



Digital Health Data Exchange

Borchert, Dr. Schapranow
Data Management for Digital Health
Winter 2023

Agenda

Pillars of the Lecture

Medical Use Cases



Biology Recap



Oncology



Nephrology



Infectious
Diseases

Technology Foundation



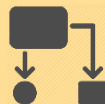
Data
Sources



Data
Formats



Processing and
Analysis



Software
Architectures

Machine Learning

Data



Refine

Evaluate



Prediction +
Probability

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2

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Medical Use Cases



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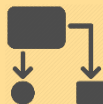
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ML



Evaluate



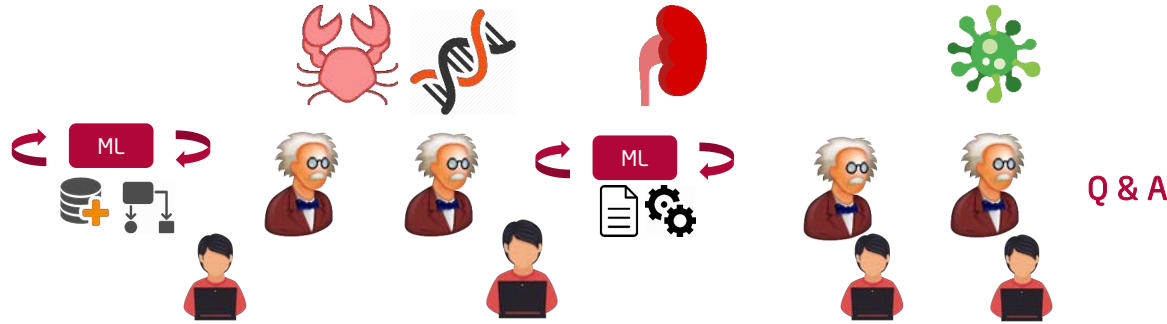
Prediction +
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3

Lecture Schedule



Final Exam
Feb 13, 2024
11:00am,
Lecture Hall HS1

Nov

Dec

Jan

Feb

- Lecture Kickoff
- Actors in Healthcare
- Digital Health Data

- Machine Learning (ML) Foundations
- Use Case Oncology
- Biology Recap

- Natural Language Processing
- Use Case Nephrology & Intensive Care
- Supervised ML & Deep Learning

- Use Case Infectious Diseases
- Unsupervised ML

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Agenda

- Definitions: EMR, EHR, PHR, ...
- Sources of digital health data
 - Hospitals
 - Practices
 - Insurance companies
- Interoperability
- Use of personal health information

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Terms you should know



EMR



EHR



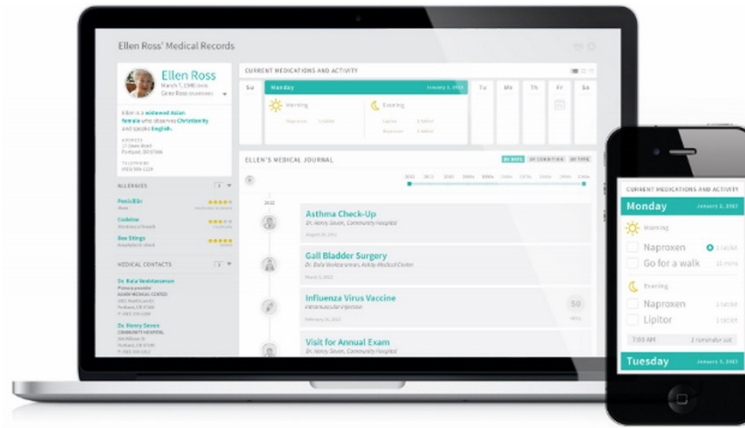
PHR

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7

Electronic Medical Record

- **Electronic Medical Record (EMR) :=**
Enabling technology, “just” electronic form of traditional (clinical) medical records
- Examples: medical history, diagnoses, medications, immunization dates, allergies
- Pro: Allows easy assessment of longitudinal data in digital form
- Cons:
 - Often limited to a single practice,
 - No process optimization,
 - No focus on compatibility & exchange with other systems



<https://www.theverge.com/2013/1/28/3925734/is-nightingale-the-future-of-user-friendly-medical-records>



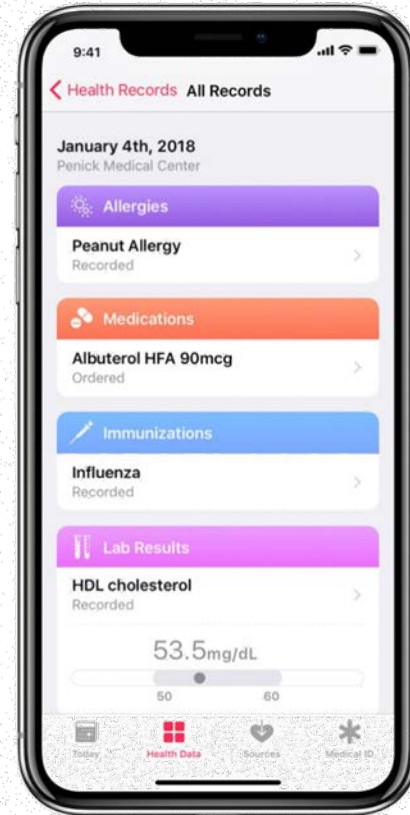
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8

Electronic Health Record

- **Electronic Health Record (EHR)** := Digital record of health information, typically combining data from multiple sources
- Focuses on the overall health of a patient to optimize healthcare processes
- Pros:
 - Broader view of care including overall past medical history, EMR data, lab data, imaging reports
 - Facilitates data sharing outside the practice with other health care providers such as laboratories and specialists
- Cons:
 - Guaranteed access to data
 - Compatibility between individual EHRs

