Practical considerations in implementing Big Data in Health Care practice

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Professor of Human Biochemistry and Physiology, University of Liège
UH of Liège is an Academic Hospital
1038 beds and about 5,500 staff members
Activities spread over 8 localizations including
4 hospitalization sites
Since 2004, the UHL has an Electronic Patient Record (EPR) including medical, nursing and paramedical information and a complete RIS-PACS for its medical imaging
These computer tools allow both the exchange of data inside the hospital and outside, ensuring an optimal continuity of hospital care and extra-mural care
### Level of computerization of EPR at CHU of Liège

<table>
<thead>
<tr>
<th>Lot</th>
<th>Description</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lot 1</td>
<td>Results server (clinical biology, medical imaging, nuclear medicine, and pathology)</td>
<td>Fully implemented</td>
</tr>
<tr>
<td>Lot 2</td>
<td>Medical record and paperless</td>
<td>Fully implemented</td>
</tr>
<tr>
<td>Lot 3</td>
<td>Resources management</td>
<td></td>
</tr>
<tr>
<td>Lot 3A</td>
<td>Management of multi-sites patient appointments</td>
<td>Fully implemented</td>
</tr>
<tr>
<td>Lot 3B</td>
<td>Management of beds (in real time and forward planning)</td>
<td>Fully implemented</td>
</tr>
<tr>
<td>Lot 4</td>
<td>Drug order and administration</td>
<td>Finalizing</td>
</tr>
<tr>
<td>Lot 5</td>
<td>Order of clinical biology and medico-technical examinations</td>
<td>Finalizing</td>
</tr>
<tr>
<td>Lot 6</td>
<td>Care management</td>
<td>Fully implemented</td>
</tr>
<tr>
<td>Lot 6A</td>
<td>Nursing electronic record</td>
<td>Fully implemented</td>
</tr>
<tr>
<td>Lot 6B</td>
<td>Paramedical electronic record</td>
<td>Fully implemented</td>
</tr>
<tr>
<td>Lot 6C</td>
<td>Food management</td>
<td>Currently</td>
</tr>
</tbody>
</table>
Electronic Medical Record Adoption Model (EMRAM)

Stage 7
- Complete EMR; external HIE (Health Information Exchange); data analytics; governance; disaster recovery; privacy and security

Stage 6
- Technology enabled medication; blood products and human milk administration; risk reporting; full CDS (clinical decision support)

Stage 5
- Physician documentation using structured templates; Intrusion/Device protection

Stage 4
- CPOE (computerized physician order entry) with CDS (clinical decision support); nursing and allied health documentation; basic business continuity

Stage 3
- Nursing and allied health documentation; EMAR (Electronic Medication Administration Records); role-based security

Stage 2
- CDR (Clinical Data Repository); internal Interoperability; basic security

Stage 1
- Ancillaries – laboratory: pharmacy and radiology/cardiology information systems; PACS (Picture Archiving and Communications System); digital Non-DICOM image management

Stage 0
- All three ancillaries not installed

https://www.himss.eu/healthcare-providers/emram
For what benefits?

- A quick access to patients’ records. Gathering all relevant information (lab results, etc.) in one place. Making it easier to consider all aspects of a patient’s condition.
- Always available, complete and up-to-date patient related information.
- The possibility of securely sharing information with patients and care providers.
- Reducing duplication of testing.
- Helping physicians to reach the correct diagnosis and to prescribe more accurately. Providing built-in safeguards against prescribing treatments that would result in adverse events.
- Possibility of online appointment scheduling, online bill payments, prescription refill requests, and sometimes even data update capabilities.
- Decreasing paperwork. Improving aggregation, analysis, and communication of patient information.
- Streamlined coding and billing
CDSS – EPR
Clinical Decision Support System Electronic Patient Record

Clinical decision support systems link health observations to clinician knowledge

Pneumonia Severity Index (PSI) of Fine score: estimates mortality for adult patients with community-acquired pneumonia
Order of clinical biology and drug administration plan

Pharmacy robots are driven by electronic prescription and drug inventory management system.
Identification of each medicinal product individually

Link to computerized prescription

Association of each identifier to:

