

# eHealth4all@EU

## Interprofessional European eHealth Programme in Higher Education

### IO4: E-Learning / B-Learning – Course Material

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University of Eastern Finland<sup>c</sup>  
University of Porto<sup>d</sup>

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- Osnabrück University of Applied Sciences, Health Informatics Research Group
- Osnabrück University, New Public Health Research Group
- University of Eastern Finland, Research Group of Health and Human Service Informatics (HHS)
- University of Porto, Centre for Health Technology and Services Research (CINTESIS)

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## Abstract

Interoperability, Data Protection and Security and Data Analytics are of high relevance for the future of eHealth and interprofessional care. Three online courses were therefore designed and delivered for these topics, all of which followed the same structure. A variety of materials were developed and different tools for knowledge transfer, communication and collaboration were used.

## 1 Introduction

The objective of the fourth Intellectual Output was to develop e-learning or blended learning courses on the topics 1) Interoperability, 2) Data Protection and Security and 3) Data Analytics and selecting and testing an appropriate electronic platform including videoconferencing for the online learning courses so student learn together in an inter-professional and culturally sensitive way. The three topics are highly relevant to the future of eHealth and interprofessional care, as they apply to all technologies in the hospital, community and other settings and hence all populations of patients, citizens and professionals.

- 1) Interoperability: This course provided the students with the perspective of the wide spectrum of problems in the field of Health Information Systems interoperability, its implications in healthcare and paths to promoting coherent and safe information exchange. The aim was to show how standards play an important role in fostering interoperability.
- 2) Data Protection and Security: In this course students learned to recognize confidentiality and data protection issues and to find solutions. They learned how to ensure information security in their work and got advice about what to do if the security of personal data has been compromised. The course also included the key concepts of data protection and the data subject's rights.
- 3) Data Analytics: In this practically oriented course, participants learned how to apply analytical techniques to clinical data. They should become confident and competent in how statistical models are used to generate clinical knowledge and evidence. We demonstrated the transfer of this knowledge into practice (practice-based evidence), particularly through predictive models in decision making.

## 2 Methods

The Moodle learning platform was chosen for the provision of learning materials and the implementation of the courses, as all participating universities had many years of experience in the use of this LMS. The installation of the University of Porto was used. Zoom was chosen as the video conferencing system, since a lot of experience was gained during the Corona pandemic and the system proved to be very stable.

All three courses followed the same structure: Kick-Off (via Zoom), self-learning phase (learning material in Moodle), virtual Summer School (via Zoom). The time schedule of the courses is shown in the figure below.



Figure 1: Schedule of the three online courses

Other tools used for collaborative work were Padlet ([www.padlet.com](http://www.padlet.com)) as well as Miro ([www.miro.com](http://www.miro.com)).

## 3 Results

A variety of materials were developed for the three courses. For each course, the materials can be found in the respective table. The documents for this can be found in the appendix.

### Interoperability (University of Porto)

The course will provide participants with a perspective of the wide spectrum of problems in the field of Health Information Systems interoperability, its implications in Healthcare and paths that promote coherent and safe information exchange. The goal of the course is to show participants how standards play an important role in fostering interoperability. It will provide a hands-on approach creating the opportunity for students to experience scenarios where information exchange occurs and putting them in the driver's seat while reaching for a solution. The files highlighted in bold are in Appendix I.

<b>Presentation: Learning Healthcare in Action: Interoperability in Healthcare</b>
<b>Presentation: The need for interoperability in healthcare information systems</b>
<b>Assignment: The need for interoperability</b>
Website: HIMMS Interoperability in Healthcare ( <a href="https://www.himss.org/resources/interoperability-healthcare">https://www.himss.org/resources/interoperability-healthcare</a> )
Article: Lehne M, Sass J, Essenwanger A, Schepers J, Thun S. Why digital medicine depends on interoperability. Digital Medicine. 2019;2:79.
Article: Pinto E, Brito AC, Cruz-Correia RJ. Identification and Characterization of Inter-Organizational Information Flows in the Portuguese National Health Service. Appl Clin Inform. 2016;7:1202-1220.
Article: Rijo R, Martinho R, Aparecida Oliveira A, Alves D, Nogueira Reis ZS, Santos-Pereira C, Correia ME, Antunes LF, Cruz-Correia RJ. Profiling IT security and interoperability in Brazilian health organisations from a business perspective. IJEHMC. 2020;11(2).
<b>Interoperability Exercises</b>
<b>Screenshot of the presentation: Standards in Health Information systems</b>
<b>Screenshot of the presentation: Principles of HL7 FHIR</b>
Videos (not freely accessible) on the topics: HL7, FHIR, openEHR
Moodle Content (not freely accessible): Why digital medicine depends on interoperability Identification and Characterization of Inter-Organizational Information Flows in the Portuguese National Health Service Profiling IT security and interoperability in Brazilian health organisations from a business perspective
Websites: HL7 Website ( <a href="https://www.hl7.org/">https://www.hl7.org/</a> ) HL7 v2 reference Page ( <a href="https://www.hl7.org/implement/standards/product_brief.cfm?product_id=185">https://www.hl7.org/implement/standards/product_brief.cfm?product_id=185</a> ) HL7 Website: FHIR Resources ( <a href="https://www.hl7.org/fhir/resourcelist.html">https://www.hl7.org/fhir/resourcelist.html</a> ) HL7 Demo Server for Testing ( <a href="https://hapi.fhir.org/">https://hapi.fhir.org/</a> )

### **Data Protection and Security (University of Eastern Finland)**

In this course students are learning basic data protection and security issues in healthcare context. Students are learning about confidentiality and secrecy issues. The

students are also learning how to ensure information security in healthcare work. Students are learning about what to do if the security of personal data has been compromised. Lessons also include the key concepts of data protection, the data subject's rights, legislation, actors and risk management in data protection and security in healthcare context. The files highlighted in bold are in Appendix II.

<b>Course Content</b>
<b>Objectives for the course</b>
<b>GDPR Enforcement Actions in Europe</b>
Data Protection and Information Security guidelines in UEF
Data Protection Ombudsman (Presentation not freely accessible)
REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data, and repealing Directive 95/46/EC (General Data Protection Regulation)
Guidelines 07/2020 on the concepts of controller and processor in the GDPR
The IMIA Code of Ethics for Health Information Professionals
App: DIGITALLY secure life
<b>Presentation: Data protection officer</b>
<b>Presentation: Data privacy in healthcare work</b>
<b>Presentation: Data privacy in my work: passwords</b>
<b>Presentation: Data breach</b>
Article: Argaw ST, Bempong NE, Eshaya-Chauvin B, Flahault A. The state of research on cyberattacks against hospitals and available best practice recommendations: a scoping review. BMC Med Inform Decis Mak. 2019 Jan 11;19(1)10.

### **Data Analytics (Osnabrück University of Applied Sciences)**

The course “Learning healthcare in action – clinical data analytics” teaches participants how to apply statistical analysis techniques to clinical data. The goal of the course is to show participants how statistical methods and models can be brought together with clinical data to generate new knowledge. In order to transfer this generated knowledge

into the clinic in the form of evidence-based medicine, the use of the presented statistical models as decision support systems will be demonstrated. The course aims to convey the content in a practical manner. Therefore, in addition to teaching the statistical methods, clinical data used to build models will be addressed. Furthermore, a focus of the course is a research workshop in which participants independently develop and validate statistical models based on clinical data. The files highlighted in bold are in Appendix III.

<b>Schedule of the Kick-Off</b>
<b>Agenda virtual European Summer School</b>
<b>Screenshot Miro-Board: structure and content of the course</b>
<b>Presentation: The eHealth4all@EU Project</b>
<b>Presentation: The Learning Health System</b>
Article: Foley TJ, Vale L. What role for learning health systems in quality improvement within healthcare providers? Learn Health Sys. 2017;1:e10025.
Article: Rattay NA, Damush TM, Miech EJ, Homoya B, Myers LJ, Penney LS, Ferguson J, Giacherio B, Kumar , Bravata DM. Empowering Implementation Teams with a Learning Health System Approach: Leveraging Data to Improve Quality of Care for Transient Ischemic Attack. J Gen Intern Med. 2020;35(Suppl 2):S823-S31.
Article: Rauch J, Denter M, Hübner U. Use of Emergency Departments by Frail Elderly Patients: Temporal Patterns and Case Complexity. Stud Health Technol Inform. 2019;264:1218-1222.
Learning Videos on Clinical Data Analytics (Link to YouTube: <a href="https://www.youtube.com/user/jenshuesers/playlists">https://www.youtube.com/user/jenshuesers/playlists</a> )
<b>Moodle screenshot: learning videos and quizzes for Lesson 1: Recap Statistics</b>
<b>Moodle screenshot: learning videos and quizzes for Lesson 2: Recap Linear Regression</b>
<b>Moodle screenshot: learning videos and quizzes for Lesson 3: Odds Ration and Case-Control-Studies</b>
<b>Moodle screenshot: learning videos and quizzes for Lesson 4: Logistic Regression</b>
<b>Moodle screenshot: learning videos and quizzes for Lesson 5: Applied Logistic Regression in SPSS</b>



<b>Moodle screenshot: learning videos and quizzes for Lesson 6: Prediction Models</b>
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<b>PDF: Task for Data Lab Day 1 “Risk Factor Analysis”</b>
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<b>PDF: Task for Data Lab Day 2 “Create a Prediction Model”</b>
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## 4 Conclusion

A variety of different teaching and learning materials have been developed and used for the three courses. In addition, different technologies were used for knowledge transfer, such as learning videos, and for communication and collaboration of participants and teachers, such as the online whiteboard Miro. Some of the materials are already freely available and can be used in other courses.

## **Appendix: Course Material**

Appendix I: Interoperability

Appendix II: Data Protection and Security

Appendix III: Data Analytics

## **Appendix I: Interoperability**

Presentation: Learning Healthcare in Action: Interoperability in Healthcare

Presentation: The need for interoperability in healthcare information systems

Assignment: The need for interoperability

Interoperability Exercises

Screenshot of the presentation: Standards in Health Information systems

Screenshot of the presentation: Principles of HL7 FHIR

# Learning Healthcare in Action: Interoperability in Healthcare

Course presentation  
Ricardo Cruz Correia  
Pedro Vieira-Marques



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## Summary

- The module Interoperability in Healthcare in the course “Learning healthcare in action” will provide participants with a perspective of the wide spectrum of **problems in the field of Health Information Systems interoperability**, its **implications** in Healthcare and paths that **promote coherent and safe information exchange**.
- The goal of the course is to show participants **how standards play an important role** in fostering interoperability. It will provide a **hands-on approach** creating the opportunity for students to experience scenarios where information exchange occurs and putting them at the driver's seat while reaching for a solution.

# Modules

Healthcare Organization and Interoperability

The need for standards

Standards in use

Advanced topics

Digital  
competencies

Interoperability in  
health

Standards usage

Healthcare Messaging  
tools

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# Students will be able to

- Exemplify communication exchange needs among most healthcare institutions
  - Associate the complexity of healthcare systems with the type for communication needs
  - Define interoperability in healthcare
  - Discuss the distance between health professionals expectations and technology limitations
  - Identify the levels of interoperability
  - Summarize the challenges and type of specialists for each level
  - Identify the main standards used in health interoperability
- Relate the different standards needed to solve one particular integration
  - Summarize the main differences among the different standards
  - Understand HL7 v2 Message structure key elements
  - Be able to identify FHIR Resources for a particular usecase
  - Search the openEHR CKM
  - Build simple openEHR templates using available tools
  - Illustrate the main challenges that interoperability face in the future
  - Identify technologies that are closely related to interoperability



A large orange shape on the left side of the slide, consisting of a vertical rectangle on the left and a quarter-circle on the right. The word "Methods" is written in white text inside the orange shape.

# Methods

- Nov
    - 30: Kick-off Synchronous session
  - Each week (8 weeks)
    - New video and/or text
    - Exercise to submit
    - In the end of the week the solution is presented
  - Jan
    - 19: Synchronous session
    - 20,21: - Evaluation test
- 
- A decorative yellow dashed arc in the bottom right corner of the slide, consisting of several short, curved segments.

# The need for interoperability in healthcare information systems

**RICARDO JOÃO CRUZ CORREIA**

**PEDRO MANUEL VIEIRA MARQUES**

FACULDADE DE MEDICINA

UNIVERSIDADE DO PORTO



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# Course lessons

1. The need for interoperability in healthcare
2. The need for standards
3. Standards in use
4. Advanced topics



# Lessons

1. The need for interoperability in healthcare
  1. The healthcare information landscape
  2. What is interoperability in healthcare
2. The need for standards
3. Standards in use
4. Advanced topics



# Lessons

1. The need for interoperability in healthcare
  1. The healthcare information landscape
    1. Type of institutions
    2. Internal organization of hospitals
  2. What is interoperability in healthcare
2. The need for standards
3. Standards in use
4. Advanced topics



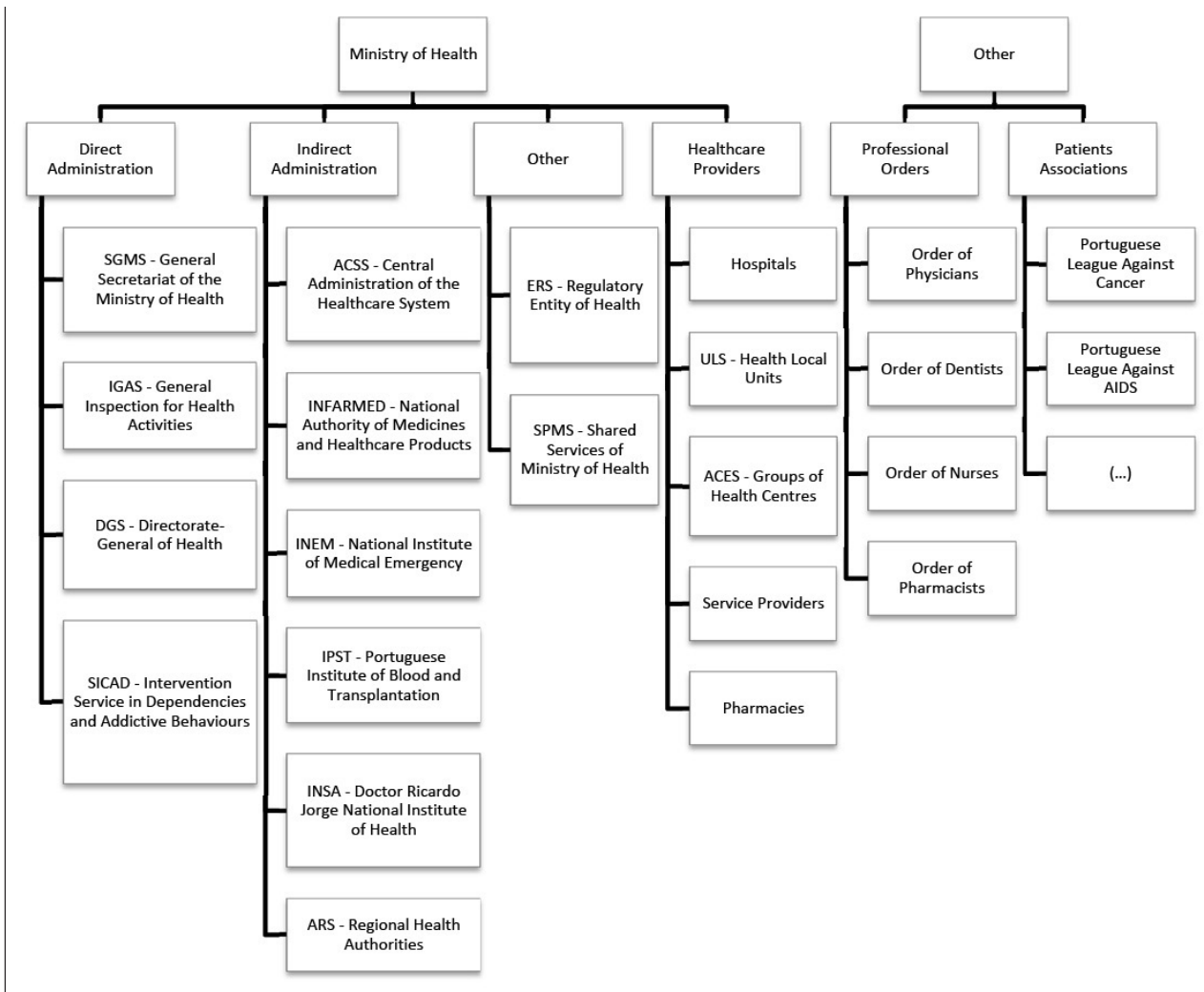
# Type of healthcare institutions

The Healthcare Information Systems landscape



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**Fig. 1** Organic structure of the Portuguese National Health Service. As expected, the Ministry of Health plays a relevant role but delegates several specific competences in other entities that are under direct or indirect supervision. Most of those are entities with national scope (except the ARS) that are required to develop initiatives or manage a certain area (e.g. INFARMED, INEM, etc.). Other relevant entities are the professional orders on one way and the Patient Associations on the other. The first usually works on regulating the profession and the second providing assistance and disseminating information with patients with a specific disease.



# Internal Organization of an Hospital

The Healthcare Information Systems landscape



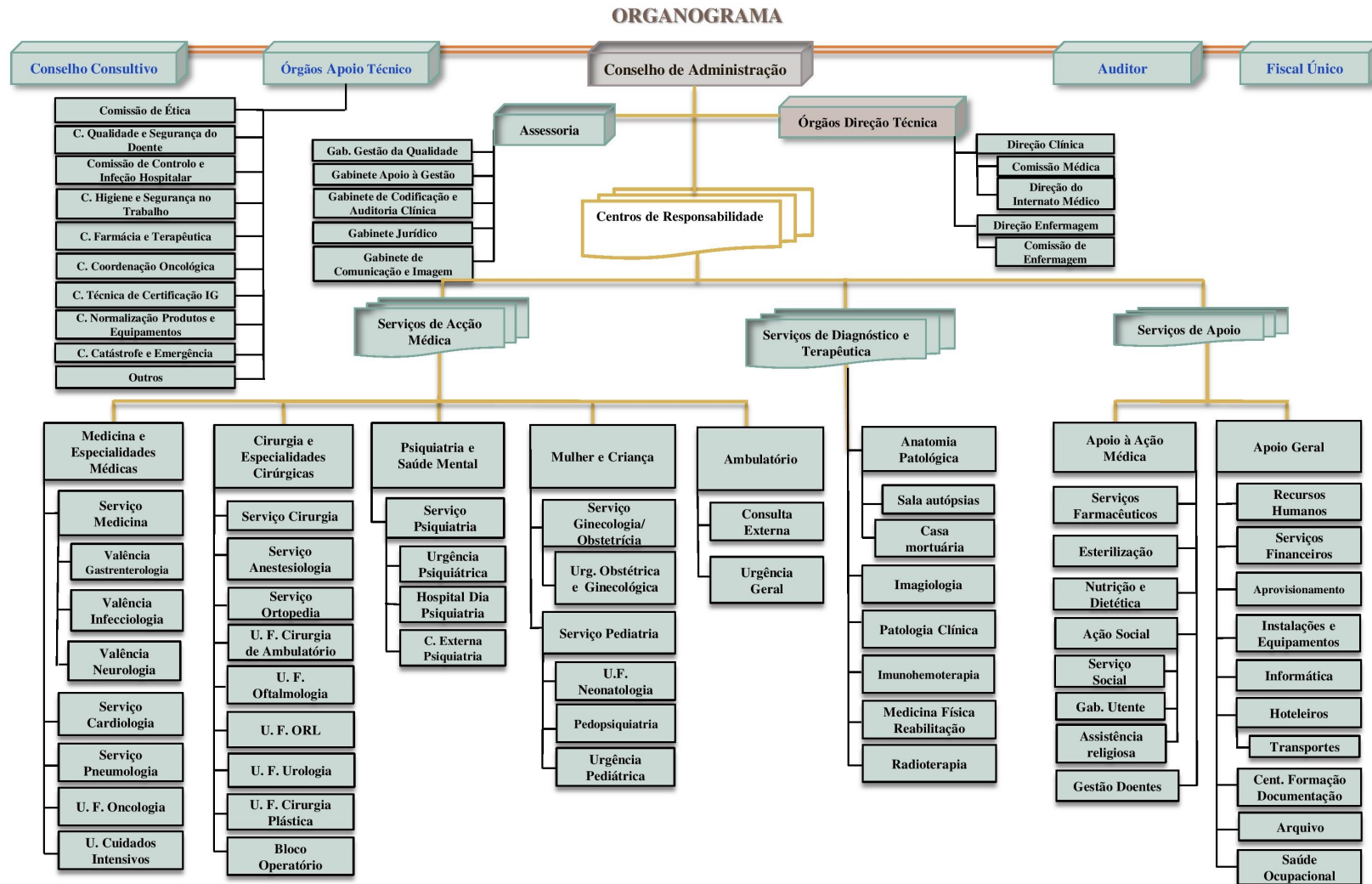
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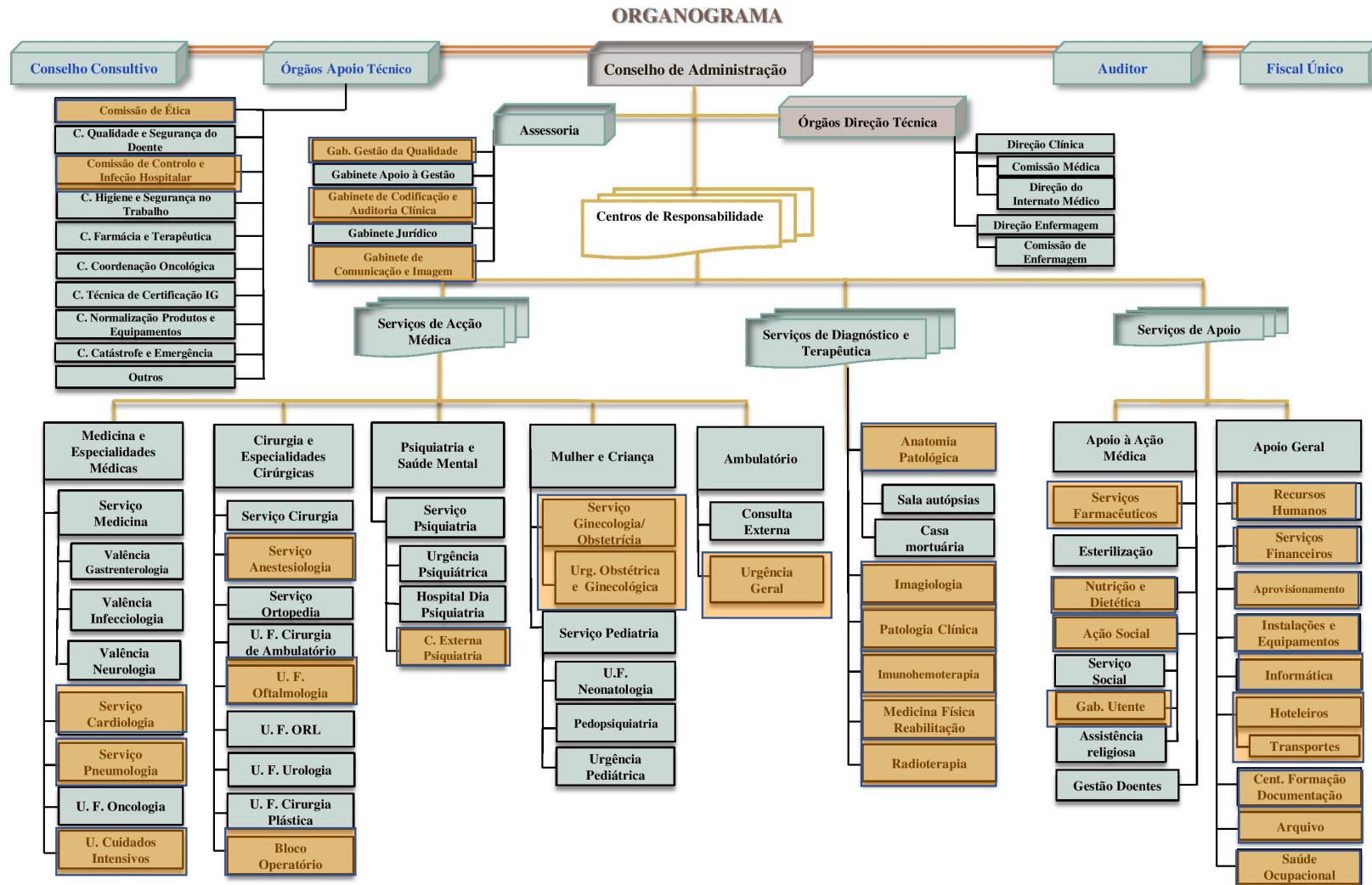