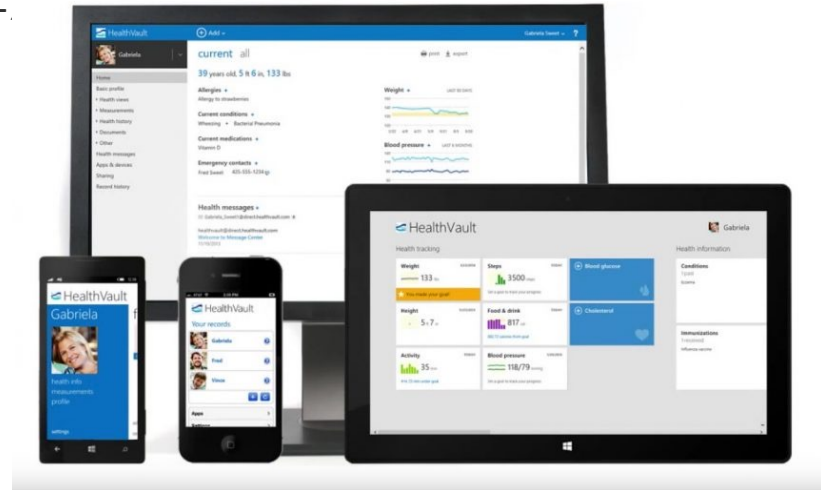


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Personal Health Record

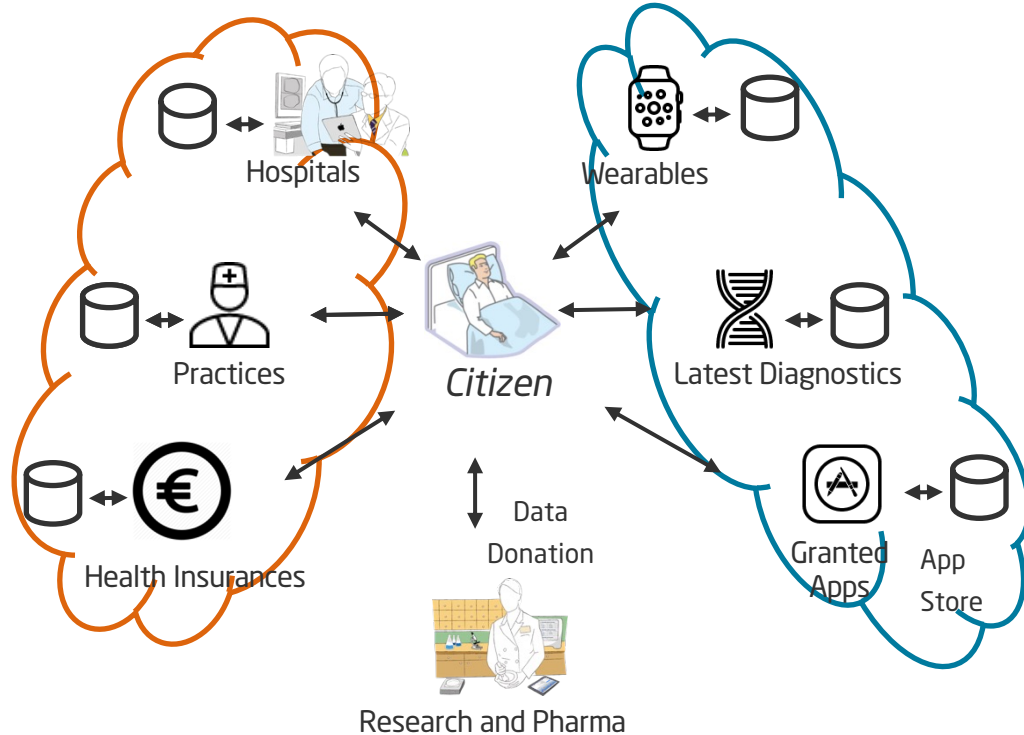
- **Personal Health Record (PHR)** := Collection of health information, typically maintained by the user and not necessary a medical professional
- Examples:
 - Microsoft HealthVault (discontinued since 2019)
 - Google Health (discontinued 2011)
- PHR is dead



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Recap: Healthcare System and Healthcare Data

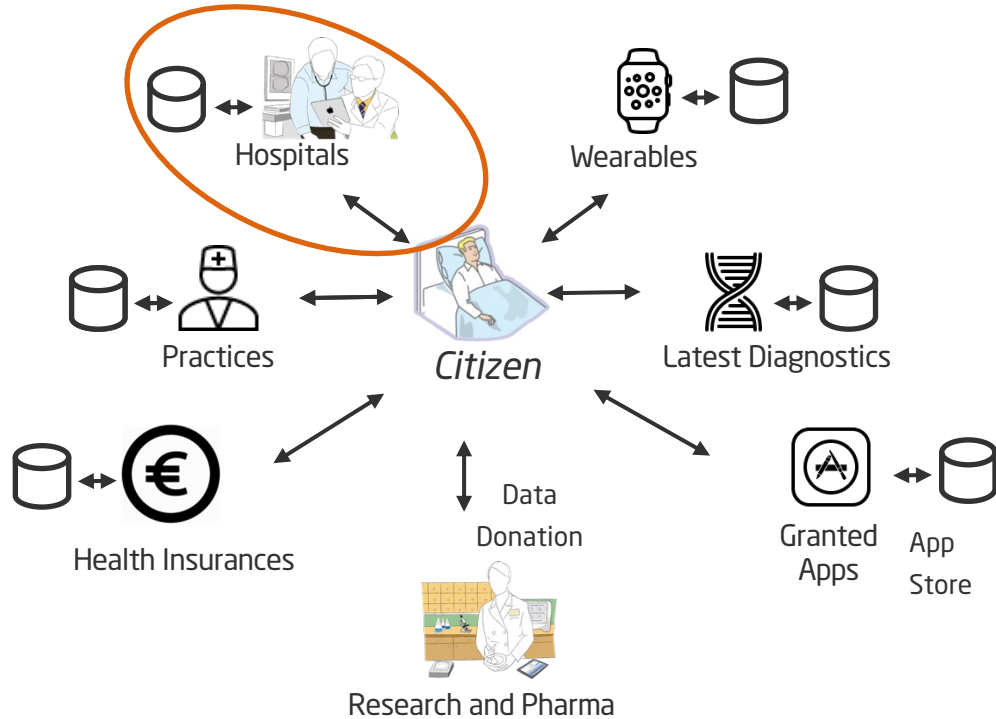


- Each actor has an individual view on or data of the citizens resp.
- Actors need to exchange specific data with each others via secured methods
- Risk: Data might get scattered across silos of individual actors
- Legal regulations for data exchange and data use are required
- Bear in mind: Specific regulations for each side of the medal

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Sources of Digital Health Data: Hospitals



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Hospital Enterprise Functions

Tasks of a Hospital?

Hint: There is much more than just patient care...