- A patient
- A drug dosage
- A drug-administration route
- A time
CLMA
Closed Loop Medication Administration

Automated medicine cabinets are also linked to the computerized prescription of drugs and only issue prescribed drugs.
CDSS – CPOE
Clinical Decision Support System
Computerized Physician Order Entry

- Interaction between drugs
- Incompatibility between the drug and the patient (sex, age, condition, etc.)
- Incompatibility between drug and patient allergy
- Incompatibility between the drug and a laboratory result
- Exceeding the authorized dose, dangerous to the patient
Data sharing with external care providers

Access to the online appointment booking portal (for patients and external physicians).

www.chuliege.be
Data sharing with external care providers

Access to the CHU medical imaging portal via a strong authentication system (for patients and external physicians).

www.chuliege.be
Data sharing with external care providers

Access to CHU shared documents via the « Réseau Santé Wallon »

The Wallon Health Network allows an exchange of computerized health documents (examination results, medical reports, letters, etc.) between healthcare providers working for the same patient.

All health care providers involved in these situations may have access to information about themselves. This exchange of information between healthcare providers facilitates its management.

In order for a healthcare provider to have access to the patient’s health data, a therapeutic link must be established.

www.rsw.be
The SIME’s Missions

- making patient’s clinical data available, whether they are stored under paper or electronic format
- coding medical information and ensure consistency with the patient’s identification
- analyzing the institution’s activity and its medical and economic components
- offering methodological support to clinical research, including the biostatistical aspects

86 agents – 78,5 FTE
<table>
<thead>
<tr>
<th>Secteur</th>
<th>Responsable de secteur</th>
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<tbody>
<tr>
<td>Codage et nomenclature</td>
<td>Philippe Kolih</td>
</tr>
<tr>
<td>Exploitation des données</td>
<td>Jessica Jacques</td>
</tr>
<tr>
<td>Appui à la recherche clinique et biostatistique</td>
<td>Nathalie Maes</td>
</tr>
<tr>
<td>Gestion des dossiers médicaux</td>
<td>Jocelyne Kariger</td>
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</table>
Data Analysis Area

Two main missions

1. Provide medical data

2. Analyze the medico-economic situation
DataWareHouse Content

- Administrative data
- Anatomopathology
- Anesthesia data
- Medical and economic data on hospital stays
- Medical Biology
- Medical imaging, Nuclear medicine
- Operating room scheduling
- Patient appointment
- Bed management
- Computerized physician drug order and nursing administration plan
- Electronic medical record
- Electronic nursing record
- Chemotherapy
Data cover patient history since 1999 and are updated daily

<table>
<thead>
<tr>
<th>Source</th>
<th>Tables</th>
<th>Champs</th>
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<tbody>
<tr>
<td>Patient et administrative</td>
<td>75</td>
<td>1300</td>
</tr>
<tr>
<td>Suivi budgétaire</td>
<td>20</td>
<td>400</td>
</tr>
<tr>
<td>Dossier médical</td>
<td>15</td>
<td>250</td>
</tr>
<tr>
<td>Facturation</td>
<td>45</td>
<td>1250</td>
</tr>
<tr>
<td>GIFA</td>
<td>32</td>
<td>650</td>
</tr>
<tr>
<td>QDOC</td>
<td>10</td>
<td>125</td>
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<tr>
<td>RCM</td>
<td>15</td>
<td>140</td>
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<tr>
<td>RHM</td>
<td>33</td>
<td>750</td>
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<tr>
<td>Radiothérapie</td>
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<tr>
<td>Ultragenda</td>
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<td>225</td>
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<tr>
<td>Ressources humaines</td>
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<td>550</td>
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<tr>
<td>Paie</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>ERP</td>
<td>180</td>
<td>8000</td>
</tr>
<tr>
<td>APO</td>
<td>15</td>
<td>375</td>
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<tr>
<td>UNILAB</td>
<td>25</td>
<td>300</td>
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Making clinical data available

Over half of the medical services have at least once asked the SIME for data

More than 30% of all demands are related to research activity
What data are clinicians interested in?