# Question

- How many departments exist in a typical hospital?
  - < 15
  - Between 15 and 30
  - Between 30 and 80
  - More than 80







Examples of areas with specific SW



# Communication needs

The Healthcare Information Systems landscape



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# Need for communication

Think about the need for communication between each of the following pairs:

1. Hospital ↔ Regional Health Authorities (ARS)
2. Hospital ↔ National Authority of Medicines and Healthcare Products (Infarmed)
3. Shared Services of Ministry of Health (SPMS) ↔ College/Order of Nurses (Ordem dos enfermeiros)
4. Hospital ↔ Central Administration of the Healthcare System (ACSS)
5. Portuguese League Against Cancer ↔ Directorate- General of Health



# Need for communication

Think about the need for communication between each of the following pairs:

1. Hospital ↔ Regional Health Authorities (ARS)

1. => Number of available beds

2. <= Number of deaths in region

2. Hospital ↔ National Authority of Medicines and Healthcare Products (Infarmed)

3. Shared Services of Ministry of Health (SPMS) ↔ College/Order of Nurses (Ordem dos enfermeiros)

4. Hospital ↔ Central Administration of the Healthcare System (ACSS)

5. Portuguese League Against Cancer ↔ Directorate- General of Health



# Need for communication

Think about the need for communication between each of the following pairs:

1. Hospital ↔ Regional Health Authorities (ARS)
2. Hospital ↔ National Authority of Medicines and Healthcare Products (Infarmed)
  1. => Adverse Drug Reactions
  2. <= List of Drugs than can be prescribed in hospitals
3. Shared Services of Ministry of Health (SPMS) ↔ College/Order of Nurses (Ordem dos enfermeiros)
4. Hospital ↔ Central Administration of the Healthcare System (ACSS)
5. Portuguese League Against Cancer ↔ Directorate- General of Health



# Need for communication

Think about the need for communication between each of the following pairs:

1. Hospital ↔ Regional Health Authorities (ARS)
2. Hospital ↔ National Authority of Medicines and Healthcare Products (Infarmed)
3. Shared Services of Ministry of Health (SPMS) ↔ College/Order of Nurses (Ordem dos enfermeiros)
  1. <= List of nurses and their professional ID
4. Hospital ↔ Central Administration of the Healthcare System (ACSS)
5. Portuguese League Against Cancer ↔ Directorate- General of Health





# Need for communication

Think about the need for communication between each of the following pairs:

1. Hospital ↔ Regional Health Authorities (ARS)
2. Hospital ↔ National Authority of Medicines and Healthcare Products (Infarmed)
3. Shared Services of Ministry of Health (SPMS) ↔ College/Order of Nurses (Ordem dos enfermeiros)
4. Hospital ↔ Central Administration of the Healthcare System (ACSS)
  1. => List of hospital encounters for reimbursement
5. Portuguese League Against Cancer ↔ Directorate- General of Health



# Need for communication

Think about the need for communication between each of the following pairs:

1. Hospital ↔ Regional Health Authorities (ARS)
2. Hospital ↔ National Authority of Medicines and Healthcare Products (Infarmed)
3. Shared Services of Ministry of Health (SPMS) ↔ College/Order of Nurses (Ordem dos enfermeiros)
4. Hospital ↔ Central Administration of the Healthcare System (ACSS)
5. Portuguese League Against Cancer ↔ Directorate- General of Health
  1. => Cancer Screening results
  2. <= List of people to be screened



# The need for communication between institutions



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# Clinical Information

- Referrals
- Exams
- Prescriptions

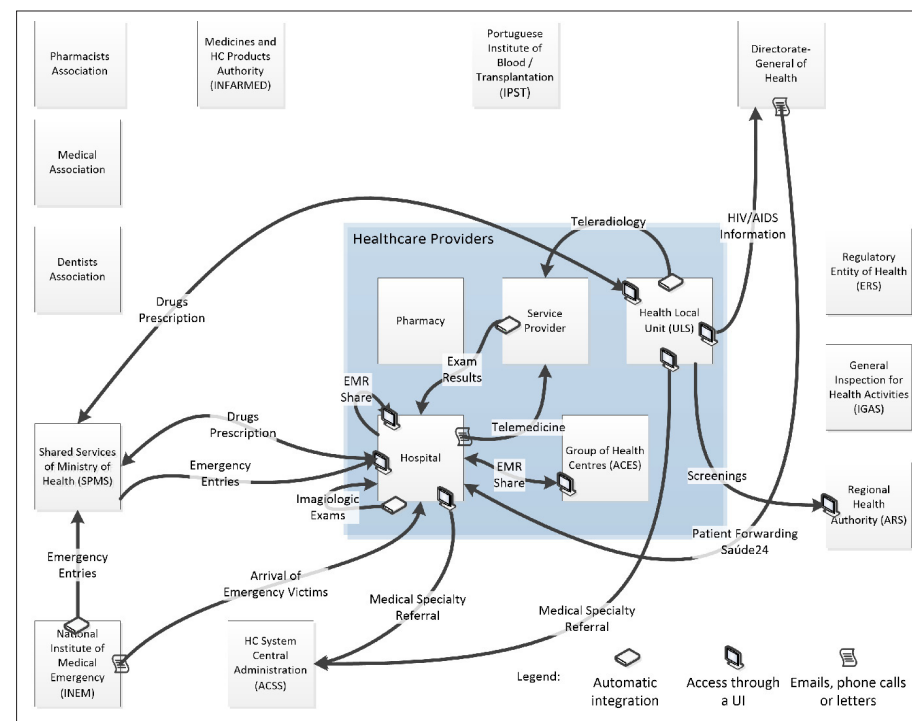


Fig. 3 Representation of clinical information flows elicited from the interviews. As expected, the healthcare providers have a special preponderance.



# Demographics

- Patient Identification
- Professional Identification

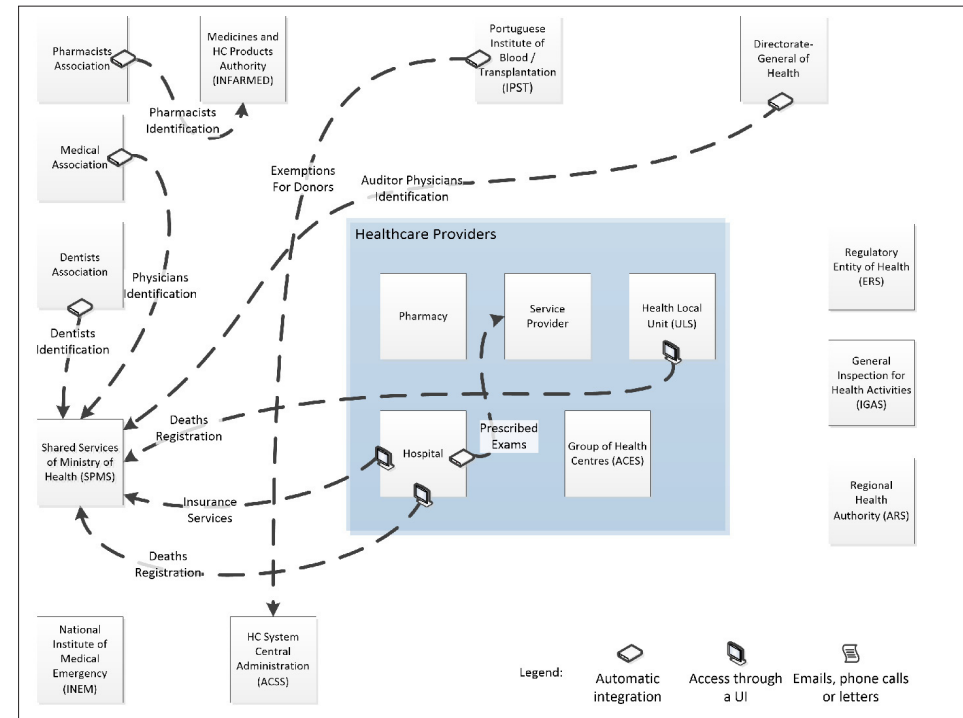


Fig. 4 Representation of information flows that allow identification of professionals or patients usually based on demographic data and in which SPMS plays a significant role.



# Statistics

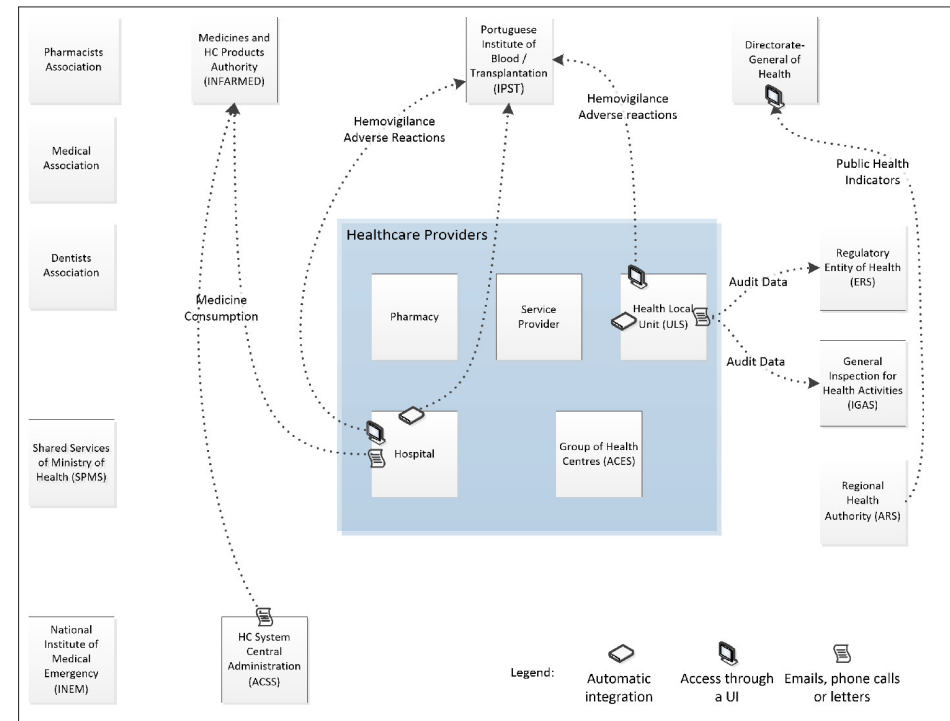


Fig. 5 Representation of statistical information flows that are generally related with audit data or public health concerns.



# Administrative

- Billing
- Salaries
- Catalogs
- Indicators

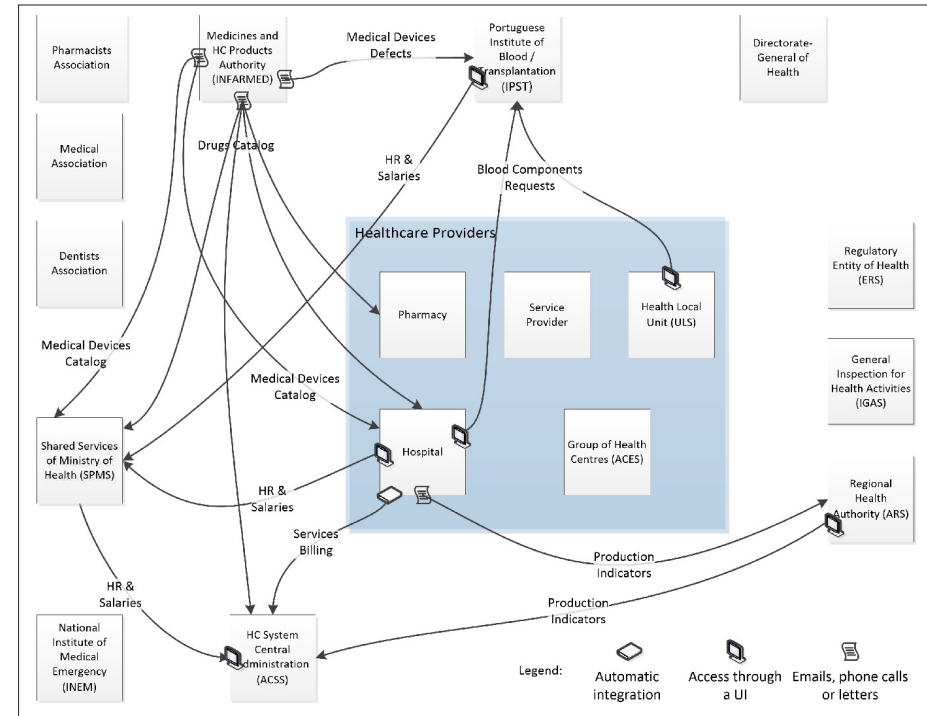


Fig. 2 Representation of administrative information flows elicited from the interviews in which INFARMED has a special preponderance.



# The need for communication inside an hospital



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# Question

- How many applications are used in a typical hospital?
  - < 15
  - Between 15 and 30
  - Between 30 and 80
  - More than 80



# List of available IS

- Many IS exist in hospitals (~ 50)
- Exchange of data amongst them is very important to improve workflow

(page 1)

Tabela resumo de Sistemas de Informação no CHVNGE

Sigla SI	URL SI	Nome SI	Descrição SI	Tipo de SI	Serviço / Especialidade	Fornecedor	NIF Fornecedor	Entidade adjudicatária	NIF Entidade Adjudicatária	Interoperabilidade
Astraia	<a href="#">URL</a>	Astraia	Base de dados Obstetrícia e Ginecologia.	Internamento	Neonatalogia	Astrimed	507007867	ASTRIMED- Informática e Tecnologia Médica,Lda.	507007867	HL7
B-Anestescic	<a href="#">URL</a>	B-Anestescic	Anestesia e Cuidados Críticos	Cirurgia	Anestesia & Cuidados Críticos	B-Simple - Sistemas de Informação, Lda.	506188841	B-Simple - Sistemas de Informação, Lda.	506188841	#N/D
B-ICU-CARE	<a href="#">URL</a>	B-ICU-CARE	Cuidados Intensivos	Urgência	Cuidados Intensivos	B-Simple - Sistemas de Informação, Lda.	506188841	B-Simple - Sistemas de Informação, Lda.	506188841	HL7
CIT	<a href="#">URL</a>	Certificados de Incapacidade Temporária	Registo e emissão de CIT pelos profissionais de saúde médicos; uma plataforma de interoperabilidade para receção de CIT de SW de outros fornecedores;	Consulta	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	#N/D
docBase	<a href="#">URL</a>	docBase	Manutenção da Solução Gestão de MCDT's Urologia e Broncologia	RCE	Urologia / Pneumologia	Mobilwave - Tecnologias de Informação, Lda.	506929183	Mobilwave - Tecnologias de Informação, Lda.	506929183	#N/D
Easyvista	<a href="#">URL</a>	Easyvista	Gestão de serviços de IT	Integração	Apoio à Prestação de Cuidados	Easyvista, S.A.	501926003	Easyvista, S.A.	501926003	#N/D
EDIS	<a href="#">URL</a>	Emergency Department Information System	Sistema de Informação de Emergência.	Urgência	Urgência	ALERT	507567455	ALERT	507567455	HL7
Ensemble	<a href="#">URL</a>	Ensemble	Integração de aplicações	Integração	Apoio à Prestação de Cuidados	InterSystems Iberia, S.L.	B85286755	InterSystems Iberia, S.L.	B85286755	HL7 DICOM
GIAF	<a href="#">URL</a>	GIAF	Software de gestão integrada	Gestão	Apoio à Prestação de Cuidados	Indra Sistemas Portugal, S.A	506176142	Indra Sistemas Portugal, S.A	506176142	#N/D
GID	<a href="#">URL</a>	Gestão Integrada da Doença	Comunicação e acesso a relatórios de exames histológicos de biópsias LIS	Consulta	Todos	SPMS	509540716	#N/D	#N/D	#N/D
Gilintt ANAPAT	<a href="#">URL</a>	Gilintt ANAPAT	Sistema de Laboratório e Anatomia Patológica	Laboratório (LIS) & Patologia Clínica	UGI de MCDT's	Gilintt - Healthcare Solutions, S. A	502479418	Gilintt - Healthcare Solutions, S. A	502479418	#N/D
Gilintt CARDIO	<a href="#">URL</a>	Gilintt CARDIO	-	Imagem (PACS)	Cardiologia	Gilintt - Healthcare Solutions, S. A	502479418	Gilintt - Healthcare Solutions, S. A	502479418	#N/D



# List of available IS

(page 2)