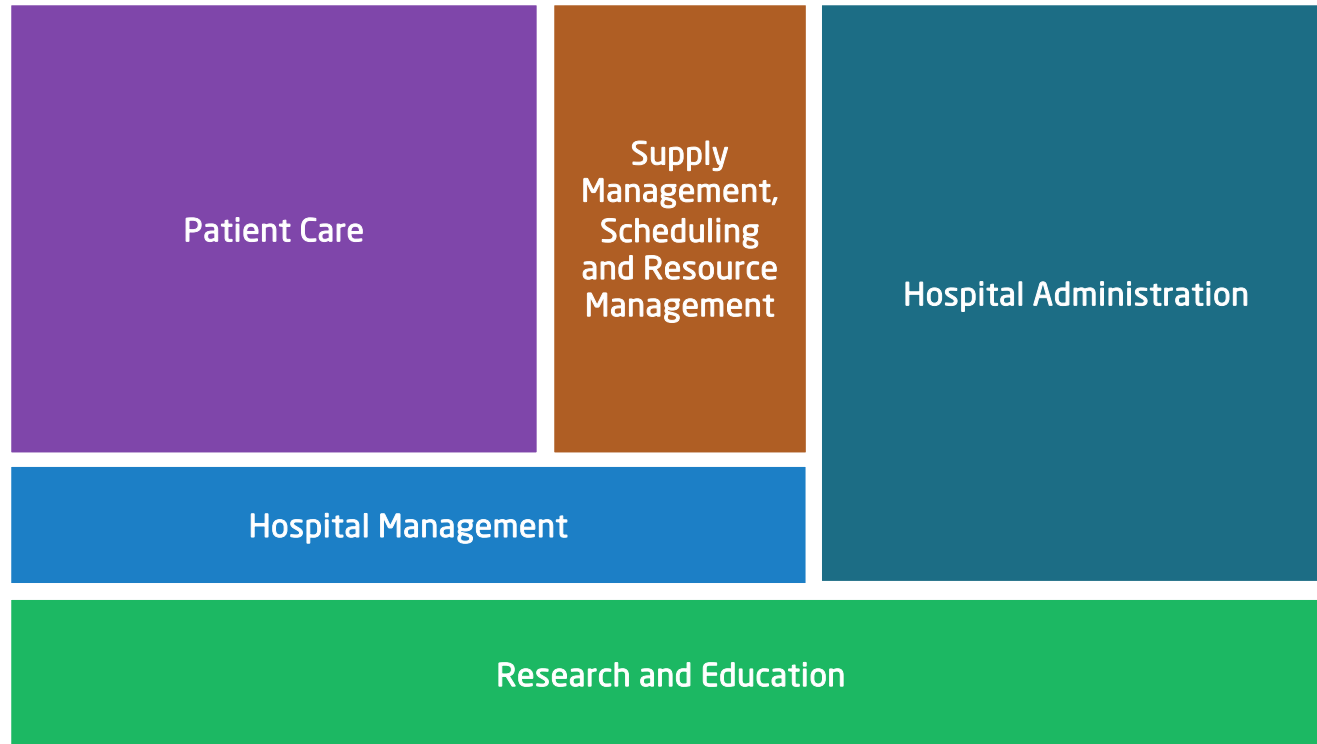
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Hospital Enterprise Functions

What does a Hospital do?







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Hospital Enterprise Functions: Patient Care





Entity type	Description
 Patient	Subject of care; information about a patient includes the patient identification number (PIN)
 Case	Hospital stay from patient admission to patient discharge or several ambulatory treatments related to one disease; information about a case includes the case identification number (CIN)
 Order	Request for a diagnostic, therapeutic or drug service, e.g. a laboratory order or a radiological order
 Diagnosis	Identified cause or nature of a disease or medical condition

Typical entity types representing certain object classes and data related to the patient and his or her histories.

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Hospital Enterprise Functions: Resource Management





Entity type	Description
 Appointment	Determines what persons have to be at a specific time/place.
 Bed	Must be managed according to its occupation.
 Health care professional	Treats patients according to his or her specialization (e. g. nephrology or pediatrics) with certain diagnoses.
 Drug	Substance administered to a patient for treatment, diagnosis or prevention

A hospital must guarantee that all resources needed for patient care are available continuously.

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16

Hospital Enterprise Functions: Administration

Entity type	Description
 Patient record archive	Central location for patient records.
 Classification	Consists of a set of classes summarizing concepts not to be distinguished during analysis.
 Classification of diagnoses	For example: International Classification of Diseases (ICD).
 Cost unit	Details about entity responsible for reimbursement of costs.

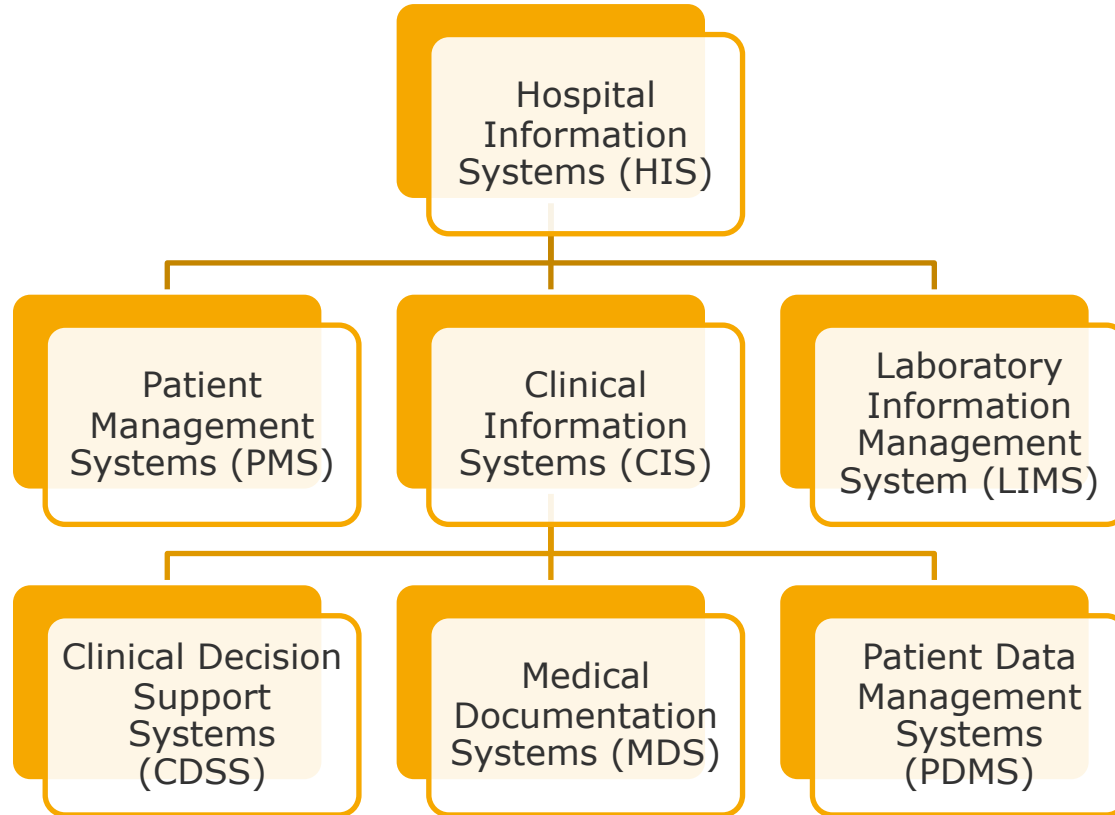
In addition to information about resources, hospital administration needs access to the following entity types.