<table>
<thead>
<tr>
<th>Data Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic patient record</td>
<td>40%</td>
</tr>
<tr>
<td>Patients’ characteristics and whereabouts</td>
<td>39%</td>
</tr>
<tr>
<td>Invoicing</td>
<td>16%</td>
</tr>
<tr>
<td>Administrative and medical data</td>
<td>15%</td>
</tr>
<tr>
<td>Laboratory</td>
<td>6%</td>
</tr>
<tr>
<td>Medical imagery</td>
<td>3%</td>
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</tbody>
</table>
A keyword: patience...
Success factors

✓ To have a successful EMR experience!
  ✓ Large use in hospital, in most of context/API, with a single Patient Identifier

✓ Define roles
  ➢ IT for DWH ETL
  ➢ Data Analysts for exploitation of the clinical data

✓ Close synergy between IT and Data Analysts
✓ Data analysts must have a scientific background
✓ The possibilities depend on the maturity of the EMR
✓ Data analysts must have access to the finest data

VALIDATE – VALIDATE – VALIDATE !
Perspectives in the Exploitation of clinical data

1. Dashboard Reporting
2. Provision of COVID clinical data
3. Sharing clinical data with pharmaceutical industries
4. Re Use of the clinical data for the research
1. Dashboard reporting: focus on oncology

The main difficulty is to define the oncological patient

1. Define the data source
   • Based on the Belgian Cancer Registry
   • Or RHM/MKG
   • Or Radiotherapy Data

2. Determine the date of incidence

3. Open a 5-year-sliding window taking into account recurrence or new cancer
<table>
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<tr>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients nouveau diag (evol)</td>
<td>2.890</td>
<td>2.933</td>
<td>2.551</td>
<td>2.808</td>
<td>2.788</td>
<td>2.888</td>
</tr>
<tr>
<td>Patients actifs (evol)</td>
<td>13.757</td>
<td>16.590</td>
<td>17.151</td>
<td>17.936</td>
<td>18.467</td>
<td>18.979</td>
</tr>
<tr>
<td>Patients potentiels (evol)</td>
<td>18.979</td>
<td>18.979</td>
<td>18.979</td>
<td>18.979</td>
<td>18.979</td>
<td>18.979</td>
</tr>
</tbody>
</table>
2. Provision of Clinical COVID Data

- Unique database, developed around several disciplines
- Weekly update for clinical research
- Content
  - Patient characteristics (including risk factors)
  - Symptoms at admission
  - Treatment
  - Biological values
  - Pathway and ICU Data
- Available to more than 30 researchers in 10 disciplines
- More than 10 published publications for the analysts
3. Sharing clinical data with pharmaceutical industries: The Insite/Trinetx Projet

Challenges To Perform Clinical Trials

- **Loosing time** with inefficient communication.
- **Almost 50% of all trial delays** caused by patient recruitment problems.
- **Missing out** on clinical trials because of not being informed.
- **Limited resources** to spend on patient recruitment.
- Confronted with **inefficiently designed clinical trials**.
- **Not compensated** for general feasibility assessment.
InSite Empowers Trial Sites

- A platform for **trustworthy re-use of EHR data** to support innovation in clinical research and healthcare operations
- **InSite Local Platform** – detailed data exploration for healthcare professionals
- Communication with multiple sponsors
Technical Overview - Platform

- ALL storage & processing of patient data inside & under control of the hospital
- NO patient data leaves the hospitals
- does NOT store or process personal data of patients
- EHR
- ETL
- CDW
- InSite Local Install
- Local InSite applications
- detailed audit log available for hospital
- Secure access for researchers
- local access policies to applications determined by hospital
The InSite Partner Hospital Network

InSite is a pan-European network, with a healthy ambition to expand beyond EU

11 Countries in which InSite is active

20M Patient records on the InSite network in 2017

>100M Patient records in the InSite partner network in 2019

InSite partner Health Care Organisations (HCOs) include
Insite join Trinext in 2019

Global collaboration
- +20 Countries
- +130 HCOs
- +300M Patients

Countries:
- Australia
- Belgium
- Brazil
- Bulgaria
- England
- Estonia
- Finland
- Germany
- Greece
- Hungary
- India
- Israel
- Italy
- Japan
- Malaysia
- Philippines
- Poland
- Scotland
- Singapore
- Spain
- Sweden
- United States
- Wales
4. Re Use of the clinical data for the research

- WearIT4Health
- InteropEHRate
- PERSIST
- HosmartAI
- Dragon
Research projects - Interreg WearIT4Health

**Programme:** Interreg Euregio Meuse-Rhine

**Lead partner:** University of Liège

**Consortium:** Research centers, Hospitals from Belgium and The Netherlands

**Objective:** Developing a multi-sensors, wearable, secured and wireless monitoring system for inpatients in medium care wards.