Glantt eResults	<a href="#">URL</a>	Glantt eResults	Disponibilização de resultados de MCDT's	Imagem (PACS)	Apoio à Prestação de Cuidados	Glantt - Healthcare Solutions, S. A	502479418	Glantt - Healthcare Solutions, S. A	502479418	#ND
Glantt HIPO	<a href="#">URL</a>	Glantt HIPO	Tratamento de hipocoagulados	Serviço de Sangue e Imunohemoterapia	UGI de MCDT's	Glantt - Healthcare Solutions, S. A	502479418	Glantt - Healthcare Solutions, S. A	502479418	#ND
Glantt NEURO	<a href="#">URL</a>	Glantt NEURO	Pedidos de MCDT	Imagem (RIS)	Neurologia / Neurocirurgia	Glantt - Healthcare Solutions, S. A	502479418	Glantt - Healthcare Solutions, S. A	502479418	#ND
Glantt PNEUMO	<a href="#">URL</a>	Glantt PNEUMO	Pedidos de MCDT	Imagem (RIS)	Pneumologia	Glantt - Healthcare Solutions, S. A	502479418	Glantt - Healthcare Solutions, S. A	502479418	#ND
Glantt RADIO	<a href="#">URL</a>	Glantt RADIO	Agrega permite o acesso aos resultados dos exames de imagem	Imagem (RIS)	Radiologia	Glantt - Healthcare Solutions, S. A	502479418	Glantt - Healthcare Solutions, S. A	502479418	#ND
Glantt SGICMF	<a href="#">URL</a>	Sistema de Gestão Integrado do Circuito do Medicamento - Farmácia	Sistema de Gestão Integrado do Circuito do Medicamento - farmácia	Farmácia	Serviço Farmacêutico	Glantt - Healthcare Solutions, S. A	502479418	Glantt - Healthcare Solutions, S. A	502479418	#ND
Glantt SGICML	<a href="#">URL</a>	Sistema de Gestão Integrado do Circuito do Medicamento - Logística	Sistema de Gestão Integrado do Circuito do Medicamento - logística	Logística	Serviço Farmacêutico	Glantt - Healthcare Solutions, S. A	502479418	Glantt - Healthcare Solutions, S. A	502479418	#ND
Glantt SIBAS	<a href="#">URL</a>	Glantt SIBAS	Sistema de Banco de Sangue	Laboratório (LIS)	UGI de MCDT's	Glantt - Healthcare Solutions, S. A	502479418	Glantt - Healthcare Solutions, S. A	502479418	#ND
Glantt SISLAB	<a href="#">URL</a>	Glantt SISLAB	Sistema de Laboratório	Laboratório (LIS)	UGI de MCDT's	Glantt - Healthcare Solutions, S. A	502479418	Glantt - Healthcare Solutions, S. A	502479418	#ND
HEPIC	<a href="#">URL</a>	Hospital Epidemiologic Control	Vigilância epidemiológica em unidades de saúde	Gestão > Indicadores	Apoio à Prestação de Cuidados	First-Global	505345978	First-Global	505345978	HL7
IDS7	<a href="#">URL</a>	IDS7	PACS da Imagiologia	Imagem (PACS)	Apoio à Prestação de Cuidados	Sectra Medical Systems S.L.	980379920	ARTCES - Unipessoal, Lda	513270396	DICOM
ObsCare	<a href="#">URL</a>	Virtual Care ObsCare	Suporte à prática ginecológica e obstétrica.	RCE	Ginecologia & Obstetria	VirtualCare, Lda	510394639	VirtualCare, Lda	510394639	openEHR
PDS	<a href="#">URL</a>	Plataforma de Dados da Saúde	Registo e partilha de informação clínica de acordo com os requisitos da Comissão Nacional de Proteção de Dados.	Logística	Apoio à Gestão	SPMS	509540716	#N/D	#N/D	HL7
PEM	<a href="#">URL</a>	Prescrição Electronica Médica de Medicamentos e Cuidados Respiratórios Domiciliários	Prescrição eletrónica de medicamentos, cuidados respiratórios domiciliários e de meios complementares de diagnóstico	Farmácia / Prescrição	Serviço Farmacêutico	SPMS	509540716	#N/D	#N/D	HL7



# List of available IS

(page 3)

PICIS	<a href="#">URL</a>	PICIS	Sincronização de dados entre dispositivos de bloco operatório; fluxo de informação do paciente.	Cirurgia	UGI de Cirurgia	Cerner Portugal	513269843	Cerner Portugal	513269843	#N/D
RHV	<a href="#">URL</a>	Recursos Humanos e Vencimentos	Processamento de remunerações e gestão de recursos humanos	Financeiro & RH	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
RISI	<a href="#">URL</a>	RISI	Gestão de risco, entidades, horários, qualidade, auditorias, comercial.	Gestão	Apoio à Prestação de Cuidados	Risi - Gestão e Administração Lda.	503 397 660	Risi - Gestão e Administração Lda.	503 397 660	#N/D
RNCCI	<a href="#">URL</a>	Plataforma Rede Nacional de Cuidados Continuados Integrados - PNCCI	Plataforma Rede Nacional de Cuidados Continuados Integrados	Consulta	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SAGMD	<a href="#">URL</a>	Sistema de Apoio à Gestão de Mobilidade de Doenças	Reembolso de Despesas com Assistência Médica no Estrangeira	ADT	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SAPA	<a href="#">URL</a>	Sistema de Atribuição de Produtos de Apoio	Sistema de Atribuição de Produtos de Apoio	Logística	Apoio à Gestão	SPMS	509540716	#N/D	#N/D	HL7
SClinico Hospitalar	<a href="#">URL</a>	SClinico Hospitalar	Acesso e registo de informação no Electronic Health Record do paciente, em consulta e internamento, por médicos e enfermeiros.	RCE	Todos	SPMS	509540716	#N/D	#N/D	HL7
SGES	<a href="#">URL</a>	Sistema de Gestao das Entidades da Saude	Identificação e caracterização das entidades prestadoras de cuidados de saúde - Módulo Instalações.	Logística	Apoio à Gestão	SPMS	509540716	#N/D	#N/D	HL7
SICA	<a href="#">URL</a>	Sistema de Informação de Contratualização e Acompanhamento	Suporte ao processo de planeamento estratégico, contratualização e monitorização do desempenho (eficiência e efectividade) da prestação de serviços"	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SICC	<a href="#">URL</a>	Sistema de Informação centralizado de contabilidade	Recolha de informação contabilística e o reporting de informação	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SICO	<a href="#">URL</a>	Sistema de Informação de Certificados de Óbito Certificação	Certificação desmaterializada de óbitos. Permite o tratamento estatístico das causas de morte	ADT	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SICTH	<a href="#">URL</a>	Sistema de Informação da Consulta a Tempo e Horas	CTH – Consulta a Tempo e Horas - Sistema integrado de referenciação e gestão do acesso à primeira consulta de especialidade hospitalar.	Consulta	Todos	SPMS	509540716	#N/D	#N/D	HL7



# List of available IS

(page 4)

SIGLIC / SIGIC	<a href="#">URL</a>	Sistema Integrado de Gestão de Inscritos para Cirurgia	Informação sobre a lista de inscritos para cirurgia no Serviço Nacional de Saúde, dados estatísticos e de indicadores para controlo de gestão da atividade cirúrgica programada.	Cirurgia	Apoio Técnico / UGI de Cirurgia	SPMS	509540716	#N/D	#N/D	HL7
SiIMA Gastroenterologia	<a href="#">URL</a>	SiIMA Gastroenterologia	Gestão de todo o workflow de exames executados em clínicas e serviços de Gastroenterologia, desde a admissão do utente até à emissão do relatório médico	Consulta	Gastroenterologia	First-Global	505345978	First-Global	505345978	HL7 DICOM
SiIMA Oftalmologia	<a href="#">URL</a>	SiIMA Oftalmologia	Gestão de todo o workflow de exames executados em clínicas e serviços de Oftalmologia, desde a admissão do utente até à emissão do relatório médico.	Consulta	Oftalmologia	First-Global	505345978	First-Global	505345978	HL7 DICOM
SIMH	<a href="#">URL</a>	Sistema de Informação para a Morbilidade Hospitalar	Sistema de Informação para a Morbilidade Hospitalar Codificação de episódios, de internamento e ambulatorio, em ICD 10 CM/PCS e agrupamento em GDH para fins de tratamento estatístico e facturação.	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SINAVE	<a href="#">URL</a>	Sistema Nacional de Apoio à Vigilância Epidemiológica	Sistema de vigilância em saúde pública: identificação de situações de risco, recolha, análise e divulgação de dados relativos a doenças transmissíveis e outros riscos em saúde pública.	Consulta	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SITAM	<a href="#">URL</a>	Sistema de Informação para Pagamento de Taxas Moderadoras em Atraso	Serviço centralizado que assegura todo o processo de alerta, notificação e cobrança das taxas moderadoras	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SIVIDA	<a href="#">URL</a>	Sistema de Informação dos paciente com VIH	Ferramenta de suporte à monitorização do Programa de Controlo do HIV/SIDA: registo de atividade de prestação de cuidados e produção de reports ad hoc.	Consulta	Apoio Técnico	SPMS	509540716	#N/D	#N/D	HL7
SONHO v1	<a href="#">URL</a>	Sistema Integrado de Informação Hospitalar	Sistema de informação dos hospitais; Apoio ao processo administrativo e financeiro hospitalar	ADT	Todos	SPMS	509540716	#N/D	#N/D	#N/D
Sorian Scheduling	<a href="#">URL</a>	Sorian Scheduling	Gestão e agendamento de cuidados de saúde hospitalares.	ADT & Logística	Apoio à Prestação de Cuidados	Cerner Portugal	513269843	Cerner Portugal	513269843	FHIR HL7



# List of available IS

- Many IS exist in hospitals (~ 50)

(page 5)

SIGLIC / SIGIC	<a href="#">URL</a>	Sistema Integrado de Gestão de Inscritos para Cirurgia	Nacional de Saúde, dados estatísticos e de indicadores para controlo de gestão da atividade cirúrgica programada.	Cirurgia	Apoio Técnico / UGI de Cirurgia	SPMS	509540716	#N/D	#N/D	HL7
SiIMA Gastroenterologia	<a href="#">URL</a>	SiIMA Gastroenterologia	Gestão de todo o workflow de exames executados em clínicas e serviços de Gastroenterologia, desde a admissão do utente até à emissão do relatório médico	Consulta	Gastroenterologia	First-Global	505345978	First-Global	505345978	HL7 DICOM
SiIMA Oftalmologia	<a href="#">URL</a>	SiIMA Oftalmologia	Gestão de todo o workflow de exames executados em clínicas e serviços de Oftalmologia, desde a admissão do utente até à emissão do relatório médico.	Consulta	Oftalmologia	First-Global	505345978	First-Global	505345978	HL7 DICOM
SIMH	<a href="#">URL</a>	Sistema de Informação para a Morbilidade Hospitalar	Sistema de Informação para a Morbilidade Hospitalar Codificação de episódios, de internamento e ambulatório, em ICD 10 CM/PCS e agrupamento em GDH para fins de tratamento estatístico e facturação.	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SINAVE	<a href="#">URL</a>	Sistema Nacional de Apoio à Vigilância Epidemiológica	Sistema de vigilância em saúde pública: identificação de situações de risco, recolha, análise e divulgação de dados relativos a doenças transmissíveis e outros riscos em saúde pública.	Consulta	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SITAM	<a href="#">URL</a>	Sistema de Informação para Pagamento de Taxas Moderadoras em Atraso	Serviço centralizado que assegura todo o processo de alerta, notificação e cobrança das taxas moderadoras	Financeiro	Apoio à Prestação de Cuidados	SPMS	509540716	#N/D	#N/D	HL7
SIVIDA	<a href="#">URL</a>	Sistema de Informação dos paciente com VIH	Ferramenta de suporte à monitorização do Programa de Controlo do HIV/SIDA: registo de atividade de prestação de cuidados e produção de reports ad hoc.	Consulta	Apoio Técnico	SPMS	509540716	#N/D	#N/D	HL7
SONHO v1	<a href="#">URL</a>	Sistema Integrado de Informação Hospitalar	Sistema de informação dos hospitais; Apoio ao processo administrativo e financeiro hospitalar	ADT	Todos	SPMS	509540716	#N/D	#N/D	#N/D
Sorian Scheduling	<a href="#">URL</a>	Sorian Scheduling	Gestão e agendamento de cuidados de saúde hospitalares.	ADT & Logística	Apoio à Prestação de Cuidados	Cerner Portugal	513269843	Cerner Portugal	513269843	FHIR HL7
syngo Dynamics	<a href="#">URL</a>	syngo Dynamics	Sistema de transferência, armazenamento, arquivo e manipulação de imagens digitais, revisão, análise, quantificação e relatórios em cardiologia.	Imagem (PACS)	Cardiologia	Siemens Health Care Diagnostics, Lda,	507925173	Siemens Health Care Diagnostics, Lda,	507925173	DICOM



# Question

When two software applications (application pair) exchange data between them there is data integration.

- How many application pairs inside a hospital need to exchange data
  - < 30
  - Between 30 and 60
  - Between 60 and 200
  - More than 200

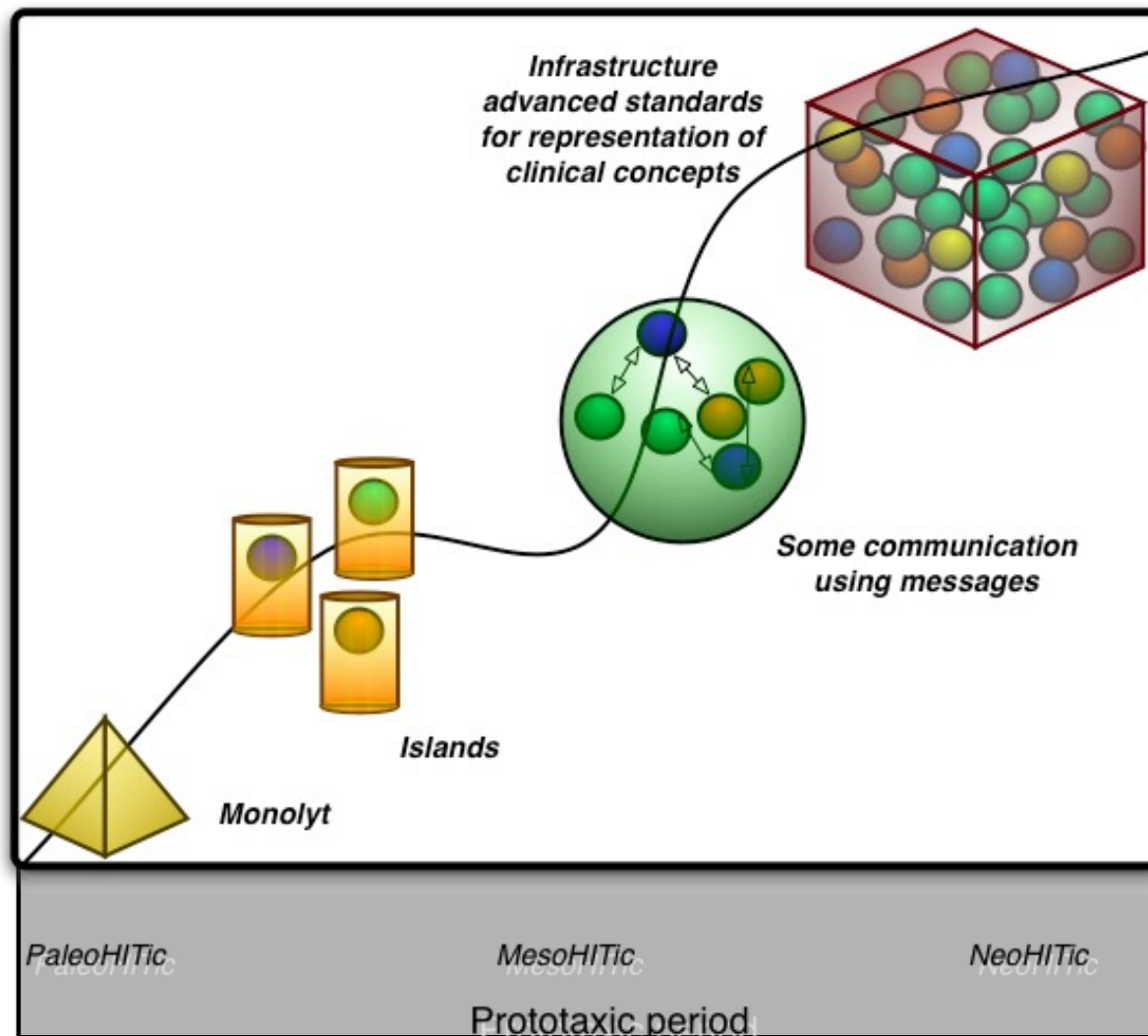


# What is interoperability



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Mori, A. R., & Freriks, G. (2005). A European Perspective on the Cultural and Political Context for Deploying the Electronic Health Record. In *Person-Centered Health Records* (pp. 201–220). Springer New York. [https://doi.org/10.1007/0-387-27375-1\\_14](https://doi.org/10.1007/0-387-27375-1_14)

# Interoperability definition (expectations)

**interoperability** (def): the level of interoperability between distinct components of an information processing environment (applications, services, systems etc) is proportional to their ability to correctly communicate their *internal semantics* to each other, *without special measures*, other than **syntax** or **technology** adaptation.



# Interoperability levels



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# Question

- Which ones of the following are health interoperability issues?
  - Lack of bandwidth to send TC Scans between hospitals
  - Application A uses a different messaging standard than Application B
  - Application A uses v3 of a diagnosis coding system and Application B v4
  - Users of Application B access data collected in Application A without proper security control



# Interoperability levels

- **Foundational (Level 1):** Establishes the inter-connectivity requirements needed for one system or application to **securely communicate** data to and receive data from another
- **Structural (Level 2):** Defines the **format, syntax** and **organization** of data exchange including at the **data field level for interpretation**
- **Semantic (Level 3):** Provides for common underlying **models and codification** of the data including the use of data elements with standardized definitions from **publicly available value sets** and coding vocabularies, providing **shared understanding** and meaning to the user
- **Organizational (Level 4):** Includes **governance, policy, social, legal and organizational considerations** to facilitate the secure, seamless and timely communication and use of data both within and between organizations, entities and individuals. These components enable shared consent, trust and integrated end-user processes and workflows



# Level 1 - Foundational

- Issues
  - Legacy systems using proprietary formats or non-appropriate communication methods (eg. direct database links)
- Specialists
  - IT personal and Software Developers
  - Health Informaticians is not critical for this level



# Level 2 - Structural

- Issues
  - Many systems still **do not use** HL7 v2 or HL7 FHIR, or use it in a non-standardized manner
  - New comers prefer to create protocols based on REST or SOAP, to use existing standards
- Specialists
  - Health Informaticians are **critical** for this level in particular with experience in integrations



# Level 3 - Semantic

- Issues
  - Many different terminologies
  - Evolution of terminologies (version control) and terminology mappings
  - Lack of consistent use of terms and concepts
- Specialists
  - Health professionals – in particular in **clinical coding**
  - Health Informatics professionals – in particular in **health ontologies** (where are these people?)



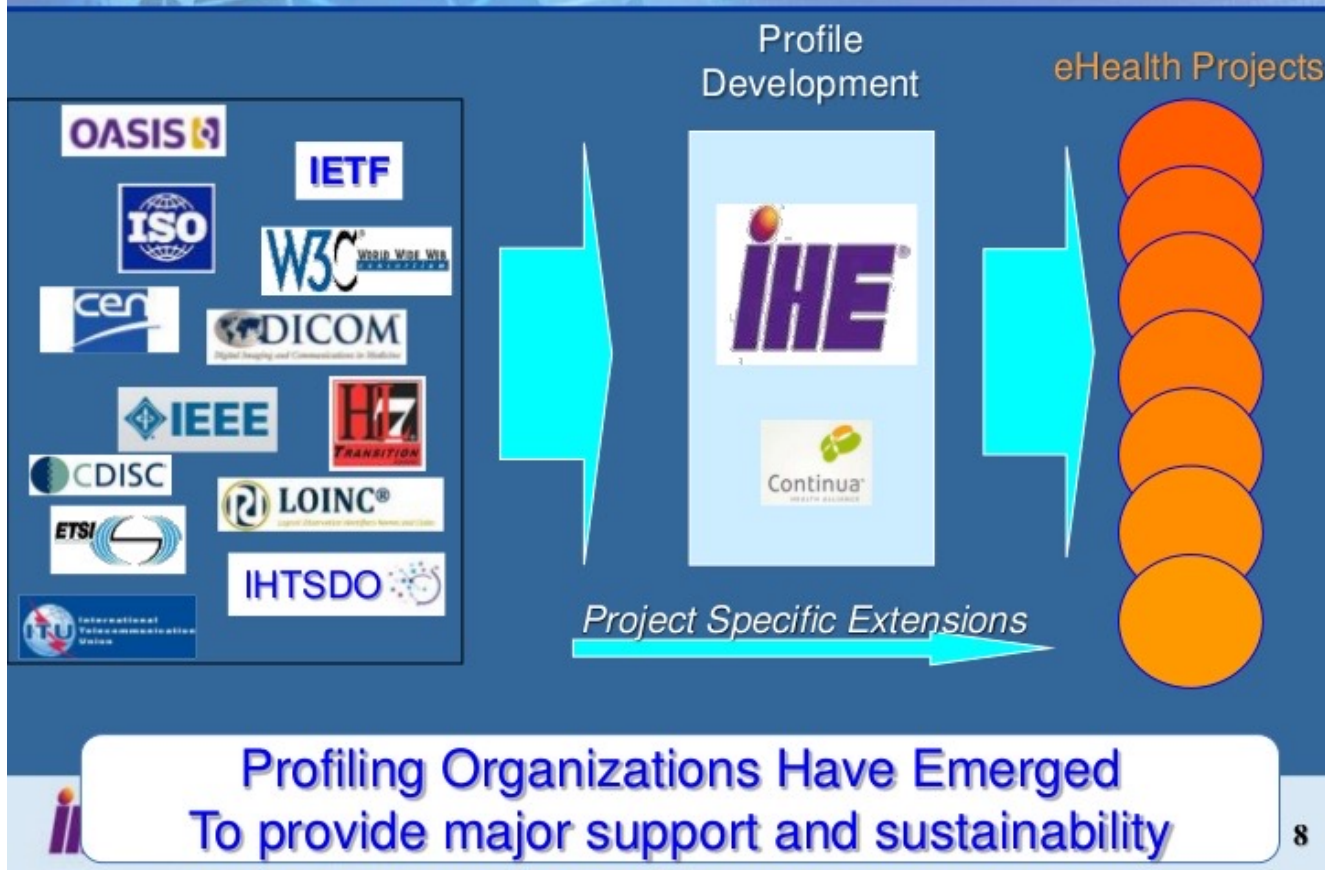


# Level 4 - Organizational

- Issues
  - Security and trust
  - Cross-border workflows
  
- Specialists
  - Legal experts
  - Health institution managers
  - Public Health
  - Experts working of patient pathways



# Interoperability: From a problem to a solution




## ANNEX

### LIST OF 'INTEGRATING THE HEALTHCARE ENTERPRISE' PROFILES ELIGIBLE FOR REFERENCING IN PUBLIC PROCUREMENT

1. IHE XCPD: Cross-Community Patient Discovery;
2. IHE XCA: Cross-Community Access;
3. IHE XCF: Cross-Community Fetch;
4. IHE XDR: Cross-Enterprise Document Reliable Interchange;
5. IHE CT: Consistent Time;
6. IHE ATNA: Audit Trail and Node Authentication;
7. IHE BPPC: Basic Patient Privacy Consents;
8. IHE XUA: Cross-Enterprise User Assertion;
9. IHE PRE: Pharmacy Prescription;
10. IHE DIS: Pharmacy Dispense;
11. IHE XPHR: Exchange of Personal Health Record Content;
12. IHE XD-MS: Cross-Enterprise Sharing of Medical Summaries Integration Profile;
13. IHE XD-SD: Cross-Enterprise Sharing of Scanned Documents;



14. IHE PIX: Patient Identifier Cross-Referencing;
15. IHE PDQ: Patient Demographics Query;
16. IHE XDS.b: Cross-Enterprise Document Sharing;
17. IHE XDS-I.b: Cross-Enterprise Document Sharing for Imaging;
18. IHE XD-LAB: Laboratory Reports;
19. IHE XDM: Cross-Enterprise Document Media Interchange;
20. IHE SVS: Sharing Value Sets;
21. IHE SWF: Radiology Scheduled Workflow;
22. IHE SWF.b: Radiology Scheduled Workflow;
23. IHE PIR: Patient Information Reconciliation;
24. IHE PAM: Patient Administration Management;
25. IHE LTW: Laboratory Testing Workflow; 
26. IHE LCSD: Laboratory Code Sets Distribution;
27. IHE LWA: Laboratory Analytical Workflow.