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17

Hospital Information Systems (Excerpt): A Hierarchy of IT Systems

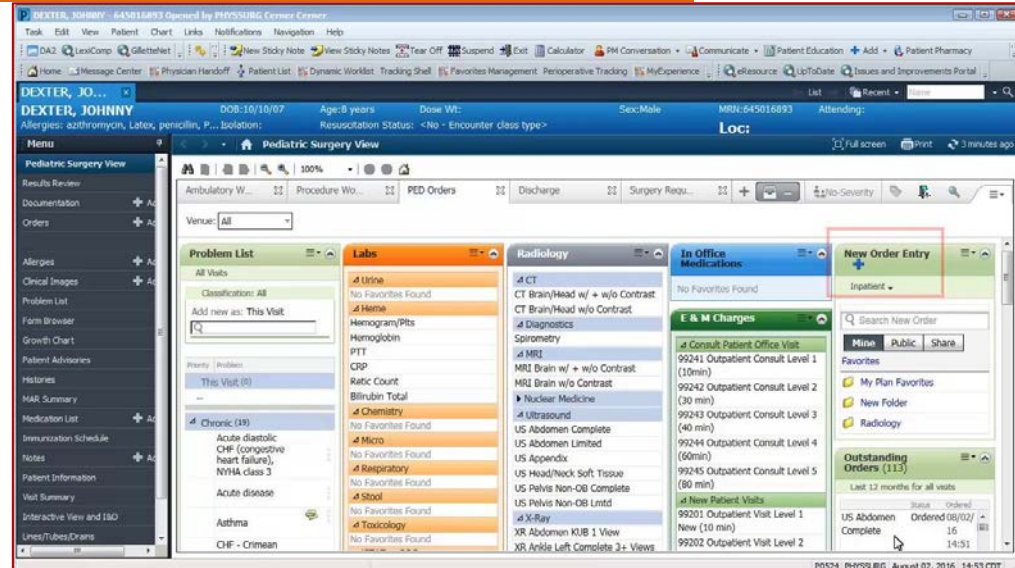


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18

Hospital Information Systems: Definitions

- **Hospital Information Systems (HIS) :=**
Describes all major IT systems within a hospital
- **Clinical Information Systems (CIS) :=**
Stores and manages data for patient care
- **Clinical Decision Support Systems (CDSS) :=**
Supports medical experts on therapy decisions



Cerner Overview Patient Chart

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Hospital Information Systems: Patient Management System (PMS)

- Aim: Patient admission, discharge, billing
- Access to latest, complete, and correct administrative patient data
- Application components must be able to transmit relevant administrative patient data

Gruppe: "AE Daimler Chrysler Gewo" (174)

Kostentraeger | Vers.-Nr. | BKZ | MSNR | BNR | Paragraph | VIP

DRV Bund | A3 | 0 | 3182720M191 | 1050 | 10A1 | 01

Nr. / Erfassung: 205056 | 01.03.2007 | Telefon: 0815 123456

Fallnummer: 205056 | 1 Stationär | Email: Claus.rueckert@itr-Softwa

Name: Medica22 | Geb.-Datum: 30.11.1968 | 45 Jahre, 1 M.

Vorname: Düsseldorf | Nationalitaet / Sprache: | Geschlecht / Konfession: m /

Titel: Dr. | Familienstand: ledig | Verpfl.: VP

c/o: | + Erw. Begleitpers.: 1-ÜF | Kind: | Submandant: GZ

Strasse: Kreuzhofstr. 1 | Wohnort: Lindenberg/Allgäu | Beschwerde liegt vor

Bewilligung: 15.01.2009 | 12301168M12310A | Begleitperson zu: | Abrechn. Gruppe: |

Datum	Art	Aufnahme	Transportmittel	Info	C1	C2	C3	C4
20.02.2009 00:00	0101	Krankenhaus	KTW		1,00	0,00	0,00	0,00
19.03.2014 08:00	022							

Voraussichtlich bis: . .

Reha-Art: 1-Reha | Verordnung: wird verlängert | Familien-Nr: 4711 | <<>> Pflegesatz RV

Pat-Art: Dialysepatient | Pflegebett | Rollstuhlpatient | Blind | Zi-Nr. / Stat. / Tel.: 026 B1 S10 609 DZS

Indikation: Orthopedics | Rehadauer: 3 Wochen | Stationaere Tage: 1853

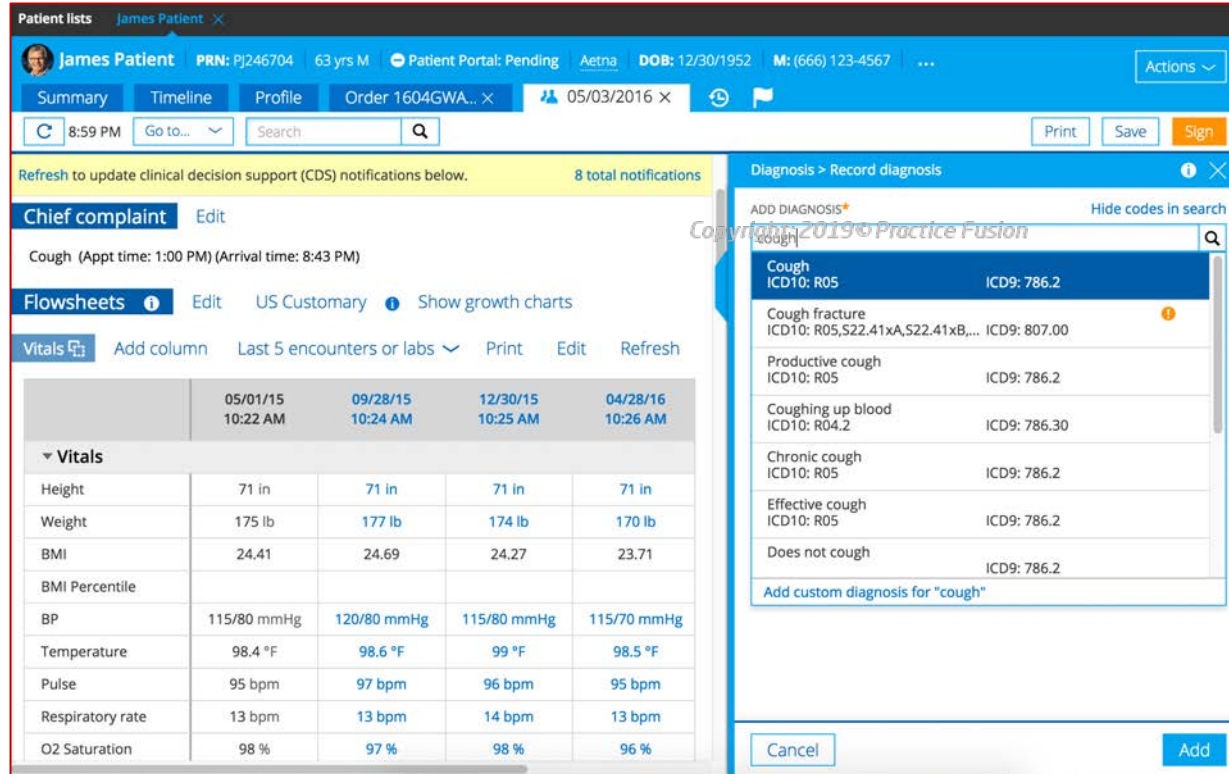
Info-Feld: F1: Aufnahmeverlauf | Besondere Wuensche: important for hotel-clinics where the patient has a lot of special wishes. | Wiedervorlage: . .

Letzter Zugriff: itr | Letztes Datum: 28.01.2014

Plan | KV-Karte

Hospital Information Systems: Medical Documentation System (MDS)

- Aim: Supports medical documentation (time- and process-optimization)
- Provides functions like speech-to-text, reuse of already documented data
- Coding of diagnoses and procedures, must provide an easy search system
- Today: documentation is consider a liability aspect, only



The screenshot displays a patient record for James Patient (PRN: PJ246704, 63 yrs M). The interface includes a navigation bar with tabs for Summary, Timeline, Profile, and Order 1604GWA... The patient's date of birth is 12/30/1952, and their phone number is (666) 123-4567. The current date is 05/03/2016. The main content area shows the Chief complaint: "Cough (Appt time: 1:00 PM) (Arrival time: 8:43 PM)". Below this is a Vitals section with a table of data for four dates: 05/01/15, 09/28/15, 12/30/15, and 04/28/16.

