity, multicomorbidities, fragility, geriatric …)

- **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 di continuità assistenziale)

Use case: long term patient management (centrale

DRILL DOWN ON LONGITUDINAL PATIENT HISTORY

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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 Terapy 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

Principal Investigator: Dr. A. Orlandi

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FOCUS: patient identification and selection criteria

Key Inclusion/Exclusion Criteria
- History og low HER2 expression
- Refactory endocrine therapy (HR+HR – Cohort)
- Has been treated with al least 1 or most 2 prior lines of chemoterapy 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 historyof myocardial infection in the last 6 month
- No history of interstitial lung disease
- No clinically active central nervous system metastases

7608 PTS AFTER CHEMOTHERAPY REGIMEN

1770 PTS AFTER DIAGNOSIS

300 PTS AFTER HORMONAL THERAPY

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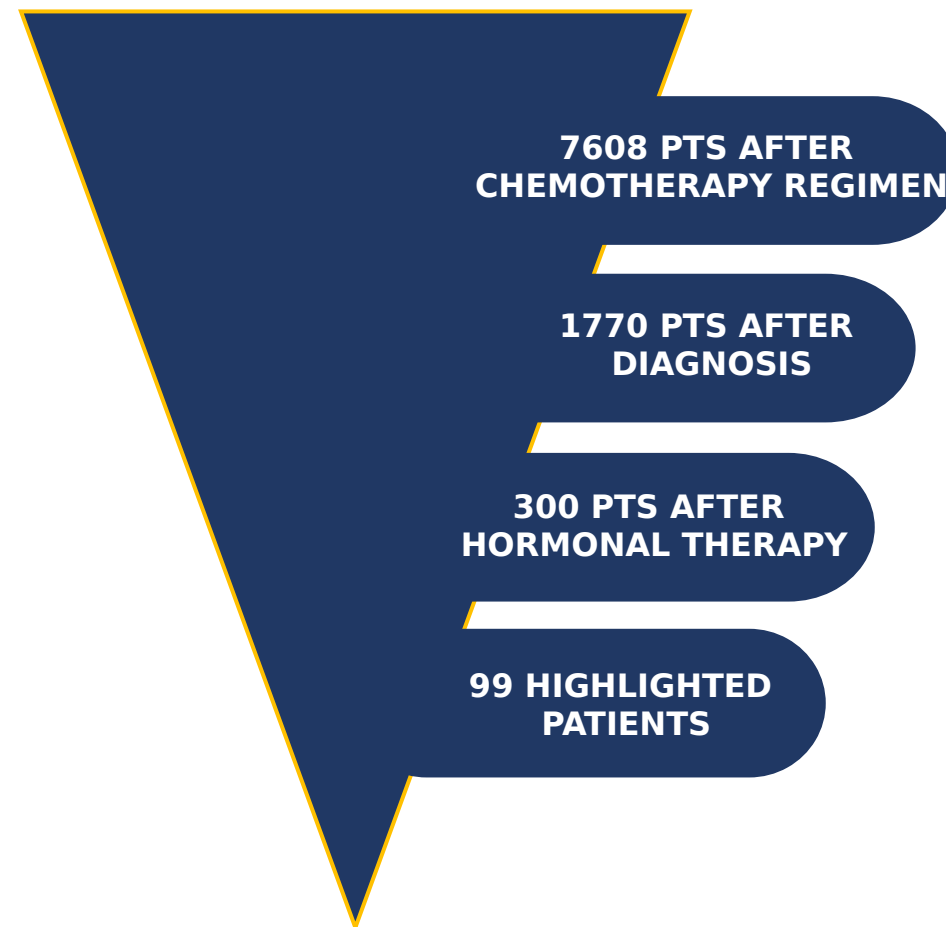
Recruitment timeline **2 years / 1 patient selected**
Screening based on AI-tool: **4 weeks**

FOCUS: patient identification and selection criteria

Color-coding
- Patient matching

Drill-down
- In depth medical report

Thanks for your attention