# IHE LTW – Laboratory Testing Workflow

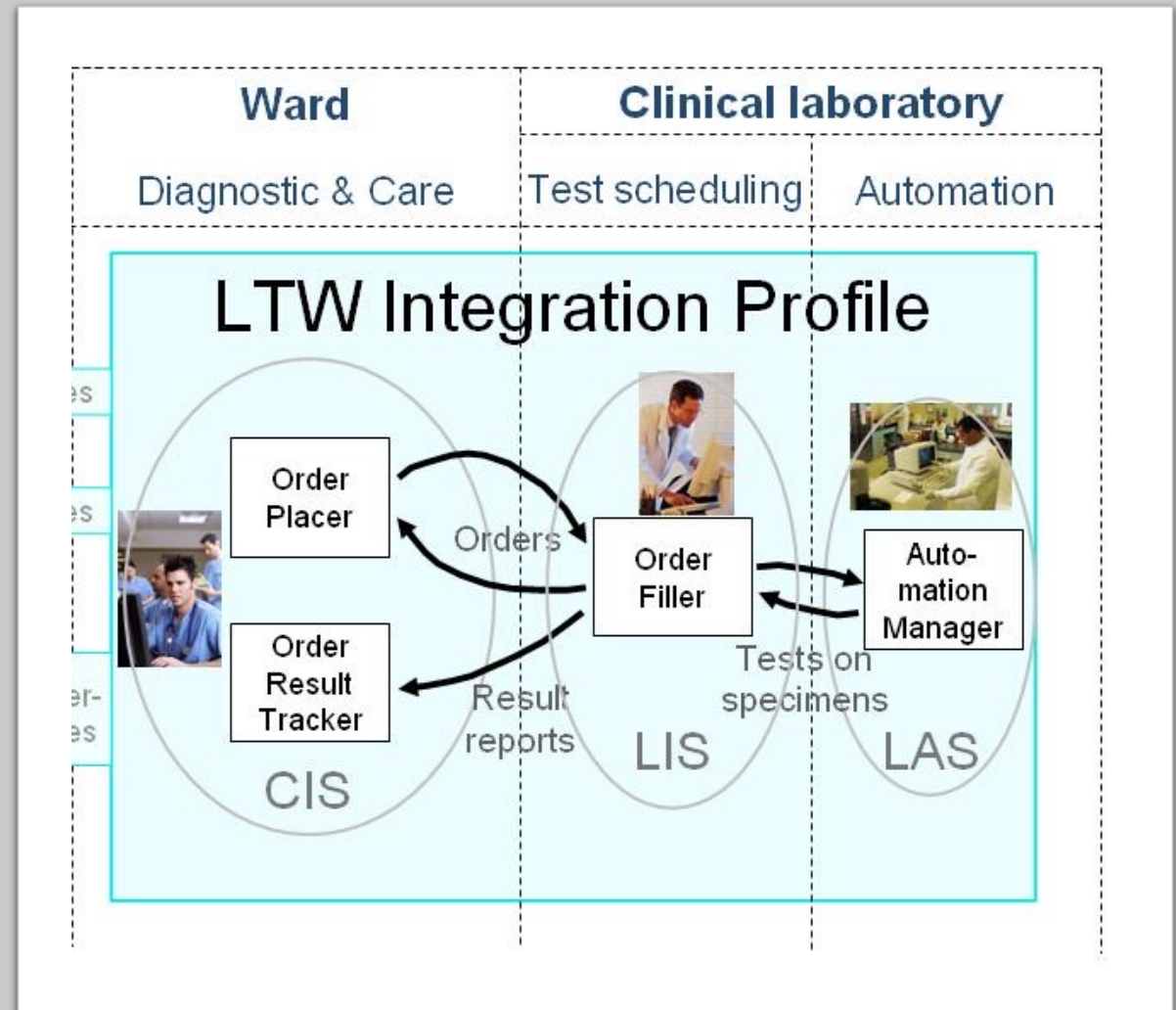
Actors:

- Order Placer
- Order Filler
- Automation Manager
- Order Result Tracker

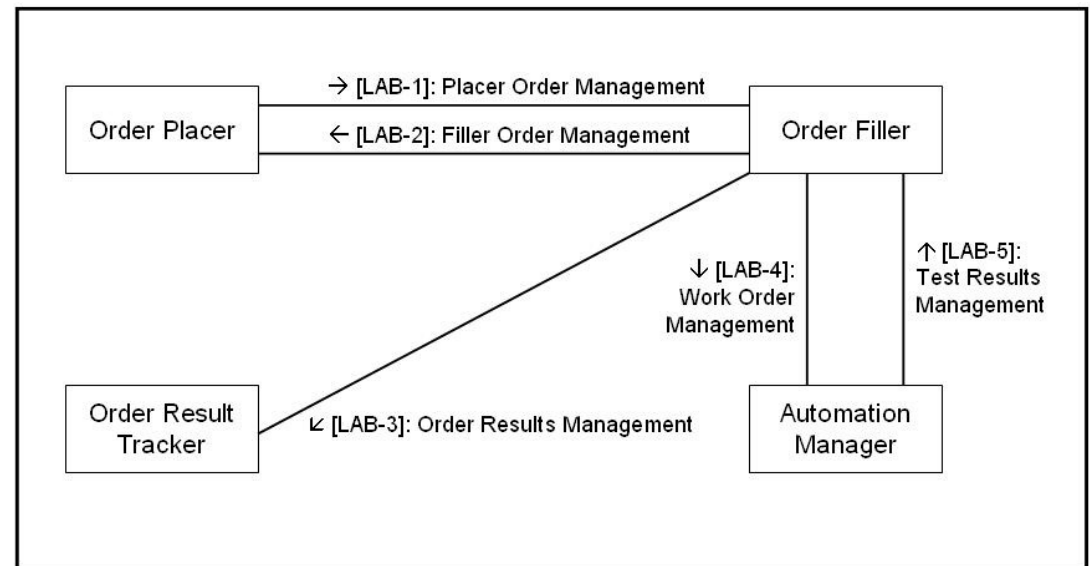
CIS – Clinical Information System

LIS – Lab Information System

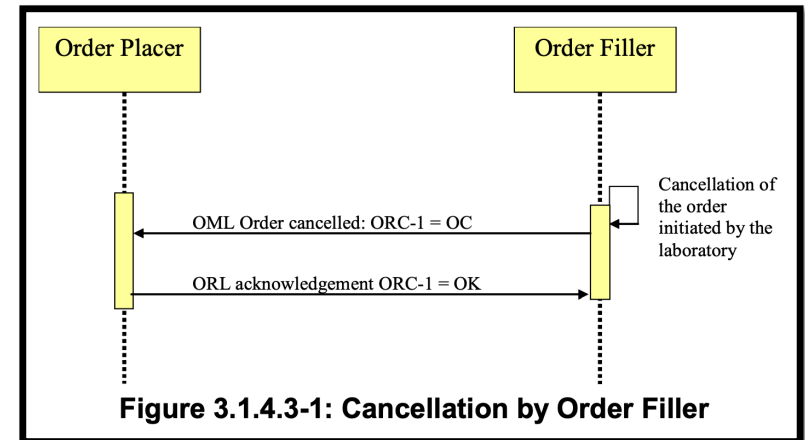
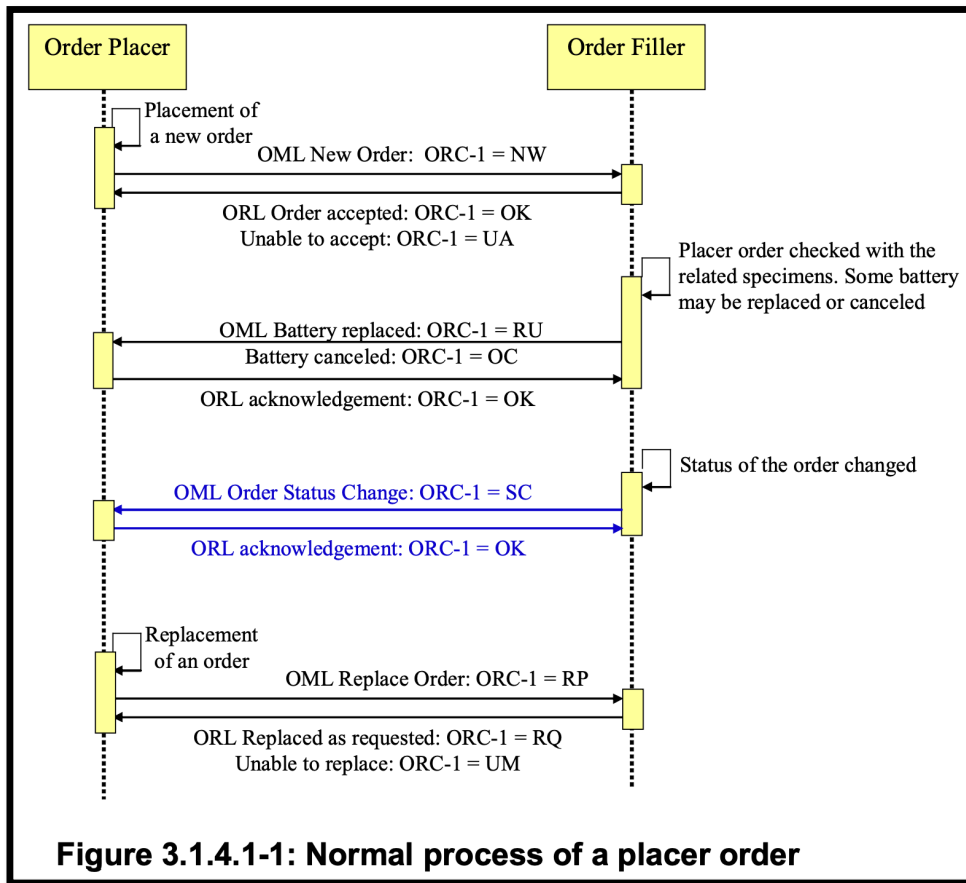
LAS – Lab Automation System



# IHE LTW - Actors and transactions



# LAB-1 – Placer Order Management



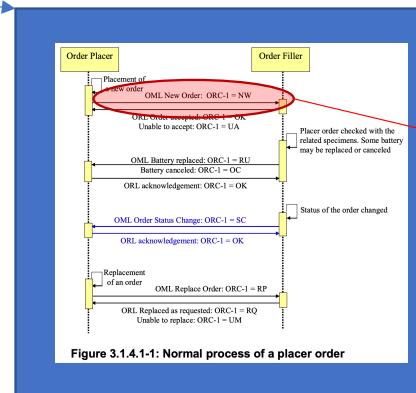
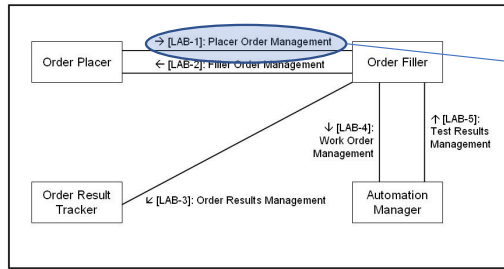
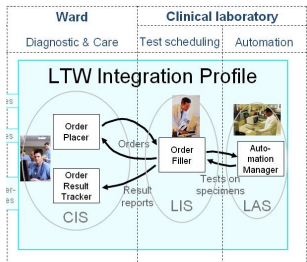
# HL7 OML example

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PID|1||111181^^^HOS^NS~123456789^^^HAS^SNS~123456789^^^HAS^SNS~12342222^^^AT^NIF||LAST_NAME^FIRST_NAME^MIDDLE_NAME^^^L||1
9910820000000|F||||^PRN^CP^^^^^^^^^^961899950~^NET^X.400^lastname@gmail.com||S||99205842^^^HOS||
CON|1||||||A||20190520||
PV1|1|INT|3^||||||20||||14000592^^^HOS|||||||20190823090035||||V||
IN1|1|990004^Num beneficiario da entidade
X^HOS|12345^DescricaoNomeOrganizacao|||||20190101|20191231||EHCPOL|LAST_NAME^FIRST_NAME^MIDDLE_NAME^^^L||19910820000
00||||||RECM|
ORC|NW|19911^HL7_DEFAULT|12345^HOS|GRP007|||||20190820163000|1845^Testes - 31^Utilizador de^^^^^^HOS~2031^Testes - 31^Utilizador
de^^^^^^N.Mecanogr\XE1\fico||1845^Testes - 31^Utilizador de^^^^^^HOS~2031^Testes - 31^Utilizador de^^^^^^N.Mecanogr\XE1\fico||||TaskReason:
Mensagem Exemplo|3147202^HOSPITAL DISTRITAL||9009^Utilizador^Teste^^^^^^N.ORDEM|1^Service is subject to medical necessity
procedures^HL70339|||||20190830||||
TQ1|1|||||20190823133000|20190823143000|A^ASAP^HL70485|
OBR|1|19911^HL7_DEFAULT|12345^HOS|O70251^RETINOGRAFIA^LOINC^103693007^Diagnostic
procedure^LOINC|||20190823130020|||2300^Observador^Exemplo^^^^^^HOS|||Informacao clinica/Observacoes de Realizacao|||||||R||
SPM|1|ID_Amostra_12345||119339001^Stool Specimen^SNOMED|||123132^Método colheita
Exemplo^SystemXPTO^NEUT^Neutralization^|344001^Ankle^SNOMED|||||||20190826100115|20190826161520||Y||||5^Mg|
```





# IHE Profiles → HL7 Messages



```
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PID|1||1161|^HOS^NS-123456789^^^HAS^SNS-123456789^^^HAS^SNS-12342222^^^AT^NFI^LAST_NAME^FIRST_NAME^MIDDLE_NAME^^^^L|I
9910820000000F||PRN^CP^^^^^^^^^961899950^^^NET^X.400^lastname@gmail.com||S||99205842^^^HOS||
CON1|||||AI|20190520|
PV1|I|NT|3^|||||20||140009592^^^HOS|||||||||20190823090035|||||V|
IN1|1990004^Num beneficiario da entidade|||||HOS-2031^Testes - 31^Utilizador de|||||N.Mecanogr|XE|f||TaskReason:
X^HOS12345^DescricaoNomeOrganizacao|||||20190101|20191231|EHCPOP|LAST_NAME^Teste^FIRST_NAME^Teste^MIDDLE_NAME^^^^L|19910820000
00|||||RECM|
ORC|NW|19911^HL7_DEFAULT|12345^HOS|GRP007|||||20190820163000|1845^Testes - 31^Utilizador de^^^^^HOS-2031^Testes - 31^Utilizador
de^^^^^N.Mecanogr|XE|f||co|1845^Testes - 31^Utilizador de^^^^^HOS-2031^Testes - 31^Utilizador de^^^^^N.Mecanogr|XE|f||co|TaskReason:
Mensagem Exemplo3147202^HOSPITAL DISTRITAL|9009^Utilizador^Teste^^^^^^N.ORDEM|Service is subject to medical necessity
procedures^HL70339|||||20190830|
TQ1|1|||||20190823133000|20190823143000|A^ASAP^HL70485|
DBR|1|19911^HL7_DEFAULT|12345^HOS|O70261^RETINOGRAFIA^LOINC-163683007^Diagnostic
procedure^LOINC|||||20190823150000|12301^Observador^Exemplo^^^^^^HOS||Informacao clinica|Observacoes de Realizacao|||||
SPM|1|ID_Amostra_12345||119339001^Stool Specimen^SNOMED||123132^Método coheita
Exemplo^SystemXPTO^NEUT^Neutralization^1344001^Ankle^SNOMED|||||20190826100116|20190826161620||Y||5^Mg|
```

Actors

Transactions

Processes

HL7 Messages

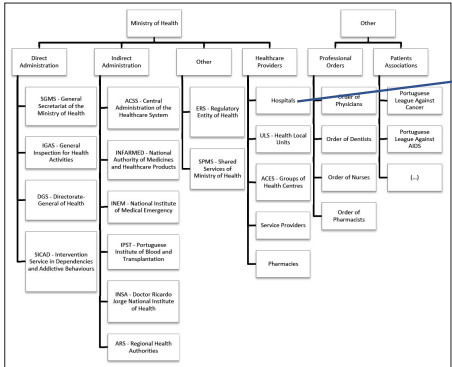


# Zoom in

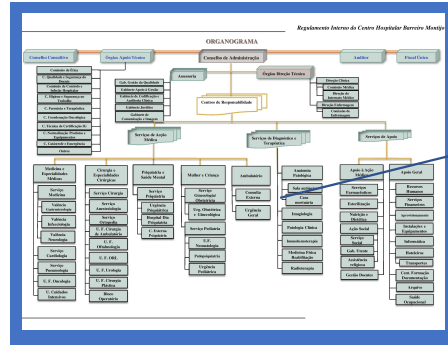


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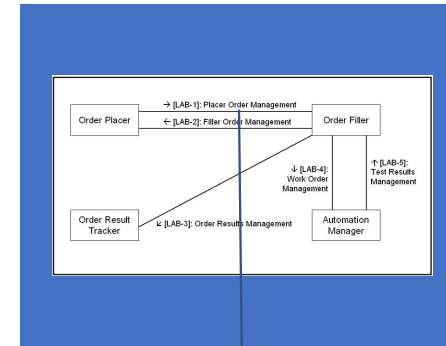
# Interoperability in health complexity



Many institutions  
~100



Many departments and IS  
~50

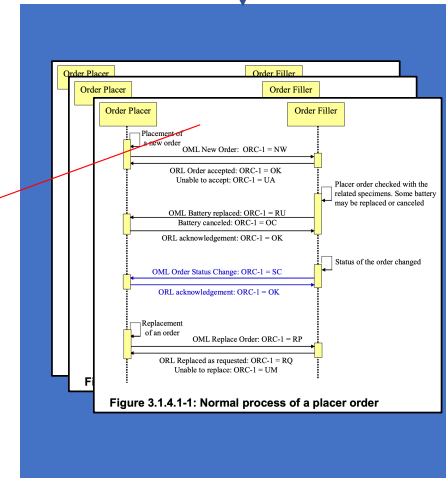


Many Transactions

Many Message Types

```

MSH|^~\&|^HL7|DEFAUL|INST|HOS|INST|20190823093000||OML^O21^OML^O21|4ab9e6b5-7372-123456789|D|2.5||AL||8856|H||
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CON1|||||A|20190520|
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Mensagen Exemplo|3147202^HOSPITAL DISTRITAL|9009^Utilizador^Teste^^^^N.ORDEM|1^Service is subject to medical necessity
procedures^HL70339|||20190830|||
TQ1|1|||20190823133000|20190823143000|A^ASAP^HL70485|
OBR|1|19911^HL7_DEFAULT|12345^HOS|O70251^RETINOGRAFIA^LOINC^103693007^Diagnostic
procedure^LOINC||20190823130020||2300^Observador^Exemplo^^^^HOS||Informacao clinica/Observacoes de Realizacao|||R|
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Exemplo^SystemXPTO^NEUT^Neutralization^344001^Ankle^SNOMED|||20190826100115|20190826161520|Y|||5^Mg
    
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Many Processes



# Challenges and opportunities



ERASMUS+ / Strategic Partnerships for Higher Education / Call 2019  
eHealth4all@EU – Interprofessional European eHealth Programme in Higher Education

# Challenges and opportunities

- The future is built on the back of data.

With data coming at health systems from **every angle**, it is important for every healthcare organization to have a rock solid **understanding of the future of interoperability** and integration.