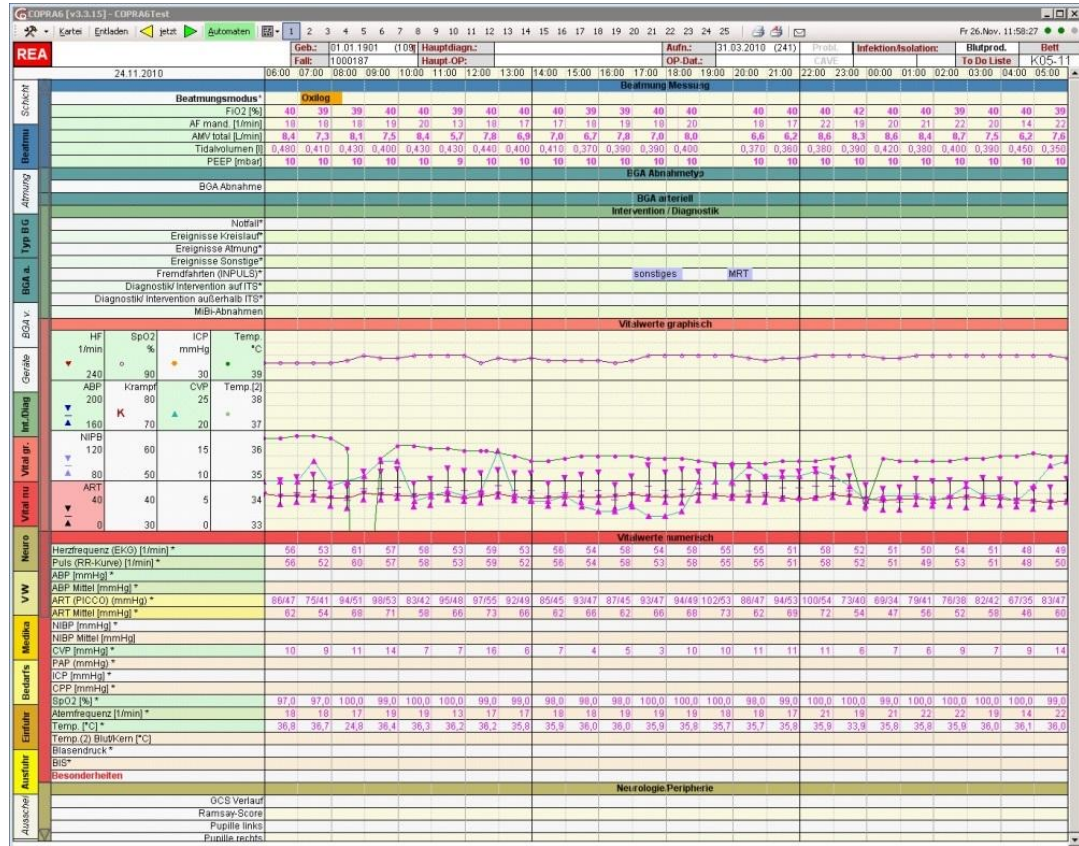
	05/01/15 10:22 AM	09/28/15 10:24 AM	12/30/15 10:25 AM	04/28/16 10:26 AM
▼ Vitals				
Height	71 in	71 in	71 in	71 in
Weight	175 lb	177 lb	174 lb	170 lb
BMI	24.41	24.69	24.27	23.71
BMI Percentile				
BP	115/80 mmHg	120/80 mmHg	115/80 mmHg	115/70 mmHg
Temperature	98.4 °F	98.6 °F	99 °F	98.5 °F
Pulse	95 bpm	97 bpm	96 bpm	95 bpm
Respiratory rate	13 bpm	13 bpm	14 bpm	13 bpm
O2 Saturation	98 %	97 %	98 %	96 %

On the right side, a "Diagnosis > Record diagnosis" window is open, showing a search for "Cough". The search results list several ICD-10 and ICD-9 codes, including "Cough ICD10: R05 ICD9: 786.2", "Cough fracture ICD10: R05,S22.41xA,S22.41xB,... ICD9: 807.00", "Productive cough ICD10: R05 ICD9: 786.2", "Coughing up blood ICD10: R04.2 ICD9: 786.30", "Chronic cough ICD10: R05 ICD9: 786.2", "Effective cough ICD10: R05 ICD9: 786.2", and "Does not cough ICD9: 786.2". There is an "Add" button at the bottom right of the search window.

Hospital Information Systems: Patient Data Management System (PDMS)

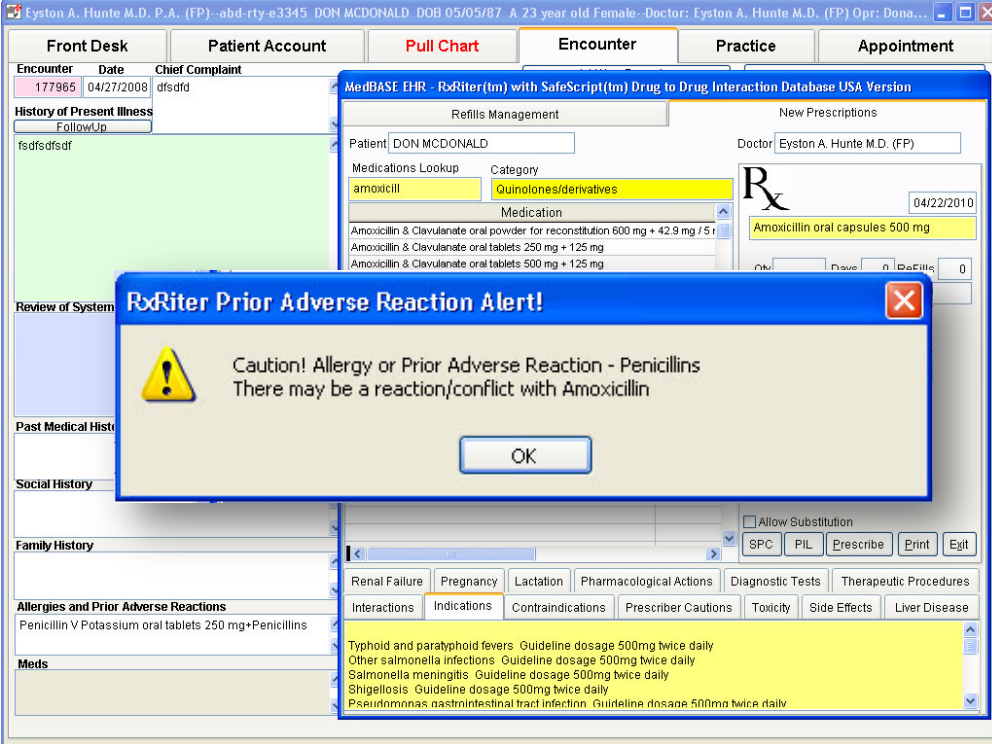
- Aim: Monitors, stores, and clearly presents a vast amount of patient-related clinical data on Intensive Care Units (ICU)
- Support real-time analyses
- Provides methods for patient discharge and transfer to other wards or institutions, e.g. a short summary of the therapy on the ICU