**Timeline:** 2018 till October 2021

**Roles of CHU Liège:**
- Co-creation & concept design
- Integration into the EMR of the hospitals
- Clinical validation study
Research projects - Interreg WearIT4Health

- Device on the chest
- Data processing
- AI predictive Early Warning Score

- ECG, PPG, Temperature, Accelerometers
- Heart rate, HRV
- Blood pressure, SpO2, Breathing rate, Activity & posture, EWS
- WiFi
- HL7 FHIR
Research projects – InteropEHRate

**Programme:** Horizon 2020  
**Lead partner:** Engineering, Rome, Italy  
**Consortium:** Italy, Greece, Belgium, Romania, Germany  

**Objective:** Empower patient to aggregate his/her health data and share them during medical visit, emergency and for research purposes.

**Timeline:** 2019 till June 2022

**Roles of CHU Liège:**
- Requirements definition
- Co-creation of patient and health care practitioners applications
- Data provider and data conversion rules
- Clinical validation study
Electronic Health Record
- Medical history
- Laboratory results
- Vital signs
- …

Patient Summary
- Current medications
- Allergies
- Family history
- …

- Medical visit (possibly abroad)
- Emergency case (possibly abroad)
- EU Research center

Smart EHR – Patient acts as a broker of his/her health data
Research projects – PERSIST

**Programme:** Horizon 2020

**Lead partner:** Gradiant, Spain

**Consortium:** Spain, Austria, Belgium, Turkey, Germany, Slovenia, Switzerland, Latvia

**Objective:** Improve the quality of life of cancer survivors with the help of artificial intelligence and Big Data.

**Timeline:** January 2020 till March 2023

**Roles of CHU Liège:**
- Clinicians expertise in oncology
- Data standardization, Data anonymization, Data provider
- Clinical study site
Research projects - PERSIST

- Electronic Health Record
- Cancer registry

EHR enrichment
Patient stratification

Retrospective
Prospective

PROMs / PREMs/Psychological and physiological data
CDSS
Research projects – HosmartAI

**Programme:** Horizon 2020

**Lead partner:** Intrasoft International

**Consortium:** Belgium, Greece, Slovenia, Spain (countries involved in radiotherapy pilot)

**Objective:** Improve the scheduling of radiotherapy appointments using AI chatbot and digital twin.

**Timeline:** January 2021 till April 2024

**Roles of CHU Liège:**

- Domain expertise, Concept definition and Validation
- Data standardization, Data anonymization, Data provider
- Clinical validation study
Research projects – HosmartAI

- Electronic Health Record
- Scheduling system
- Oncology Information System

Retrospective

Prospective

Speech enabled chatbot

Horizon 2020 Programme

Smart scheduling
Digital twin
Programme: IMI2 – Call 21
Lead partner: OncoRadiomics S.A., Liège, Belgium
Consortium: Belgium, United Kingdom, The Netherlands, Italy
Objective: Rapid and secure AI imaging based diagnosis, stratification, follow-up, and preparedness for coronavirus pandemics
Timeline: 10/2020 till 09/2023
Research projects – IMI2 – DRAGON

• **Roles of CHU Liège:**
  i. Multicentric data harmonization development
  ii. Imaging and non-imaging biomarkers exploration
  iii. Diagnosis and prognosis tools designing based on clinical evidence
  iv. Data provider
  v. Clinical validation study

• **Data journey**
  - DICOM & CSV files generated by CHUL
  - Data harmonization process
  - Imaging and non-imaging biomarkers assays
  - Design of specific AI-based models for diagnosis and prognosis purpose
  - Patient empowerment through the development and validation of mobile phone application

• **CHU Liège coordinator**
Dr. Julien Guiot - Pneumologist
Thank you!