- The ability to exchange healthcare information between systems in a **timely** and **understandable** manner has always been important, and as the **volume** and **type** of health-related information **increases**, it is becoming even more important and **difficult** to achieve.



# Market Growth

Healthcare IT Integration Market: Revenue in USD million, by Geography, Global, 2015-2024

Region	2015	2016	2017	2018	2024	CAGR (%)
North America	787.74	864.58	948.92	1,047.83	1,899.64	10.42
Europe	373.98	411.56	452.91	501.46	923.80	10.72
Asia-Pacific	323.00	356.74	393.99	437.80	824.07	11.12
Middle East & Africa	62.04	66.96	72.28	78.49	128.74	8.60
South America	88.05	96.00	104.63	114.68	197.08	9.44



# Interoperability Drives

- GDPR – traceability
- Data Lakes – getting data from many sources
- Process Mining – understanding how an organization works
- Machine Learning – need for semantic models that are safe to get conclusions
- Home monitoring – interoperability between hospitals / primary care / homes
- Wearables – getting data from wearables into health records



# Thanks



ERASMUS+ / Strategic Partnerships for Higher Education / Call 2019  
eHealth4all@EU – Interprofessional European eHealth Programme in Higher Education



The need for interoperability Assignment.

Each group must choose one of the topics below, create a storyboard for 20min that illustrates the issue, and present it afterward.

1. Lab results are not available for users
2. Patient identification has errors
3. Applications use different diagnosis coding systems
4. Confidentiality is at risk due to the exchange of data between applications

### **Exercise #1 - The need for interoperability Assignment.**

Each group must choose one of the topics below, create a storyboard for 20min that illustrates the issue, and present it afterwards.

1. Lab results are not available for users
2. Patient identification has errors
3. Applications use different diagnosis coding systems.
4. Confidentiality is at risk due to the exchange of data between applications.

### **Exercise #2 - Exercise: Identify data to be exchanged between different institutions**

In this exercise, you are asked to identify data that seem helpful to be exchanged between different health institutions.

### **Exercise #3 – Organization chart from a hospital**

For this exercise, you should look for an organigram (organisation chart) of a hospital in your country and list all the departments/services mentioned.

### **Exercise # 4 – Organization chart of a National Health Service**

For this exercise, you should look for an organigram (organisation chart) of the National Health Service in your country and list all the mentioned institutions.

### **Exercise # 5 – Data Flows**

Take your storyboard off the shelf again and create a data flow diagram where you represent each relevant institution that could be involved and the potentially different messages exchanged. Think about the nature of data and the timing of exchange, and describe the elements present in each message. Associate to each data element a description regarding its nature (integer, text, date-time, etc.)

### **Exercise #6 - Play with HL7 V2**

Go to the site: <https://hl7messageparser.azurewebsites.net/>

There you will find two buttons; the Parse Button allows you to see an HL7 v2 message in a user-friendly way and to navigate its structure. On the Get samples, you can access sample messages of different kinds. You can copy and paste it into the parser.

The assignment is to choose one available sample that could represent the admission of your storyboard patient, changing its content to reflect the correct data.

Submit the user-friendly version generated as a pdf or a screenshot.

## Exercise #7 – Play with FHIR

Pick up again your storyboard and the exercises completed before. Visit the FHIR Resources website and, using their description choose five appropriate resources that could be used to document your use case. Within each resource, you can find examples of their usage.

## Exercise #8 – Play with SNOMED

Select six SNOMED-CT concepts (relevant to your practice) and describe the idea considering the Concept Details on the snomed website.

## Exercise #9 – Play with openEHR

Follow the instructions in the tutorial. Create an openEHR template that could support the following form:

The image shows a screenshot of an openEHR form template for a Medication order. The form is structured as follows:

- Medication order** (Section Header)
- \*Narrative** (Text input field)
- Order** (Section Header)
- \* Medication item** (Text input field), **Form** (Text input field), **Description** (Text input field)
- Route** (Text input field), **Overall directions description** (Text input field)
- Dosage/Frequency** (Section Header)
- Dose** (Text input field), **Dose description** (Text input field)
- Frequency** (Text input field)
- Interval** (Text input field) **hours** (Text input field) **minutes** (Text input field) **seconds** (Text input field)
- Specific time** (Text input field)
- Timing description** (Text input field)
- Direction duration** (Text input field) **months** (Text input field) **weeks** (Text input field) **days** (Text input field)
- Additional instruction** (Text input field) **Clinical indication** (Text input field) **By patient request** (Radio button)

:



Search this recording 🔍

Details	Principles of	0:00
<b>Contents</b>	- Fast Healthcare Interoperability Resources	0:12
Discussion	FHIR – Main Building Blocks	0:43
Notes	Resources	1:24
Bookmarks	Resources	2:26
Hide	Logical Fhir Specification Architecture	2:53
	Resources	3:51
	Resources references	4:46
	Resources extensibility	5:24
	Example Glucose measurement Observation	6:06
	The Patient Resource	7:39
	Questionnaire Response	8:05
	Data types	8:25
	FHIR Profile Resource	8:47
	FHIR – Main advantages	9:20
	Where to start playing with FHIR	9:51

# Principles of

ERASMUS+ / Strategic Partnership for Higher Education / Call 2019  
 Auto-play is disabled in your web browser. Press play to start. programme in Higher Education



U. PORTO

▶ ⏪ ⏩ 0:00 ————— -10:02 🔊 1x Speed 📊 Slides 🖥️ Screen

- The HL7 FHIR® is the latest Standard from the HL7 foundation, <https://www.hl7.org/fhir/>
- Evolves from previous HL7 standards (V2, V3, CDA)
- Describes a data format and structured elements for the representation and exchange of information.
- Compared to other versions, it is easier to be used, proposing the use of more recent technologies for the representation and exchange of information (eg. JSON, REST).
- Allows registered extensibility (there is a model to formalize the extension of base resources)
  - ↳ Unlike what happens with the use of segments in HL7 v2.
- The currently on release 4.

- Data Types
- Resources
  - ↳ They make up a set of modular components that represent basic concepts (eg. Patient, Family History, Allergies, etc.)
- An application programming interface for exchanging Health information
  - ↳ Prepared to address information communication challenges present for instance in mobile phone apps, cloud communications, FHIR-based data sharing.

- Resources represent granular concepts
  - ↳ Person, Lab-Result, Diagnosis, Prescription, Care
  - ↳ Intended to represent 80% of the main concepts
- May have Extensions - Constraints or Attribute Codes
- Resources may contain a narrative that explains the resource format.
- Coded Concepts and Terminologies can be used
- They are available in JSON or XML formats.

## **Appendix II: Data Protection and Security**

Course Content

Objectives for the course

GDPR Enforcement Actions in Europe

Presentation: Data protection officer

Presentation: Data privacy in healthcare work

Presentation: Data privacy in my work: passwords

Presentation: Data breach

**1. Kick Off 14. – 15.9.2021**

- Padlet, please introduce your self
- Objectives for the course
- Time schedule
- Course evaluation
- Learning objectives (return to depositbox)
- Presentation

**2. Introduction 14.9. -5.10.2021**

- Learn key concepts
- Draw mind map
- Make comments of two mind map

**3. Data Protection legislation 27.9. – 10.10.2021**

- Write an essay (1000 words) about differences in data protection legislation in different countries.
- Pairwork, make a power point presentation about your countries data protection legislation differences.
- Compare legislation differences in different countries.

**4. Data Protection actors 11.10. – 24.10.2021**

- Listen to a lecture,
- write an essay
- comment another students (2) essay writing

**5. Confidentiality, secrecy and patient information 25.10. – 2.11.2021**

- CASE learning where professional can discuss about patient issues?
- Discussion of patient rights and confidentiality in healthcare work. Prepare to discuss about this case in zoom 2.11.

**6. Risk management in healthcare 1.11. - 17.11.2021**

Describe the process of how to act in the event of a cyber attack or security breach.

Find out what is your organizations guidance in security breach cases.

Write an essay of 1000 words.

This course lessons include the key concepts of data protection and the data subject's rights. You will learn to recognize confidentiality and data protection issues and find solutions to them.

You will also learn how to ensure information security in your work. In this course you will get advice about what to do if the security of personal data has been compromised.

Completion of the course is spread over nine weeks. Course includes pair work and individual work. You can choose which tools you use in your pair work Teams, O365 etc.

The course consists of learning assignments, videos and additional material. The course is evaluated numerically with 1 to 5 grades. First, please introduce your self to other course members in Padlet. Second, please create your own learning objectives for the course. Third, deposit your own learning objectives to deposit box.







# Data protection officer

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Tiina Jokinen 2021

## Data protection officer

- She is responsible implementation of legislation and guidance in her organization
- She gives data protection supervision and
- monitoring of compliance and enforcement of patient`s rights



# Dataprotection officer

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- Counseling and guidance
- preparation of documentation
- control of availability and preservation
- Impact assessment
- Educate workers to data privacy issues
- cooperation with the supervisory authority



A person wearing a blue hard hat and a white lab coat is holding a glowing red sphere. The background is a blurred industrial or laboratory setting with windows and equipment. A large white circle is overlaid on the left side of the image, containing text.

# Responsibilities in organization

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- operational management
- the employee is responsible for his own work and activities
- The customer is responsible for the consents she is giving

Management is responsible of

- security and privacy organization of work, policies,
- guidelines,
- appointment of data protection officer,
- staff training,
- regular reporting
- documentation



**RISK  
MANAGEMENT**



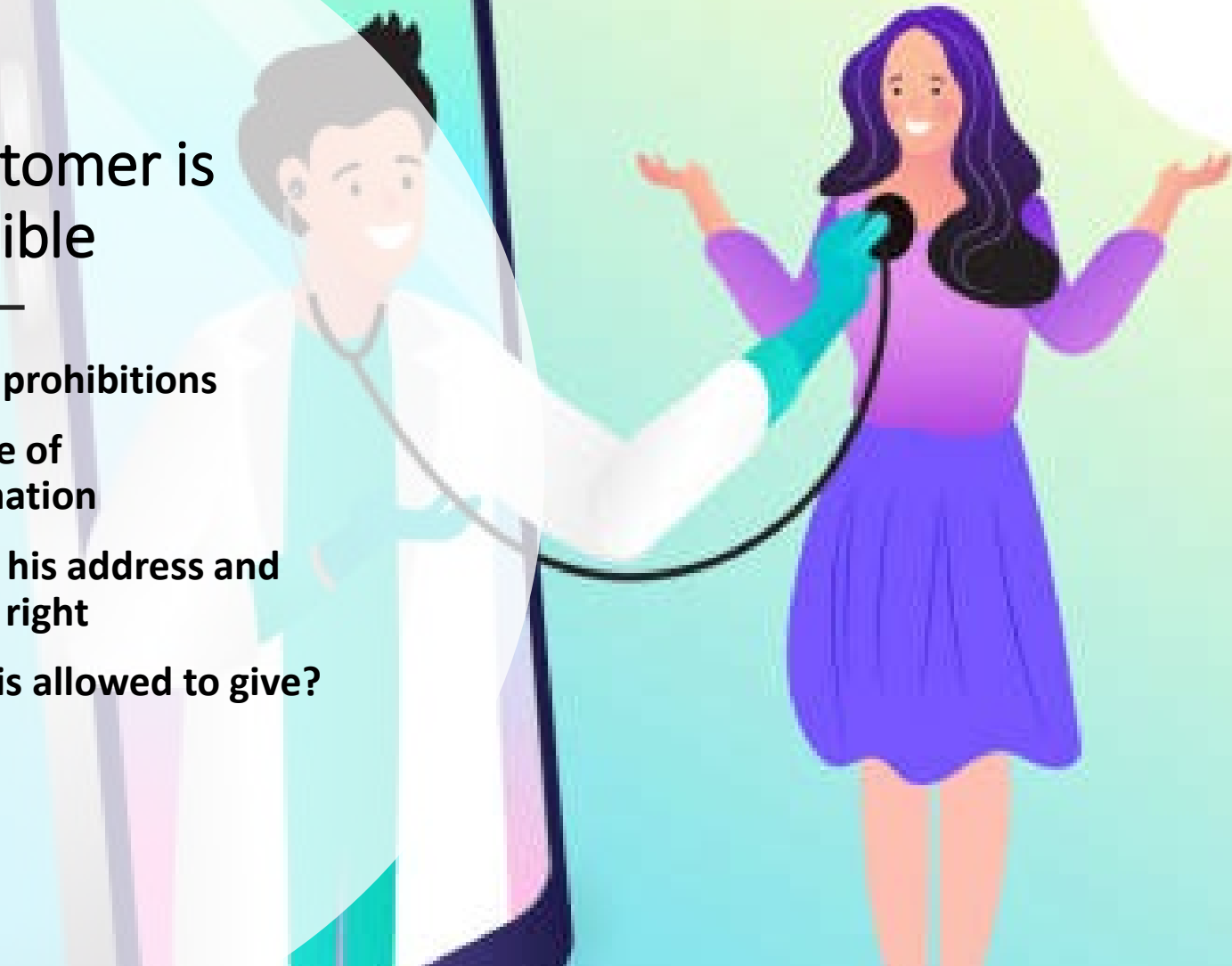
## Staff/ workers are responsible

- informing the patient of consents and prohibitions
- Every time patient comes to service we need to check patients contact information
- duty of secrecy
- proper processing of data, what is this in healthcare work?

## Patient / customer is responsible

---

- **decide on consents and prohibitions**
- **relating to the disclosure of personal/patient information**
- **He has to take care that his address and contact information are right**
- **To who his information is allowed to give?**





# Data privacy in healthcare work

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Tiina Jokinen 2021



# Learning objectives

- In this lesson we learn how to consider data protection and security in your everyday work in healthcare

# Data privacy in my work: passwords

---

- do not borrow your password,
- store safely and
- create a strong password
- Learn how to create a strong password:
- [strongerthebetter](#)



# Healthcare work

---

- The workstation and information systems are used with your own personal username and password



## Organization rules

---

- No internal devices may be connected to the organizations internal networks
- the programs may not be installed on organizations computer (at least without the permission of ICT)





An illustration showing two hands in business attire holding a large, brown folder. The folder has the word 'CONFIDENTIAL' printed on it in a bold, black, sans-serif font. The background is a light, neutral color with soft shadows and highlights, suggesting a professional office environment. The hands are rendered in a stylized, flat-shaded manner, with one hand in a light blue sleeve and the other in a dark blue sleeve.

## Data privacy in my organization

---

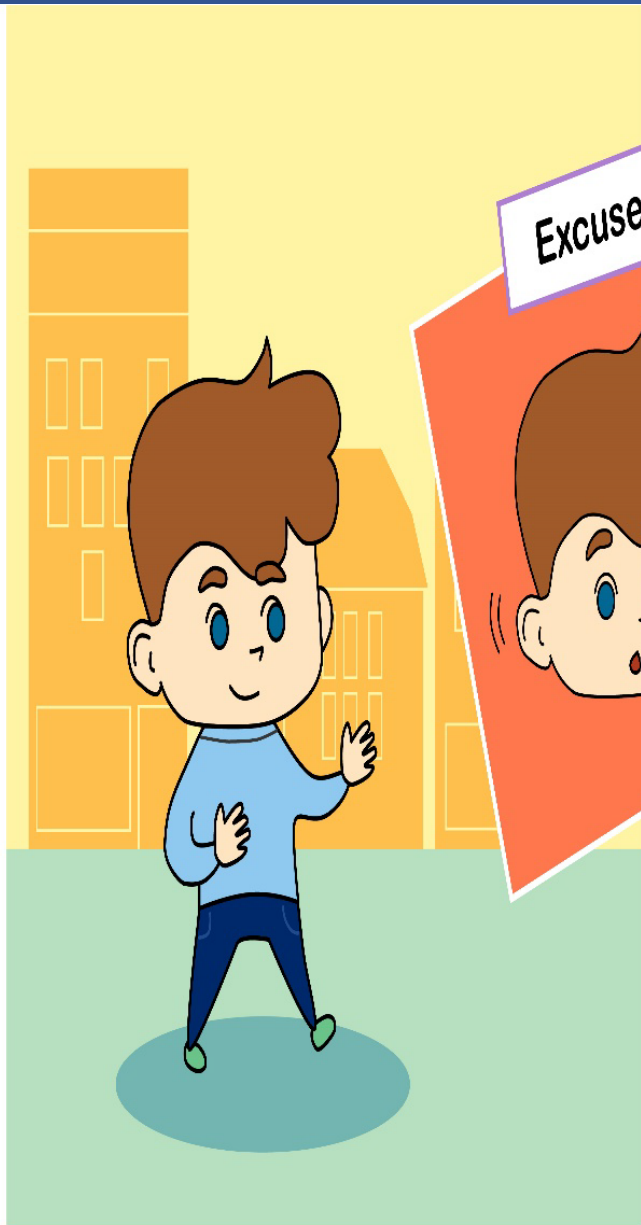
- Client data **must not be** stored on the workstation (computer) hard disk
- If you suspect a computer virus, stop working and report to ICT (security manager or security team) and your organizations servicedesk

# Email

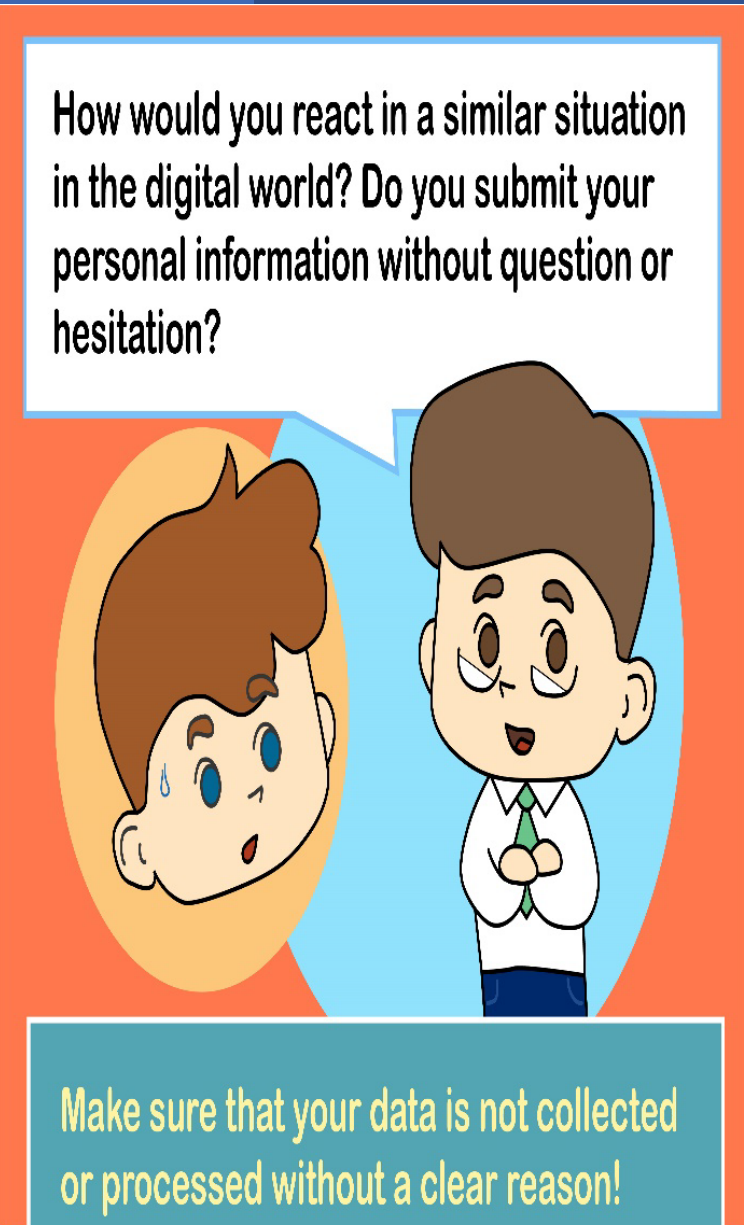
The image features a white laptop with a black keyboard, set against a teal background. Several colorful envelopes (purple, green, red, white, orange, and yellow) are scattered around the laptop, some appearing to float or be sent from the screen. A large, semi-transparent white circle is overlaid on the left side of the laptop, containing the text and a list of points.

- 
- Confidential things / patient information may not be sent by ordinary unsecured email
  - Do not use work e-mail for leisure purposes; work email is for work purposes





Could you please tell me your name, e-mail address and home address?



How would you react in a similar situation in the digital world? Do you submit your personal information without question or hesitation?

Make sure that your data is not collected or processed without a clear reason!

# Print

---

- When printing, check the default printer - a recommended printer is “a safety printer”
- When leaving the workstation, lock or close computer



# Social media and work

- Work must not be disturbed because of social media
- Photos of colleagues should not be published without his permission



A person is shown from the side, holding a smartphone. The background is a blurred indoor setting with a laptop and some plants. Overlaid on the scene are various social media icons and emojis, including hearts, stars, speech bubbles with numbers, and various facial expressions like surprised, laughing, and heart eyes. The overall theme is digital communication and social media.

# Social media and work

- Every employee is responsible for their own writings and pictures shared in social media
- How about patient responsibility? Taking pictures of nurses and posting them to some.