COPRA, <https://docplayer.org/60370571-Christian-schade-lobeck.html>



Hospital Information Systems: Clinical Decision Support Systems (CDSS)

- Aim: Assist clinical professionals in data interpretation and decision-making
- Monitor patients and issue real-time alerts
- Make diagnostics suggestions
- Provide limited therapeutic advice
- Provide information on medication alternatives or interactions
- Drug safety and adverse events prevention



The screenshot displays a medical software interface with a patient account for DON MCDONALD. A 'MedBASE EHR - RxRiter(tm) with SafeScript(tm) Drug to Drug Interaction Database USA Version' window is open, showing a search for 'amoxicill' in the 'Quinolones/derivatives' category. The results list 'Amoxicillin & Clavulanate oral powder for reconstitution 600 mg + 42.9 mg / 5 l', 'Amoxicillin & Clavulanate oral tablets 250 mg + 125 mg', and 'Amoxicillin & Clavulanate oral tablets 500 mg + 125 mg'. A 'New Prescriptions' window shows 'Amoxicillin oral capsules 500 mg'. A prominent blue dialog box with a yellow warning icon reads: 'RxRiter Prior Adverse Reaction Alert! Caution! Allergy or Prior Adverse Reaction - Penicillins There may be a reaction/conflict with Amoxicillin'. Below the dialog, a list of drug interactions is visible, including 'Typhoid and paratyphoid fevers', 'Other salmonella infections', 'Salmonella meningitis', 'Shigellosis', and 'Pseudomonas gastrointestinal tract infection', each with a guideline dosage of 500mg twice daily. The interface also includes tabs for 'Front Desk', 'Patient Account', 'Pull Chart', 'Encounter', 'Practice', and 'Appointment', and various buttons like 'SPC', 'PIL', 'Escribe', 'Print', and 'Exit'.

Hospital Information Systems: Laboratory Information Management System (LIMS)

- Aim: Support the processes and data management in labs
- Focus: Specific patient sample / order
- Track individual samples across the complete lab process
- Support reproducibility and quality management
- Assemble results to support report preparation
- Many special-purpose solutions



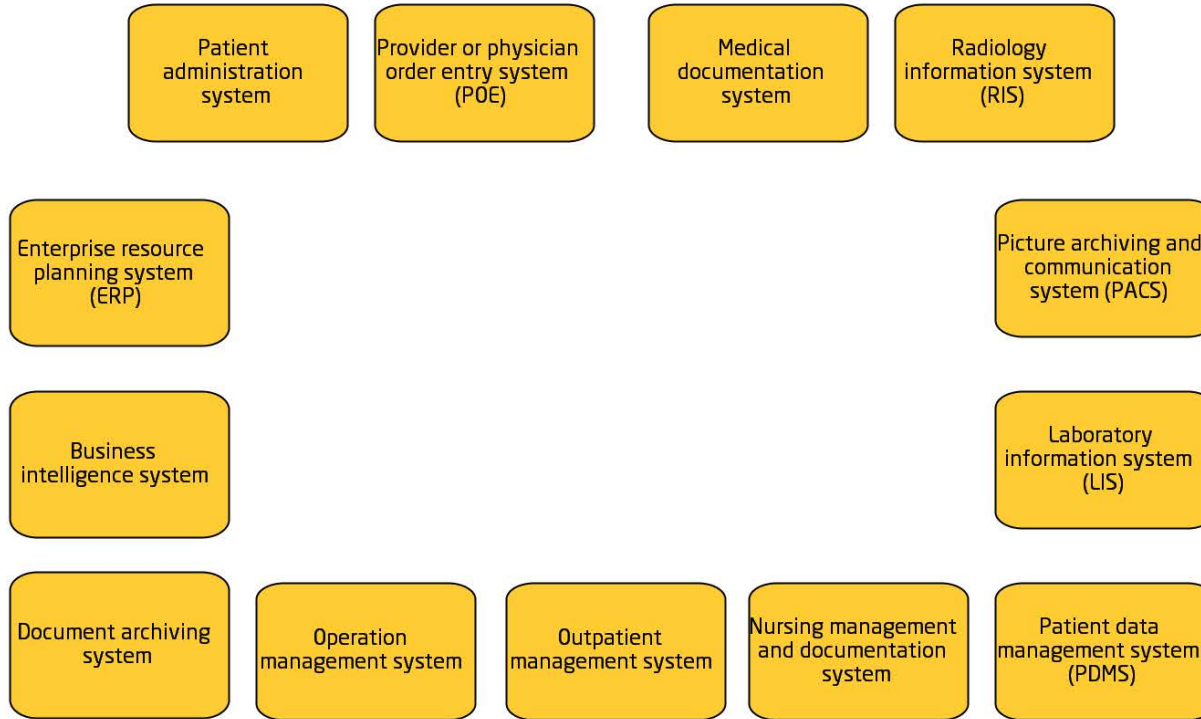
<https://www.broadinstitute.org/genomics>

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24

Hospital Information Systems: Reference Software Architecture

Winter et al., Architectures of Hospital Information Systems (2010)