# Social media and work

- Check your private settings regularly
- Are you aware that the information you publish in social media will spread even though you publish it in a closed group



# Social media and work



- Don't accept strangers as friends or followers in social media
- If your profile contains information about your employer, you will publish things as an unofficial representative of your organization

# Data privacy in my work: passwords

- do not borrow your password,
- store safely and
- create a strong password
- Learn how to create a strong password:
- [strongerthebetter](#)



# Healthcare work

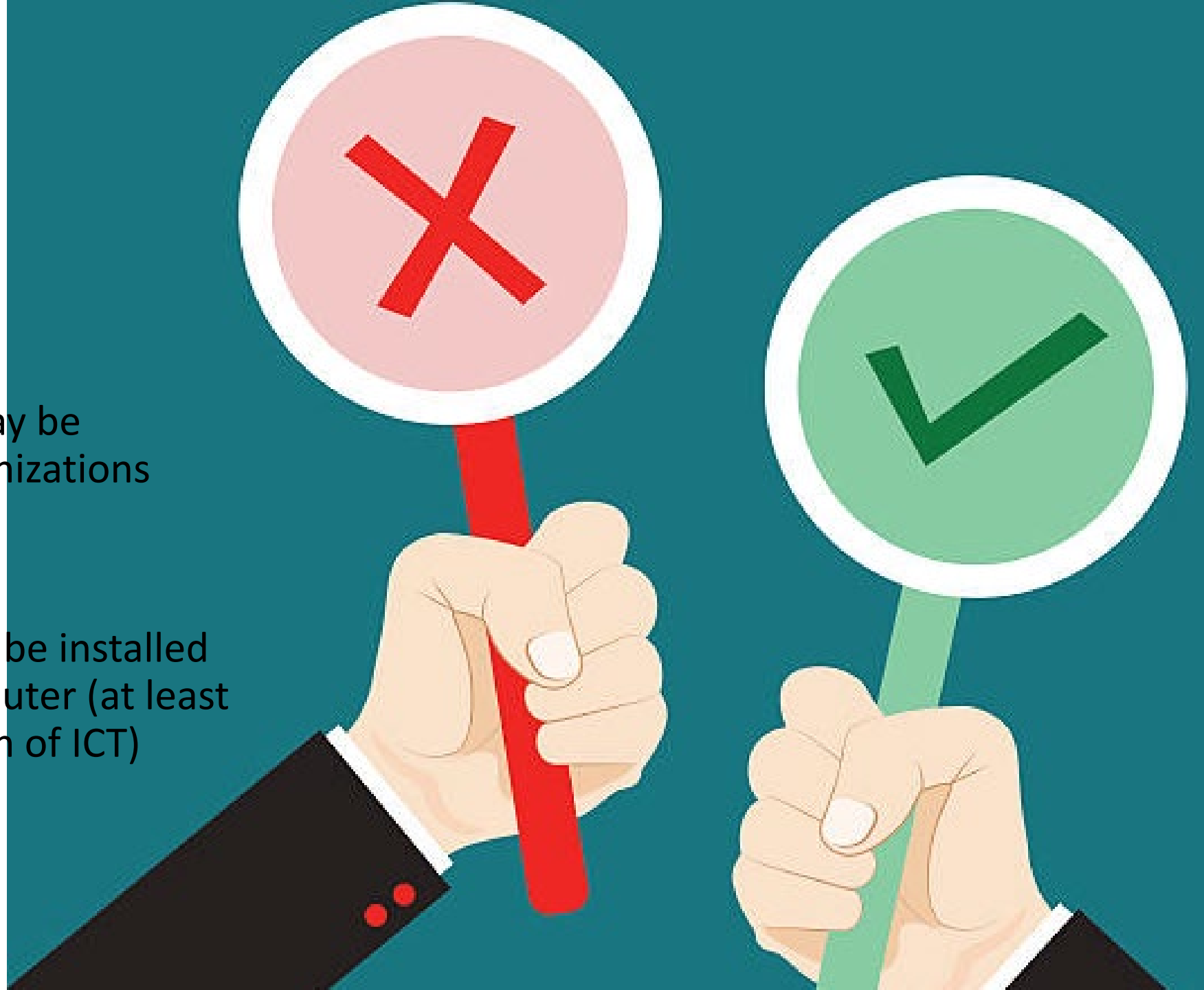
- The workstation and information systems are used with your own personal username and password





## Organization rules

- No internal devices may be connected to the organizations internal networks
- the programs may not be installed on organizations computer (at least without the permission of ICT)





**Security breach is an event that resulted personal data:**

- is destroyed
- disappears
- changes
- unauthorized disclosure of personal data
- or accessed by a third party (person that has no right of access)

## Appendix III: Data Analytics

Schedule of the Kick-Off

Agenda virtual European Summer School

Screenshot Miro-Board: structure and content of the course

Presentation: The eHealth4all@EU Project

Presentation: The Learning Health System

Moodle screenshot: learning videos and quizzes for Lesson 1: Recap Statistics

Moodle screenshot: learning videos and quizzes for Lesson 2: Recap Linear Regression

Moodle screenshot: learning videos and quizzes for Lesson 3: Odds Ratio and Case-Control-Studies

Moodle screenshot: learning videos and quizzes for Lesson 4: Logistic Regression

Moodle screenshot: learning videos and quizzes for Lesson 5: Applied Logistic Regression in SPSS

Moodle screenshot: learning videos and quizzes for Lesson 6: Prediction Models

Task for Data Lab Day 1 “Risk Factor Analysis”

Task for Data Lab Day 2 “Create a Prediction Model”

## Agenda Thursday, 17<sup>th</sup> June 2021

<b>Welcome</b>	The eHealth4all@EU project Syllabus and time schedule Learning outcomes
10 minutes break	
<b>Introduction</b>	Introduction of all participants Learning Management Platform
10 minutes break	
<b>Learning Health System</b>	Presentation Questions & Answers Adjournment

## Agenda Friday, 18<sup>th</sup> June 2021

<b>Learning Health System: Practical Examples in Wound Care</b>	Presentation Questions & Answers
10 minutes break	
<b>Sharing Experience in Data Analytics</b>	Applications Data Methods
10 minutes break	
<b>Introduction into SPSS</b>	Data and variable management Descriptive statistics and visualization

**Monday, 23<sup>rd</sup> August 2021**

**Welcome**

**Mini Lecture:** From Data to Knowledge

**Team Work:** Q&A

**Data Demonstration:** Data Description and Modeling

30 minutes break

**Data Analytics Lab**

Dataset Introduction

“Risk Factor Analysis” with Logistic Regression

**Tuesday, 24<sup>th</sup> August 2021**

**Welcome**

**Presentations:**

“Risk Factor Analysis” followed by an open discussion

**Data Demonstration:**

Find the Fit – Forward and Backward Selection

30 minutes break

**Data Analytics Lab**

“Designing a Risk Prediction Model” with Logistic Regression

**Wednesday, 25<sup>th</sup> August 2021**

**Welcome**

**Presentations** of the results of the Data Analytics Labs “Designing a Risk Prediction Model”

30 minutes break

**Feedback and Evaluation**

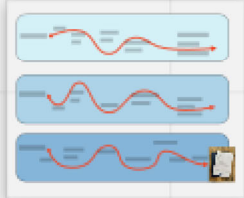
**Upcoming Courses:**

„Data Protection & Security“ and „Interoperability“

**Course Completion**

Welcome to Day 1  
"Analyzing Risk Factors"

Course Event W...



Map Activity: Wha...



Teams



Mini Lecture  
Topic: From Data



Coffee/Lunch Break

Data Demonstration  
Topic:  
Descriptive

Data Analytics Lab  
Topic:  
Data Analysis of potential risk

Material and ...

**Material and Tasks**

You will learn how to use the data to create the decision tree for individual patients.

Please record your analysis in the Powerpoint template.

Remember, each group will present their results in a 10 minute session. They will also be available.

Here you find the task description and the power point template you have to use

**and Download**

**Power Point Template**

**Dataset**

Get together at 16:55 (15:55 Portugal; 17:55 Ireland) in Zoom

Welcome to Day 2  
"Creating Prediction Models"

Positive Gos...

**Learning Re...**

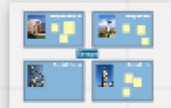
Assessment goals and resources  
Learning objectives

The available evidence and methodology  
The research plan

Presentation of the results of the Data Analytic Lab

Coffee/Lunch Break

Data Demonstration  
Topic:  
Choosing the



Data Analytics Lab  
Topic:  
Data Analysis of potential risk

Copy of Mate...

**Material and Tasks**

You will learn how to use the data to create the decision tree for individual patients.

Please record your analysis in the Powerpoint template.

Remember, each group will present their results in a 10 minute session. They will also be available.

Here you find the task description and the power point template you have to use

**and Download**

**Power Point Template**

**Dataset**

Get together at XXXX in Zoom

Welcome to Day 3  
"Presentations and Certificates"

Activities and resources  
Learning objectives

Team Quatrack

Team Insiplo

Team Porto

Coffee Break (15 minutes)



Online HealthCheck  
(a HealthCheck Survey on Summer holidays)

Upcoming Courses  
University of Health and Care Sciences  
University of Bristol

Certificates Ceremony  
(Certificates per presentation)



# *The eHealth4all@EU Project*

With the support of the  
Erasmus+ Programme  
of the European Union

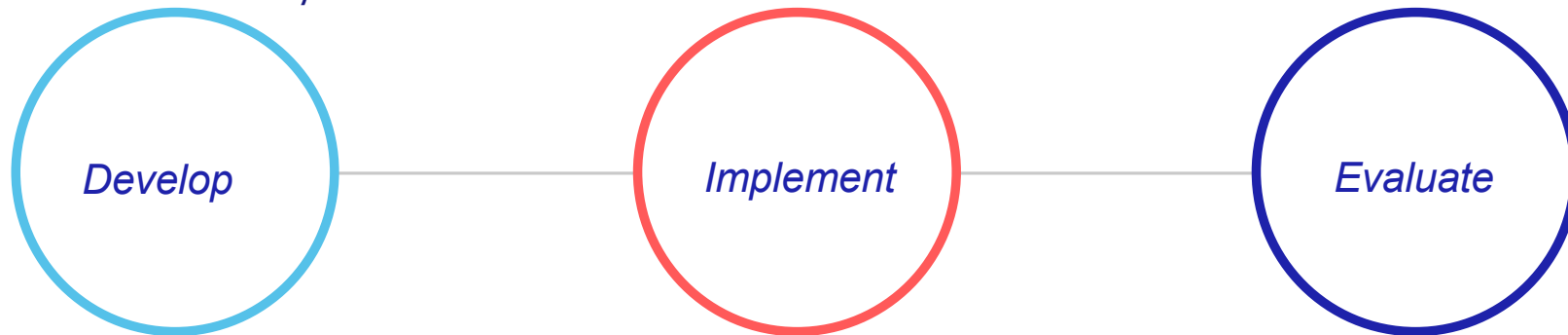


# Project Overview

With the support of the  
Erasmus+ Programme  
of the European Union



The Interprofessional European eHealth Programme in Higher Education (eHealth4all@EU) aims to:



an interprofessional eHealth training programme for graduate students from medicine, nursing, allied health, informatics, engineering, business, law, and management.





# Introducing the Project Partners, cont'd

University of Applied Sciences and University Osnabrück together with Health Campus Osnabrück, Germany



14,000 Students  
1,200 Employees  
4 Faculties + 1 Institute

Bachelor/Master programmes in:

- Health management
- Nursing science
- Nursing management
- Physio-, occupational and speech therapy
- Midwifery

14,000 Students  
1,800 Employees  
9 Departments

Bachelor/Master programmes in:

- Health sciences (education)
- Nursing science (education)
- Psychology



Campus Osnabrück University of Applied Sciences and Osnabrück University

With the support of the Erasmus+ Programme of the European Union



HOCHSCHULE OSNABRÜCK  
UNIVERSITY OF APPLIED SCIENCES



U.PORTO



With the support of the  
Erasmus+ Programme  
of the European Union



# Introducing the Project Partners

## CINTESIS University of Porto and Escola Superior Enfermagem do Porto (ESEP) Portugal



31,000 students  
3,900 employees  
13 Faculties + 1 Institute

Bachelor/Master programmes in:

- Medicine
- Dentistry
- Psychology
- Medical informatics



Nursing School  
2,000 students

Bachelor/Master programmes in:

- Nursing
- Community health
- Medical-surgical nursing
- Rehabilitation
- Infant child health
- Midwifery
- Mental health and psychiatry
- Nursing clinical supervision
- Nursing information systems
- Management and leadership



HOCHSCHULE OSNABRÜCK  
UNIVERSITY OF APPLIED SCIENCES



# Introducing the Project Partners ,cont'd

## University of Eastern Finland, Kuopio and Joensuu Finland

15,500 Students  
2,500 Staff members  
4 Faculties  
2 Locations

Master programmes in:

- Health and Social Management,
- Health and Human Services Informatics,
- Health Economics



University of Eastern Finland, Kuopio Campus



With the support of the  
Erasmus+ Programme  
of the European Union



HOCHSCHULE OSNABRÜCK  
UNIVERSITY OF APPLIED SCIENCES



U. PORTO



UNIVERSITY  
OF EASTERN  
FINLAND



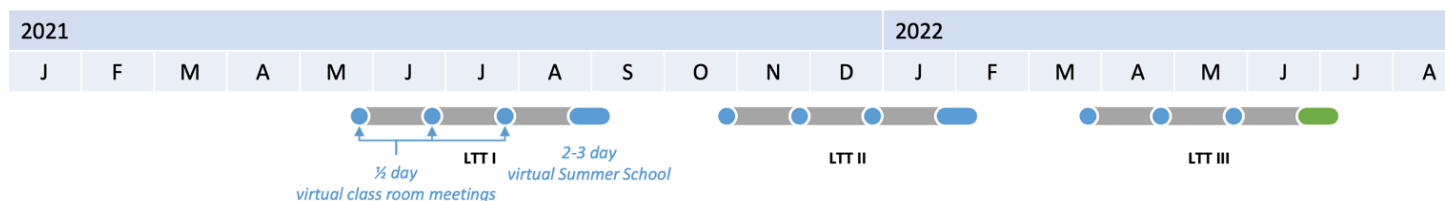
# Project Timeline



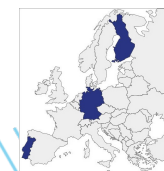
eHealth4all@EU  
Interprofessional European eHealth Programme in Higher Education



## Revised Learning-Teaching-Training (LTT) Activities



Process	3 months of merely asynchroneus, preparatory learning activities followed by a 2-3 days (virtual) or 5 days physical European Summer School (vESS)		
	vESS: 2-3 days	vESS: 2-3 days	ESS: 5 days (in Porto)
E-Learning formats			
Problem-based learning			
Collaboration of learners			
Comments			
1. Interoperability	X	prep-phase + vESS	prep-phase + ESS
2. Data Prot. & Security	X	prep-phase + vESS	prep-phase + ESS
3. Big Data & Analytics	prep-phase + vESS	X	prep-phase + ESS
4. Innovation & Entrepr.	X	X	ESS only
5. Leadership & Govern.	X	X	ESS only
6. Ethics & Legal Topics	X	X	ESS only



HOCHSCHULE OSNABRÜCK  
UNIVERSITY OF APPLIED SCIENCES



UNIVERSITY OF EASTERN FINLAND

# Clinical Data Analytics International Course

With the support of the Erasmus+ Programme of the European Union



## Learning Healthcare in Action: Clinical Data Analytics

International Online Course



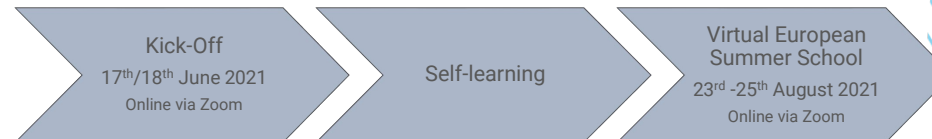
**Students come from:**  
Kuopio  
Osnabrück  
Porto  
and  
The United States



Campus Osnabrück University of Applied Sciences and Osnabrück University

In this practically oriented course, you will learn how to apply **analytical techniques to clinical data**. You will become confident and competent in how statistical models are used to **generate clinical knowledge and evidence**. We demonstrate the **transfer of this knowledge into practice** (practice-based evidence), particularly through predictive models in decision making.

After a Kick-Off Meeting, a self-learning phase, in which you make yourself acquainted with the topic in a self-paced manner, follows. In a final workshop, you will **collaborate with peers from Germany, Finland and Portugal** to develop your own models and discuss application areas.



Graduation: Certificate with 3 ECTS

### Who is this course for?

This course is recommended to Master's or PhD students in health care and professionals from nursing, physiotherapy, midwifery, medicine, and alike. We also invite students from health care management, health sciences, economics, law, engineering, informatics and computer science to this interdisciplinary course.

### How much does it cost to attend the course?

Participation is free of charge.

### Further information and registration

Nicole Egbert, M.A.  
Health Informatics Research Group  
Osnabrück University of Applied Sciences  
E-Mail: [n.egbert@hs-osnabrueck.de](mailto:n.egbert@hs-osnabrueck.de)  
<https://www.hs-osnabrueck.de/ehealth4alleu/courses/>

Deadline for application:  
4<sup>th</sup> June 2021



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# Agenda for 17<sup>th</sup> and 18<sup>th</sup> June 2021

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Agenda 17 <sup>th</sup> June 2021	
<b>Welcome</b>	The eHealth4all@EU project Syllabus and time schedule Learning outcomes
10 minutes break	
<b>Introduction</b>	Introduction of all participants Learning Management Platform
10 minutes break	
<b>Learning Health System</b>	Presentation Questions & Answers Adjournment

Agenda 18 <sup>th</sup> June 2021	
<b>Learning Health System: Practical Examples in Wound Care</b>	Presentation Questions & Answers
10 minutes break	
<b>Sharing Experience in Data Analytics</b>	Applications Data Methods
10 minutes break	
<b>Introduction into SPSS</b>	Data and variable management Descriptive statistics and visualization



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# *Impressions Campus*



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Rathaus von Osnabrück, Ort des Westfälischen Friedens 1648  
Foto: Presseamt Osnabrück (©S. Jürgenzen)

# *Impressions Town*



# *The Learning Health System*

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**Ursula H. Hübner**

**Professor of Medical and Health  
Informatics and Quantitative Methods**



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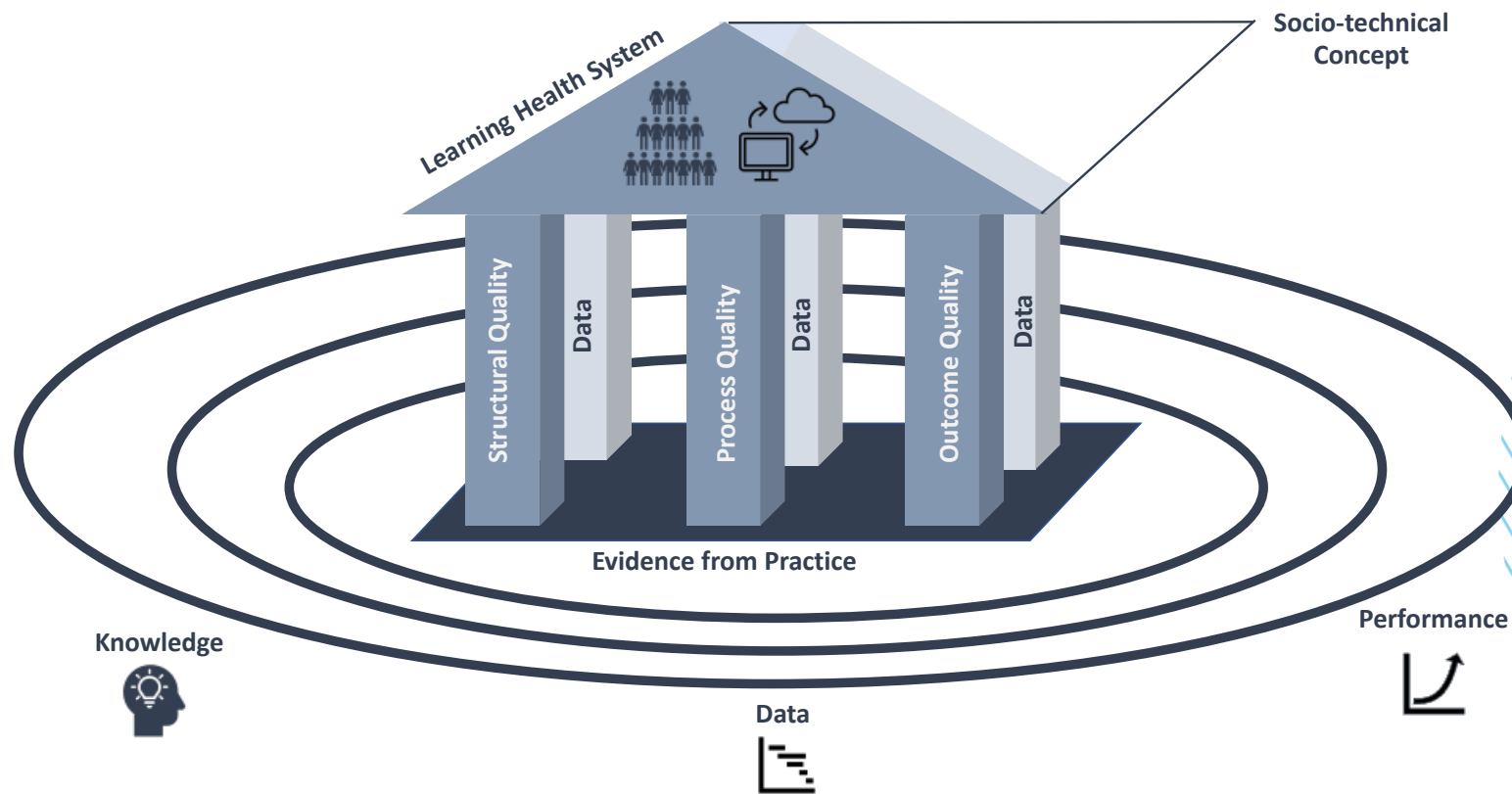
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# What is a Learning Health System?



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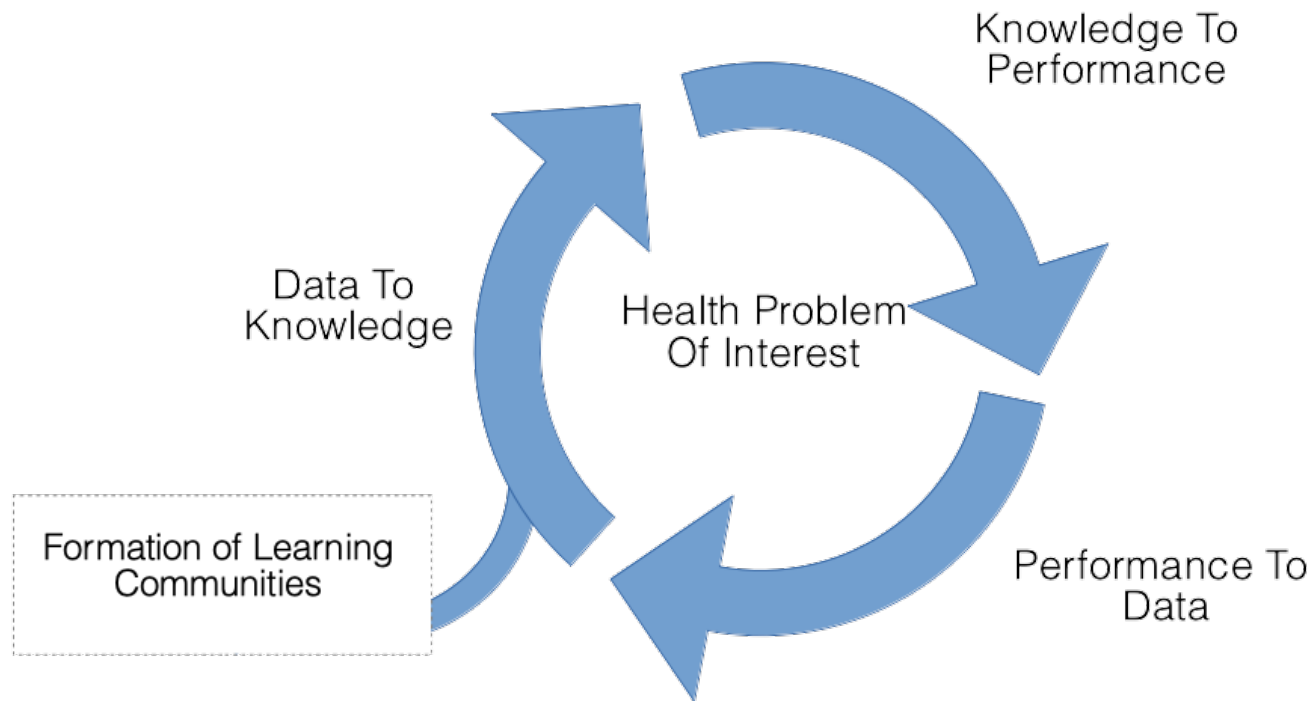
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Rauch J, Hübner U. Learning Health Systems: Concepts, Principles and Practice for Data-Driven Health. In: Hübner U, Wilson M. G., Shaw Morawski T, Ball MJ Nursing Informatics: A Health Informatics, Interprofessional and Global Perspective. Springer London 2021

# The LHS Learning Cycle



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# The LHS Learning Cycle

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Data in patient booking system:  
Longitudinal analysis of patients who did not show up.  
Development of a forecasting model.

Data To Knowledge

Health Problem Of Interest

Occupancy rates

Formation of Learning Communities

Knowing that 20% of the out patients in cardiology do not show up on Mondays and Fridays. These days can be overbooked.

Knowledge To Performance

Recording the occupancy rate in cardiology over the seven days of the week for six months.

Performance To Data



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# Types of an LHS

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Types	Examples
Automation	Pre-populated forms for ordering lab tests
Benchmarks	Comparison with the best in emergency department throughput
Predictions and Forecasts	Consumption of medical products such as wound dressings, prescription of antibiotics
Decision support	Decision support in differential diagnosis of a chronic wound
Real-time Surveillance	Infection rates of newborns
Research Support	Identification of patient cohorts for heart failure and patients older than 65 years for quasi-experimental study design



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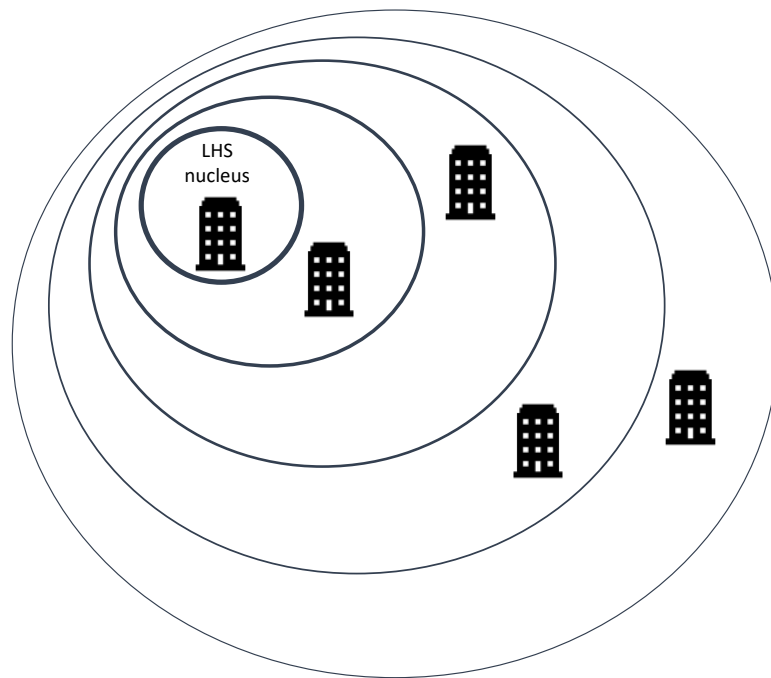
Foley TJ, Vale L. What role for learning health systems in quality improvement within healthcare providers? *Learn Health Syst.* 2017 May 31;1(4):e10025. doi: 10.1002/lrh2.10025.



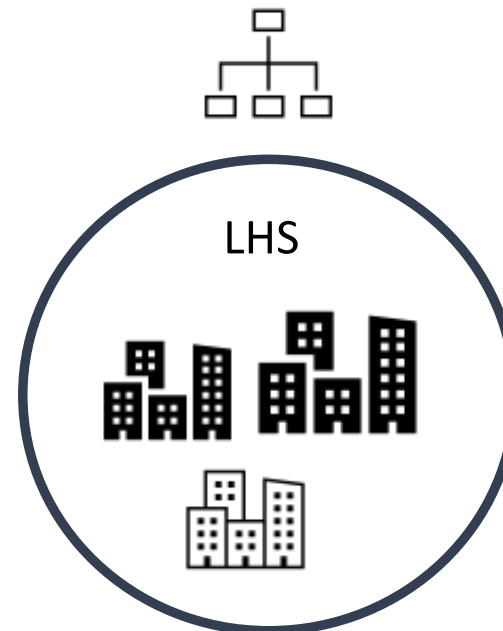
# Local vs. national Learning Health Systems

Local LHS with the potential to grow

National LHS with a predefined concept



Overall concept

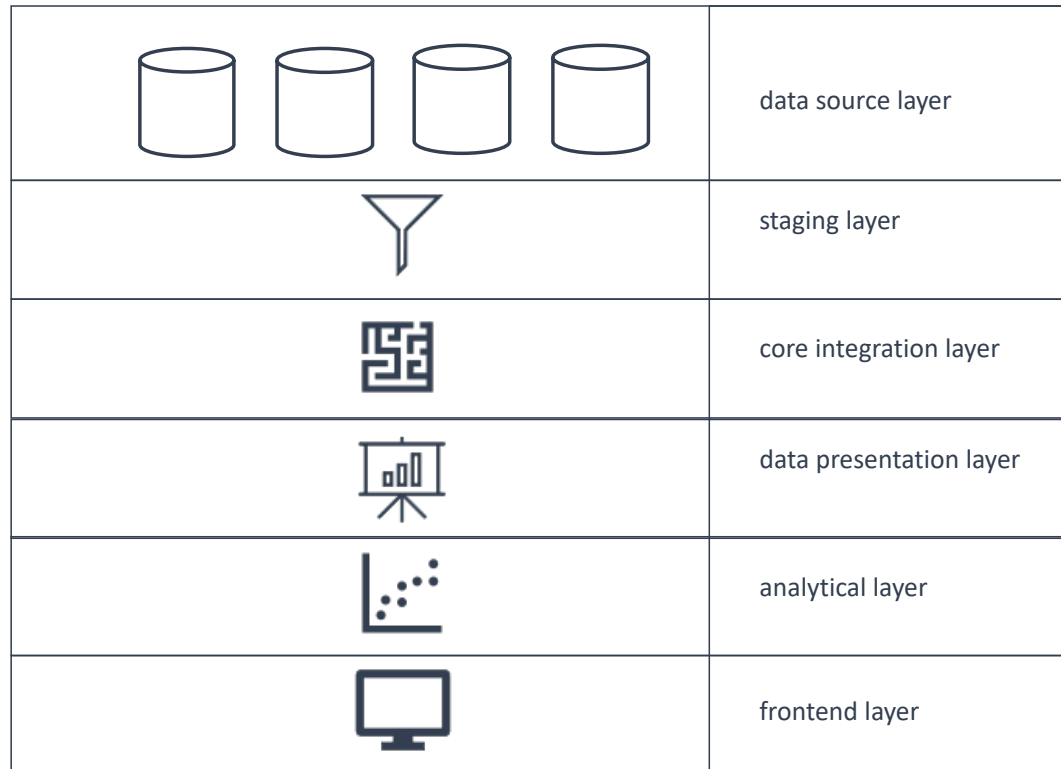


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# Technical Architecture of an LHS



Interoperable electronic health records

Extraction, Transform, Load ETL pipeline

Data warehouse

Data visualisation

Data analytics

Dashboard

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# Learning Health Systems: Example

## Example 1

The Veterans Health Administration belongs to the US Department of Veterans Affairs (VA), and is the largest integrated health care system in the country, which provides care at 1,255 health care facilities, including 170 medical centers and 1,074 outpatient sites of care [23]. It operates an extensive network of EHRs. A clinical data warehouse integrates patient data from local EHRs to make them available for application in a nationwide LHS. To improve the quality of care for veterans with a transient ischemic attack (TIA) and thus reduce the stroke risk, the VA started the PREVENT program as an LHS application [24]. The primary outcome is the provision of all types of care TIA patients are eligible for, e.g. anticoagulation therapy, brain imaging and carotid imaging, statin therapy. A dashboard serves as a hub for the LHS that integrates and visualizes data on the performance of a hospital site which allows benchmarking. The dashboard serves as a source of clinical guidelines and other educational and scientific material. It is intended to be used as a meeting place for teams from different locations in the VA and professions. When evaluating this system, the users appreciated the access to data and their integration as well as the opportunity to monitor the progress in their own department. They found that it motivated teams to drill down to individual cases when overall rates got worse or did not meet the expectations. This contributed to active team learning and establishing a community of practice across the organization involving providers from different departments and reaching a multidisciplinary approach to achieve quality improvements. The hub turned out to be a catalyst for learning how to learn [24].



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Rattray NA, Damush TM, Miech EJ, Homoya B, Myers LJ, Penney LS, Ferguson J, Giacherio B, Kumar M, Bravata DM. Empowering Implementation Teams with a Learning Health System Approach: Leveraging Data to Improve Quality of Care for Transient Ischemic Attack. *J Gen Intern Med.* 2020 Nov;35(Suppl 2):823-831. doi: 10.1007/s11606-020-06160-y.

# *Learning Health Systems: Task 1*

Please describe the LHS in Example 1 in terms of

- a) Organization involved
- b) Scale (local, regional, national ...)
- c) Type
- d) Health problem
- e) Overall aim of the LHS
- f) Technological systems involved
- g) Population of patients

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# Learning Health Systems: Data Analytics

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Analytical Method	Purpose	Examples
Descriptive statistics	Describe sample, obtain overview	Age distribution of patients in emergency department
Classical inferential statistics	Hypotheses testing	Do young physicians prescribe antibiotics more often than older physicians?
Data mining	Data exploration for new patterns, outliers (anomaly) detection, dependencies (associations, sequences)	Patient phenotyping, e.g. defining homogenous subgroups in obese patients
Time series analysis	Analysis of longitudinal data: detection of patterns and change, forecasting	Survival analysis of patients with full functional recovery from stroke, ARIMA time series models for forecasting the occupancy of ICU beds for COVID-19 patients
Machine Learning	Supervised learning, clustering, reduction of dimensions, structured prediction, anomaly detection, neural networks, reinforcement learning	Classification of chronic wounds from wound images, prediction of therapy outcomes



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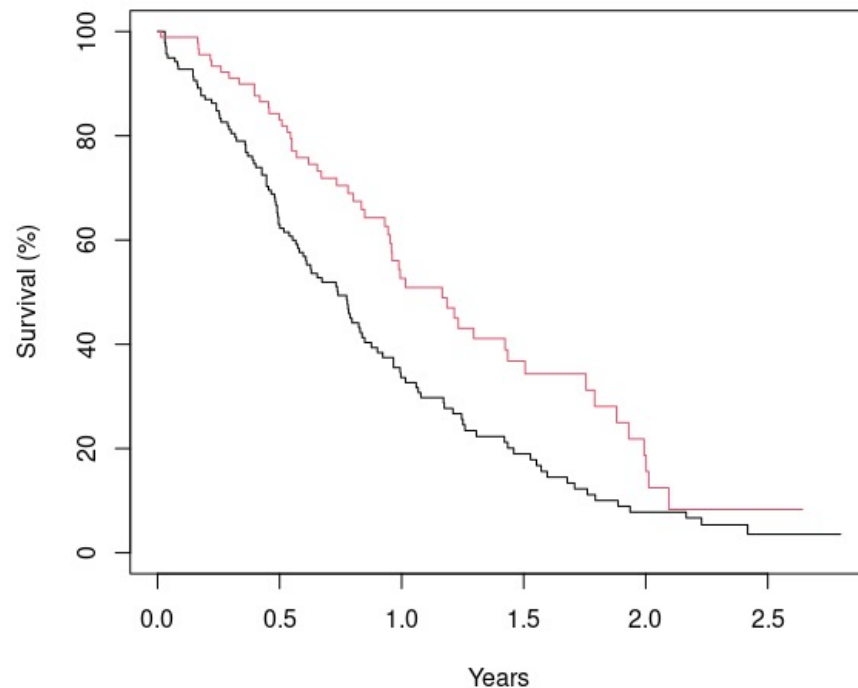
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Rauch J, Hübner U. Learning Health Systems: Concepts, Principles and Practice for Data-Driven Health. In: Hübner U, Wilson M. G., Shaw Morawski T, Ball MJ Nursing Informatics: A Health Informatics, Interprofessional and Global Perspective. Springer London 2021



# Survival Analysis of Lung Cancer Patients



Survival data for lung cancer patients (females in red, males in black) shown as a Kaplan-Meier curve. When the proportional hazards assumption holds, the curves for a factor are approximately parallel.

Data from:  
Therneau, Terry M., and Thomas Lumley. "Package 'survival.'" R Top Doc 128.10 (2015): 28-33.

Loprinzi CL, Laurie JA, Wieand HS, Krook JE, Novotny PJ, Kugler JW, Bartel J, Law M, Bateman M, Klatt NE, et al. Prospective evaluation of prognostic variables from patient-completed questionnaires. North Central Cancer Treatment Group. *Journal of Clinical Oncology*. 12(3):601-7, 1994.



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# Time Series Analysis: Forecast Drug Prescription



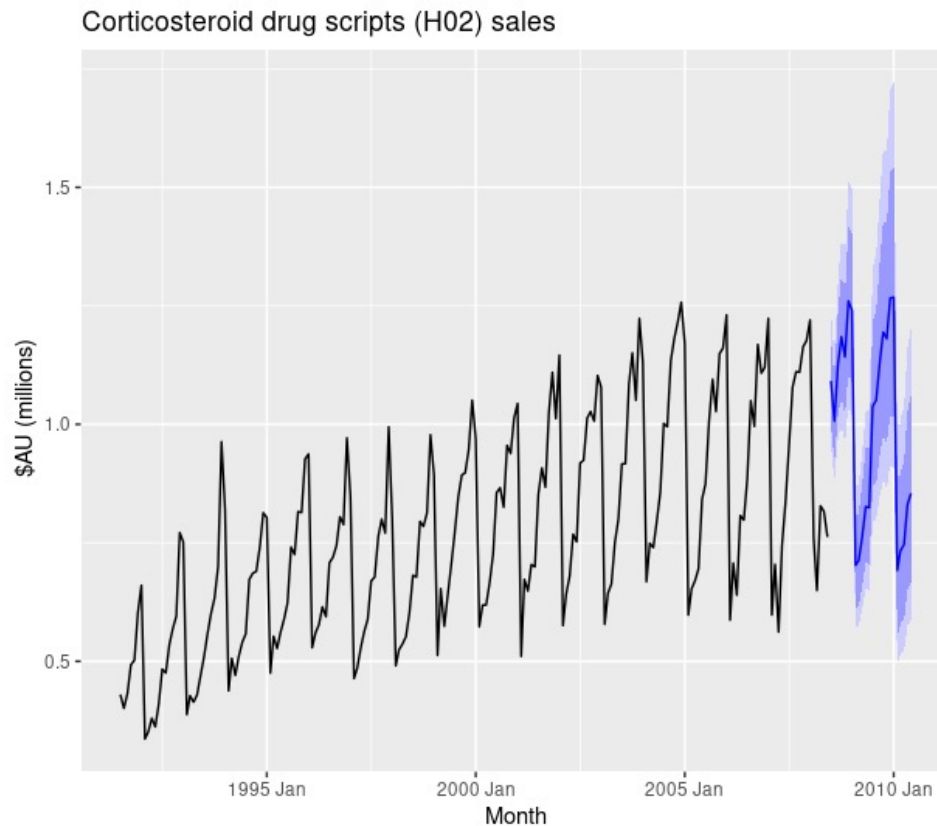
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Forecasts from an ARIMA model applied to monthly Australian corticosteroid (H02) prescription data.

Data from:  
Hyndman, Rob J., and George Athanasopoulos. Forecasting: principles and practice. OTexts, 2018.

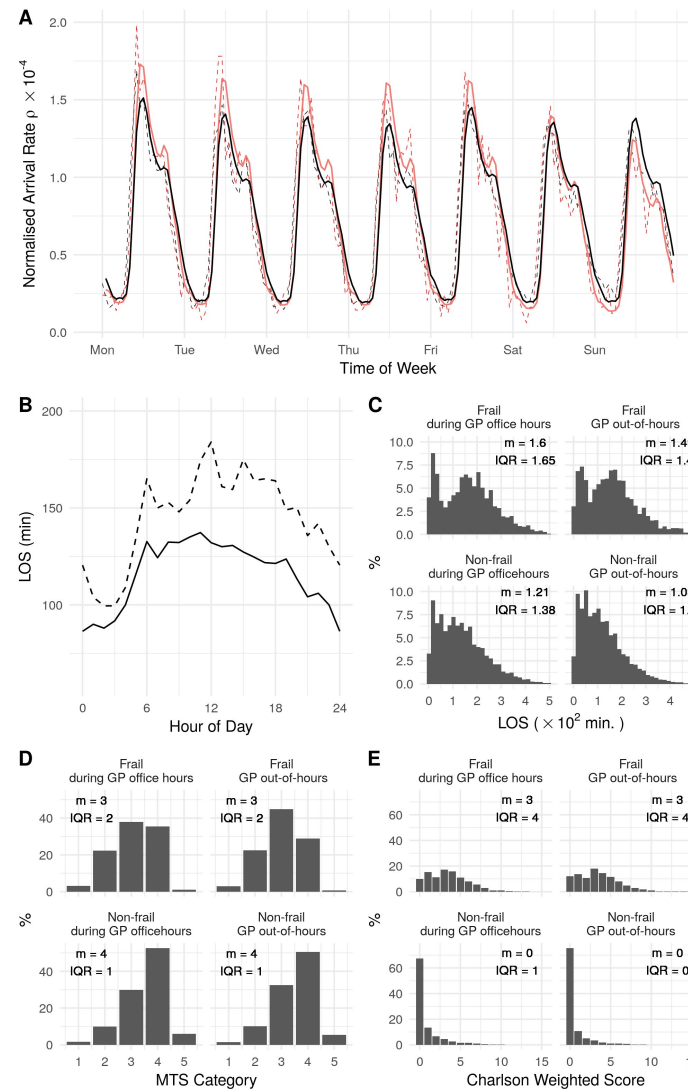
# Example: Frail patients in EDs

Setting: Emergency Department Klinikum  
Osnabrück Germany (Jan 2017 – Jul 2018)

	Non-frail	Frail	Total
Within GP hours	20,693	3,152	23,845
Outside GP hours	21,399	2,837	24,272
Total	42,092	6,025	48,117

**Figure 1.** Comparison of frail vs. non-frail patients by time of day. (A) Modelled (solid lines) and observed (dashed lines) normalised mean arrival rates to the ED (black: non-frail patients). (B) Median length of stay in the ED dependent on time of arrival (dashed line: frail patients). (C-E) Relative frequencies and medians ( $m$ ) and interquartile range (IQR) for LOS, triage (Manchester Triage System) and Charlson comorbidity score.