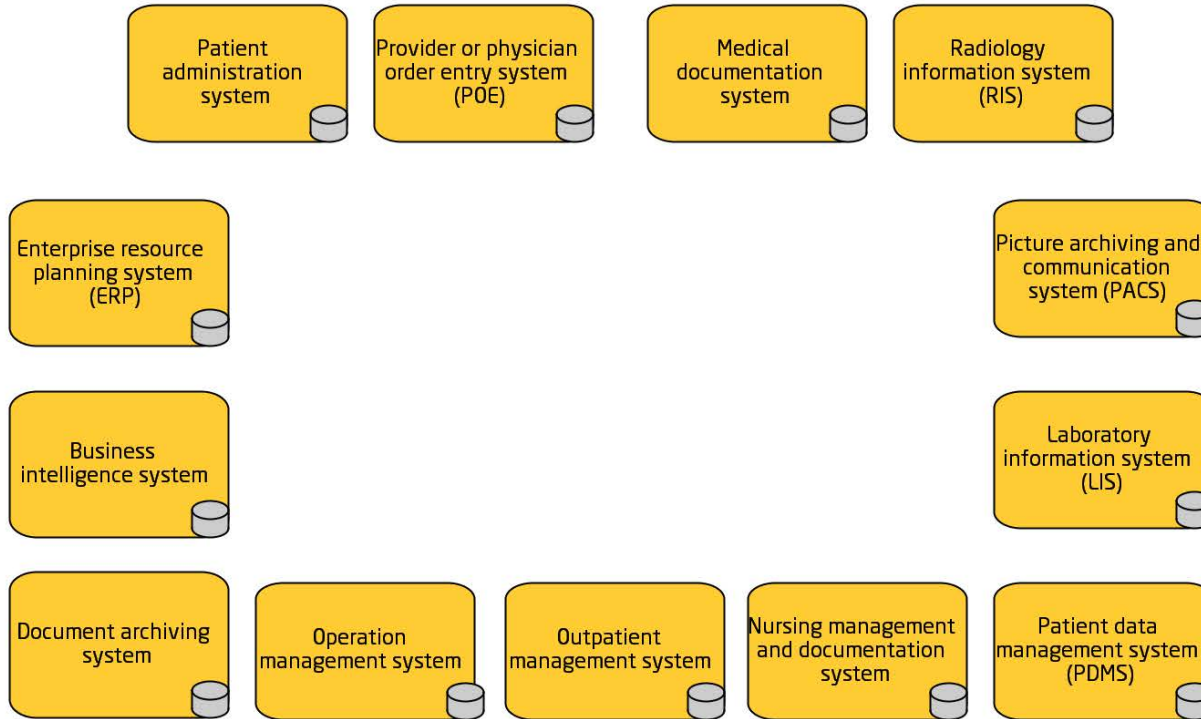


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25

Hospital Information Systems: Reference Software Architecture (cont'd)

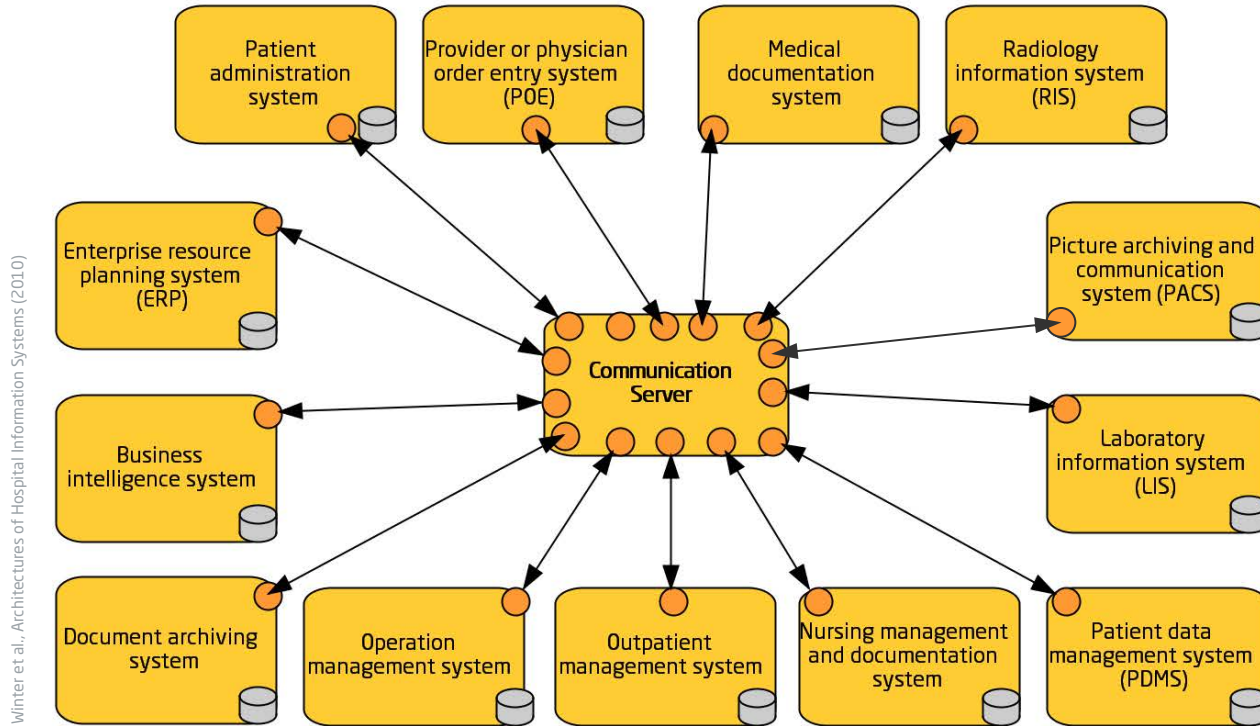
Winter et al., Architectures of Hospital Information Systems (2010)



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26

Hospital Information Systems: Reference Software Architecture (cont'd)