Rauch J, Denter M, Hübner U. Use of Emergency Departments by Frail Elderly Patients: Temporal Patterns and Case Complexity. Stud Health Technol Inform. 2019 Sep 3;267:215-223. doi: 10.3233/SHTI190830.



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# *Learning Health Systems: Task 2*

Discuss: What practical implications do these findings have regarding the organisation of the ED?

- a) Patient types
- b) GP Office hours
- c) Comorbidities
- d) Acuity (Manchester Triage System)

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## 1) Lesson: Recap Statistics

### ***This lesson contains 2 videos and 2 quizzes***

In this introductory lesson, we will discuss basic statistics, i.e., descriptive statistics, which is the foundation to learn from data through modelling, as we will see in upcoming sections.

If you are unfamiliar with this topic, it will give you a basic understanding of descriptive statistics.

 [Session 1 - Video: Recap Quantitative Research in Health Sciences - Data Structure and Variables](#)

In this video we reconsider some key concepts of quantitative research in health sciences. In this video we look how information (data) is structured and documented for quantitative analyses.

 [Session 1 - Quiz: Recap Quantitative Research in Health Sciences - Data Structure and Variables](#)

Quiz to test your knowledge on the topic **Data Structure and Variables**

 [Session 2 - Video: Recap Quantitative Research in Health Sciences - Descriptive Statistics](#)

In this video we reconsider key concepts of quantitative health sciences. This video revisits methods of descriptive statistics.

 [Session 2 - Quiz: Recap Quantitative Research in Health Sciences - Descriptive Statistics](#)

Quiz to test your knowledge on the topic **Descriptive Statistics**

 [Slides for the first lesson - Recap Statistics](#) Hochgeladen 31.05.2021 13:50


 [Forum: Recap Statistics](#)

This forum can be used for questions and exchange on the topic **Recap Statistics**

## 2) Lesson: Recap Linear Regression

**This lesson contains 6 videos and 6 quizzes**


This lesson introduces basic descriptive statistics and the use of linear regression models to describe linear patterns in the data.

 [Session 1 - Video: Linear Regression Introduction](#)

In this video we discuss how we can represent patterns in data using a simple line. This line is a model describing the data with only few values - the parameters (intercept and slope).

 [Session 1 - Quiz: Linear Regression Introduction](#)

Quiz to test your knowledge on the topic **Linear Regression Introduction**

 [Session 2 - Video: Linear Regression Assumptions](#)

We can represent pattern in the data with a simple linear regression model - thats simply a line representing the trend. However, some assumptions must hold true to use a linear regression as a representation of the data. In this video we will discuss these assumptions.

 [Session 2 - Quiz: Linear Regression Assumptions](#)

Quiz to test your knowledge on the topic **Linear Regression Assumptions**

 [Session 3 - Video: Linear Regression Model Validation](#)

With a linear model we can represent the data and identify trends and relationships. However, only valid models provide our understanding of the relationships. In this video we discuss methods to validate the model.

 [Session 3 - Quiz: Linear Regression Model Validation](#)

Quiz to test your knowledge on the topic **Linear Regression Model Validation**

 [Session 4 - Video: Linear Regression Coefficient Interpretation](#)

The linear model describes patterns and relationships through its parameters - the coefficients. The coefficients of a linear model carry meaning and can be interpreted to identify the relationship between the independent variable and the dependent variable. In this video we discuss the interpretation of the model coefficients.

 [Session 4 - Quiz: Linear Regression Coefficient Interpretation](#)

Quiz to test your knowledge on the topic **Linear Regression Coefficient Interpretation**

 [Session 5 - Video: Linear Regression - Multivariable Regression](#)

In this video we discuss the linear regression model that uses the information of two or more independent variables to explain the dependent variable y. We learn about continuous and categorical variables and their interpretation. Furthermore, we discuss the features of multi-variable regression.

 [Session 5 - Quiz: Linear Regression - Multivariable Regression](#)


Quiz to test your knowledge on the topic **Linear Regression - Multivariable Regression**

 [Session 6 - Video: Linear Regression Applied in SPSS](#)

In this video we will see how we can create a linear regression model in SPSS. We will look at continuous and categorical variables. Furthermore, we will see how we validate the model and check the assumptions thereof.

 [Quiz: Use-Case for closing the session](#)

 [Exercise Data For Linear Regression](#) Hochgeladen 31.05.2021 13:00

 [Slides for the second Lecture "Data Modeling with Linear Regression"](#) Hochgeladen 31.05.2021 13:54

 [Forum: Recap Linear Regression](#)

This forum can be used for questions and exchange on the topic **Recap Linear Regression**



### 3) Lesson: Odds Ratio and Case-Control Studies

**This lesson contains 5 videos and 5 quizzes**

Learn about Odds Ratios and their use cases in clinical research. First part of video series that explains logistic regression for clinical data analysis.

 [Session 1 - Video: Relationship between two binary variables](#)

Introduction to the analysis of potential relationships between two binary variables.

 [Session 1 - Quiz: Relationship between two binary variables](#)

Quiz to test your knowledge on the topic **Relationship between two binary variables**

 [Session 2 - Video: Relationship between two binary variables \(Relative Risks and Odds Ratios\)](#)

In this video, we will see how statistics such as relative risks and odds ratios quantify the relationship between two binary variables. Relative risks and odds ratios will show us if ice-cream consumption and sunny weather is actually related.

 [Session 2 - Quiz: Relationship between two binary variables \(Relative Risks and Odds Ratios\)](#)

Quiz to test your knowledge on the topic **Relationship between two binary variables (Relative Risks and Odds Ratios)**

 [Session 3 - Video: Odds Ratios in Case-Control Studies](#)

This video explains why odds ratios are so popular in clinical research and especially in case-control studies.

 [Session 3 - Quiz: Odds Ratios in Case-Control Studies](#)

Quiz to test your knowledge on the topic **Odds Ratios in Case-Control Studies**

 [Session 4 - Video: Confidence Intervall of Odds Ratios](#)


Are two binary variables associated? This key question is not answered by the calculated odds ratio but by its confidence interval! We look at how we obtain and interpret the confidence interval to answer the question of correlation.

 [Session 4 - Quiz: Confidence Intervall of Odds Ratios](#)


Quiz to test your knowledge on the topic **Confidence Intervall of Odds Ratios**

 [Session 5 - Video: Use Cases for Odds Ratios](#)

In addition to case-control studies, odds ratios are also applicable in other clinical research use cases. In this video, we will look at two further use cases and learn that logistic regression, a popular statistical method used in clinical research, plays a central role in this context.

 [Session 5 - Quiz: Use Cases for Odds Ratios](#)

Quiz to test your knowledge on the topic **Use Cases for Odds Ratios**

 [Slides for the third lesson: "Odds Ratios and Case Control Studies"](#) Hochgeladen 31.05.2021 13:56


 [Forum: Odds Ratio and Case-Control Studies](#)

This forum can be used for questions and exchange on the topic **Odds Ratio and Case-Control Studies**

## 4) Lesson: Logistic Regression

This lesson contains 8 videos and 7 quizzes


How can we model the relationships using a binary outcome variable? One way is to use logistic regression which is a statistical model. In this lesson you will learn about logistic regression. We will explore its use-cases, the model structure, the model creation and assumptions and the models interpretation.

 [Session 1 - Video: What is logistic regression?](#)

In this video we learn what a logistic regression is and in what situation this statistical method is useful.

 [Session 1 - Quiz: What is logistic regression?](#)

Quiz to test your knowledge on the topic **What is logistic regression?**

 [Session 2 - Video: The Logistic Regression Model](#)

In this video we start with simple linear regression models. Based on this model we explore the idea of the logistic regression model that builds on linear regression models.

 [Session 2 - Quiz: The Logistic Regression Model](#)

Quiz to test your knowledge on the topic **The Logistic Regression Model**

 [Session 3 - Video: Logistic Regression and Odds](#)

In this video we will learn about the logit, a central concept in logistic regression.

 [Session 3 - Quiz: Logistic Regression and Odds](#)

Quiz to test your knowledge on the topic **Logistic Regression and Odds**

 [Session 4 - Video: Logistic Regression and Maximum Likelihood](#)

In this session, we will see how we construct a logistic regression model from clinical data. The task is, to find the model that best fits the data. We will learn how to obtain this model!

 [Session 4 - Quiz: Logistic Regression and Maximum Likelihood](#)

Quiz to test your knowledge on the topic **Logistic Regression and Maximum Likelihood**

 [Session 5 - Video: Logistic Regression Coefficients](#)

A statistical model has coefficients, that define the model and carry meaning. We will learn how to interpret the coefficients to make sense of our logistic regression model.

 [Session 5 - Quiz: Logistic Regression Coefficients](#)

Quiz to test your knowledge on the topic **Logistic Regression Coefficients**

 [Session 6 - Video: Logistic Regression and Odds Ratios](#)


The coefficients of logistic regression can be actually interpreted as odds ratios. In three use-cases, you will learn to interpret odds ratios of logistic regression models.

 [Session 6 - Quiz: Logistic Regression and Odds Ratios](#)

Quiz to test your knowledge on the topic **Logistic Regression and Odds Ratios**

 [Session 7 - Video: Does the Odds Ratio indicate a relationship? Confidence Intervals of OR explained](#)

With logistic regression, we obtain odds ratios which quantify the relationship between the independent variable and the binary outcome. The key question is if we can infer that the odds ratio is actually different from one. To confidently make a claim about the relationship, we interpret the confidence interval. In this video we understand how to handle confidence intervals.

 [Session 7 - Quiz: Does the Odds Ratio indicate a relationship? Confidence Intervals of OR explained](#)

Quiz to test your knowledge on the topic **Does the Odds Ratio indicate a relationship? Confidence Intervals of OR explained**

 [Session 8 - Video: Assumptions for a Logistic Regression Model](#)

To make valid inferences from the model regression coefficient some assumptions must hold true. We will explore these assumptions

 [Slides for the fourth lesson: "Logistic Regression"](#) Hochgeladen 31.05.2021 13:58

 [Excel Data used in the Lecture to explain Logistic Regression](#) Hochgeladen 31.05.2021 14:16

In this file, you find the information that is used in the sessions throughout the lecture about logistic regression.

 [Forum: Logistic Regression](#)


This forum can be used for questions and exchange on the topic **Logistic Regression**



## 5) Lesson: Applied Logistic Regression in SPSS

**This lesson contains 7 videos and 1 quiz**


In this lesson we learn about use-cases of Logistic Regression in Health Sciences and see how we can compute Logistic Regression with the statistical software program SPSS.

 [Session 1 - Video: Logistic Regression Use Cases](#)

Logistic regression is a popular statistical model in clinical research. In this video we demonstrate its use in research, patient care, and public health.

 [Session 1 - Quiz: Logistic Regression Use Cases](#)

Quiz to test your knowledge on the topic **Logistic Regression Use Cases**

 [Session 2 - Video: Logistic Regression Use Cases \(2\)](#)

Logistic Regression models the relationship between a binary outcome variable and independent (explaining) variables. We will look at concrete use cases of logistic regression in clinical research.

 [Session 3 - Video: Applied Logistic Regression in SPSS with continuous independent variable](#)

This video demonstrates the use of a logistic regression model in SPSS using a continuous variable.

 [Session 4 - Video: Applied Logistic Regression: Make sense of units in logistic regression](#)

We demonstrate how we can deal with units in logistic regression using SPSS. The odds ratio is the factor by which the odds change when the independent variable increases by one unit. However, for continuous variables it is often hard to make sense of the meaning of odds ratios. However we can edit units of the continuous variables to obtain more interpretable odds ratios. This video demonstrates the process using a clinical example.

 [Session 5 - Video: Applied Logistic Regression with a binary dependent variable in SPSS](#)

In many cases, simple 2 by 2 frequency tables can be used to calculate odds ratios to quantify the relationship between two binary variables. However, logistic regression is able to do so as well. We will demonstrate this in SPSS.

 [Session 6 - Video: Applied Logistic Regression: Include confounder variables in a model](#)

To account for potential confounding, we can use multiple logistic regression which has two or more independent variables. We show, how we can use SPSS to adjust the effect of family history of cardiovascular diseases on coronary heart disease by including the continuous variable BMI as confounder as a second independent variable.

 [Session 7 - Video: Applied Logistic Regression: Include confounder variables in a model](#)

Smoking is a risk factor for heart disease. How does the risk change with respect to a Non-Smoker if I start smoking casually and how does the risk change with respect to a Non-Smoker when I start to smoke heavily? In this video we will explore how we can create categorical variables in SPSS to use them as dummy variables in a logistic regression model. Then, we learn how we can interpret the logistic regression model to answer questions stated above.

 [Exercise Data for Logistic Regression - The South African Hearth Disease Dataset](#) Hochgeladen 31.05.2021 14:12

This file contains data about South African Men and Information about their Heart Disease Status and related variable.

 [Slides for the fifth lesson: "Applied Logistic Regression"](#) Hochgeladen 31.05.2021 14:06

 [Forum: Applied Logistic Regression in SPSS](#)

This forum can be used for questions and exchange on the topic **Applied Logistic Regression in SPSS**

## 6) Lesson: Prediction Models using Logistic Regression

Logistic Regression is an indispensable tool for health science to describe and detect patterns between variables.

In this context, Logistic Regression can be used for prediction purposes, when patterns are in the data. For example, using patient data, Logistic Regression helps to identify risk patients and thus guide and support clinicians in their decision making.

In this lesson, we discuss the use-case of prediction and clinical decision making with logistic regression.

### [Session 1 - Video: Prediction Models and Effect Estimation](#)



In general, regression models can be used for two main use-cases. Identify potential relationship and estimate individual risks. First, effect estimation or relationship analysis in which the association between the independent variables with the dependent variable is quantified. In this way, potential risk factors, preventive factors or effective treatments can be identified. The second use-case is the "prediction" of individual risks. In this context, the independent variables are considered as predictors. Based on these predictors, the probability of the outcome is estimated. The estimation results can be used in a clinical context for clinical decision support. Data that is stored electronically can be for individual risk estimation.

### [Session 2 - Video: Model Validation: The Area Under The Curve explained](#)



Having multiple sets of predictors at the disposal, different prediction models can be created. To find the model with the highest validity, we compare the models using the area under the receiver operating curve. This statistics quantifies the predictive performance.

### [Session 3 - Video: Logistic Regression Model Validation in SPSS: AUC in SPSS](#)



In this video you will learn how a AUC curve statistic is computed using SPSS. Furthermore, this video introduce Ockham's razor and explain its role in statistical modeling.

### [Session 4 - Video: Predictor preprocessing and Model Design for Clinical Decision Support](#)



In this video, we look at the different kinds of predictors and how predictor preprocessing helps to improve the model's useability.

### [Slides for the sixth lesson: "Prediction Models"](#) Hochgeladen 31.05.2021 14:05



### [Forum: Prediction Models](#)

This forum can be used for questions and exchange on the topic **Prediction Models**

# eHealth4all@EU Summer School

## Learning Health System in Action – Clinical

### Data Analytics

#### Use-Case

You are a researcher in a hospital which is part of a hospital organization with six other hospitals. Your job is to support the medical staff to plan and conduct data analysis on their data.

The diabetology department is interested in the potential risk factors for diabetes of patients in the hospital. As a researcher, you join an initiative of the medical informatics staff and the diabetology department to answer the questions of potential risk factors.

You suggest analyzing last year's data from the hospital's electronic health record.

Furthermore, you recommend using a case-control study design. The medical informatics department conducts the ETL process and thus provides the data for analysis. Luckily, the department of informatics pre-processed the data already! So, you do not have to bother with this notoriously time-consuming task. Instead, you can start right away, analyzing the data.

## Data Analytics Lab – Day 1: „Risk Factor Analysis“

### Description

In this **Data Analysis Lab**, you and your group will analyze a realistic (however not real) clinical dataset. The aim is to investigate potential risk factors of diabetes with this dataset.

The main challenge is to build a statistical model to obtain information about potential risk factors. Additionally, you find further the sub-tasks below. Your result is a PowerPoint presentation that contains your presentation. On day two of the workshop, we randomly select a group that presents the results. (~ 15 minutes). Afterward, all participants are invited to contribute their results and participate in a discussion shortly.

### Tasks

- 1.) **Describe the study/ research design in brief bullet points! What are the advantages of the present study design? What are its limits? What other alternative designs?**

(Note the content of [Lesson 3 – Especially the Video 3: Odds Ratios in Case-Control Studies](#))

- a. What is the broad research question?
  - b. What is the outcome in this data analysis task?
- 2.) **Take a look at the dataset and construct at least three hypotheses about potential relationships.** Do potential confounders exist? Describe and consider them, if necessary, and use a multivariate model. Otherwise, when you do not consider any cofounder variables, try a univariate model
    - a. For confounding, note the content of [Lesson 3: Session 5 Use Cases for Odds Ratios](#) and [Lesson 5: Session 6 Applied Logistic Regression](#)
  - 3.) Present your hypotheses.
  - 4.) What is the outcome variable in the model (dependent variable)?
  - 5.) What are the predictors (independent variables)?



- 6.) **Describe the dataset. Use descriptive statistics to do so, especially consider using visualizations.** For this, use SPSS.
- 7.) Test your hypothesis: Create three distinct statistical models to investigate one potential risk factor of diabetes in each model and explain the relationship between the outcome and the risk factors (Consider Odds Ratios).
- a. Interpret the model coefficients
  - b. Consider transforming the unit of a variable, if this supports the coefficient's interpretation ([Lesson 4 Session 4 - Video: Applied Logistic Regression: Make sense of units in logistic regression](#))
- For Logistic Regression in SPSS see: [Lesson 5 Session 3: Applied Logistic Regression in SPSS with continuous independent variable](#) and [Lesson 5 Session 5: Applied Logistic Regression with a binary dependent variable in SPSS](#)
- 8.) Pick a risk factor and describe the relationship in more detail ([Lesson 5 Session 6 - Video: Logistic Regression and Odds Ratios](#))
- a. Use a concrete patient example to explain the relationship (how does the probability change when the predictor changes?)
  - b. Consider using visualizations to support your explanations (such as the logistic curve)
- 9.) Close with a conclusion where you summarize and discuss (strengths, limitations of your analysis) your results.

# eHealth4all Summer School

## Learning Health System in Action – Clinical Data Analytics

### Use-Case – Data Analytics Lab of the eHealth4all Summer School

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You suggest analyzing last year's data from the hospital's electronic health record.

Furthermore, you recommend using a case-control study design. The medical informatics department conducts the ETL process and thus provides the data for analysis. Luckily, the department of informatics pre-processed the data already! So, you do not have to bother with this notoriously time-consuming task. Instead, you can start right away, analyzing the data.

## Data Analytics Lab – Day 2: „Create a Prediction Model“

### Description:

**In this Data Analytic Lab you will create two logistic model and discuss them.** Your job is to create a **logistic regression model that predicts the individual diabetes risk** for a patient based on a set of suitable predictors.

In both models, you will again use the *diabetes-dataset*. However, you will use two different approaches to fit the model.

**For the first model, you will use the knowledge from the first Data Analytic Lab and create a model.** Which factors were associated with the outcome? Use them to create a multivariate prediction model.

**For the second model, you will use Forward- or Backward selection,** to automatically select the set of predictors for your diabetes risk prediction model.

### Main Tasks:

1. Upon your knowledge from the previous Data Analytics Lab. “Risk Factors” build a multivariate logistic regression model to predict the diabetes outcome variable. Explore models with different predictors (independent variables) to find your final model.
  - a. Create a regression table to show the model coefficients
  - b. Explain and interpret the model coefficients
2. Validate the model on the data using the AUC statistic (AUC curve). Visualize the curve.
3. Discuss a potential use-case of your model:
  - a. How will use the model (target group)? Will the model be easy to use for the target or easy to implement in clinical processes?

### Optional Tasks

1. Create a model using back- or forward selection in SPSS

- a. Show and interpret the regression table
  - b. Compute the AUC statistic to compare the models
  - c. Compare and discuss this model with your previous model. Do they differ with respect to the predictors? Which model is the easiest to use model? What are the disadvantages and advantages?
2. Add descriptive statistics that describe your dataset (you can use the statistics you created in the first data analytics lab)
  3. **Discuss your work in a broader manner.** Where can this research be embedded in a Learning Health System? Consider what role the hospital may play in a learning health system (you can use the resources Ursula Hübner has provided in the Kick-Off meeting, you find in on the Moodle platform).
    1. Which parameters can be collected in a learning health system in a next learning cycle? Please make suggestions based on the results and your experiences.