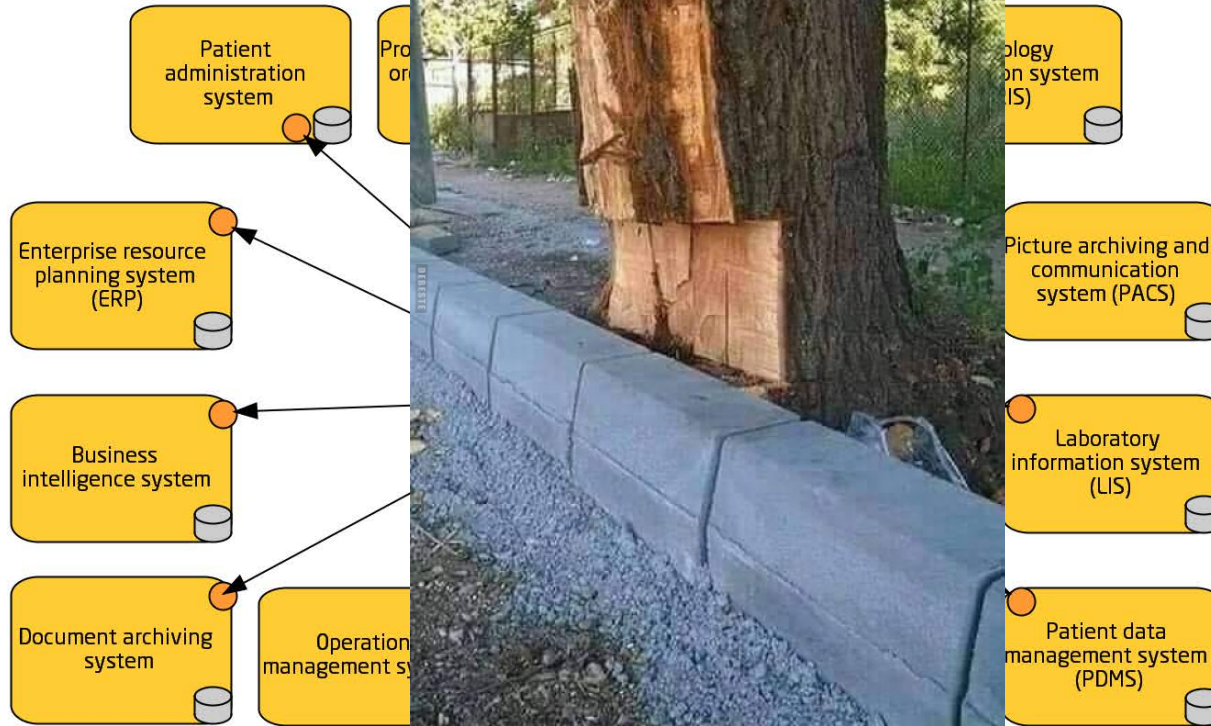


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27

Hospital Information Systems Reference Software Architecture

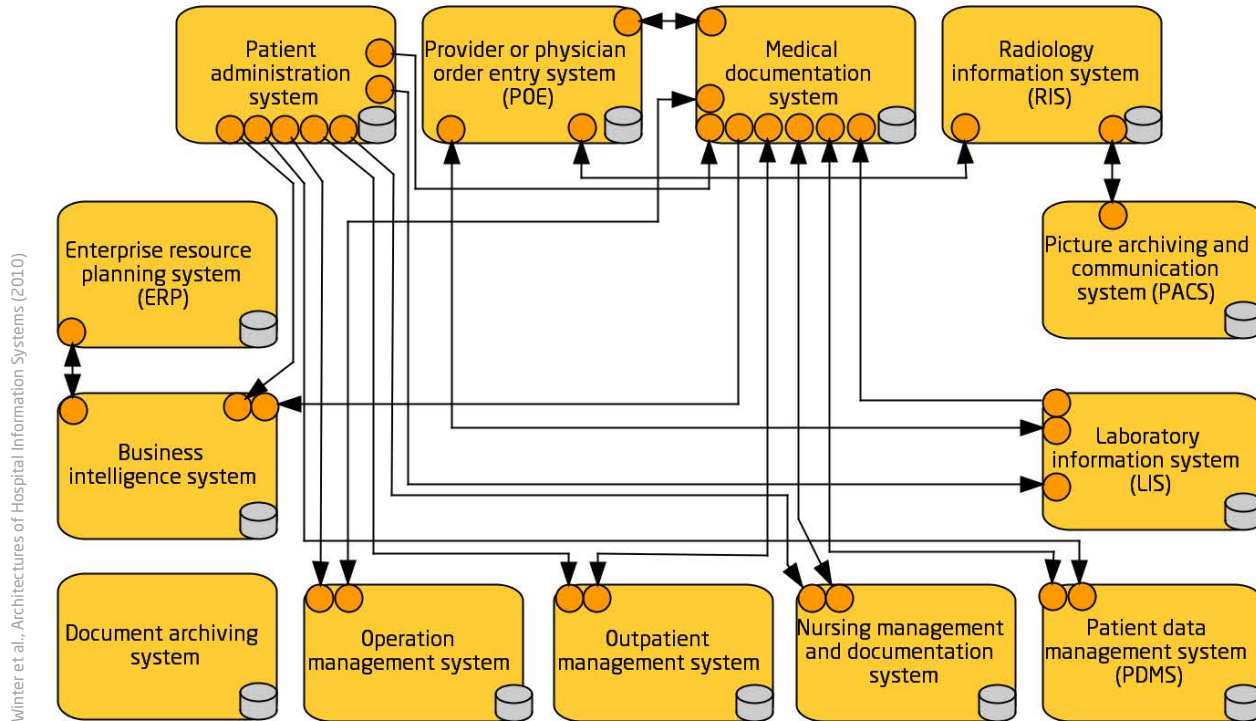
Winter et al., Architectures of Hospital Information Systems (2010)



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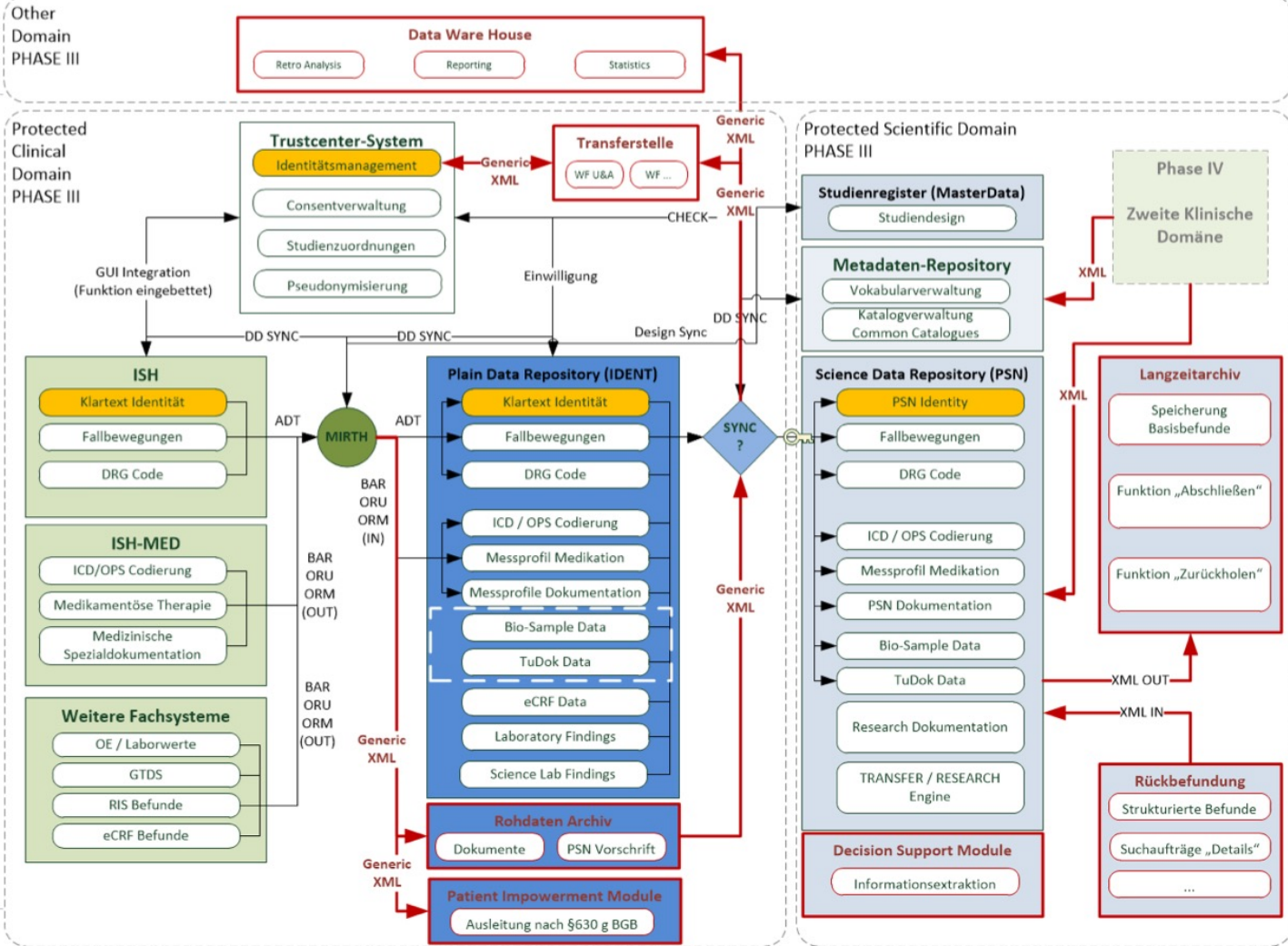
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28

Hospital Information Systems: Reference Software Architecture (cont'd)



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29



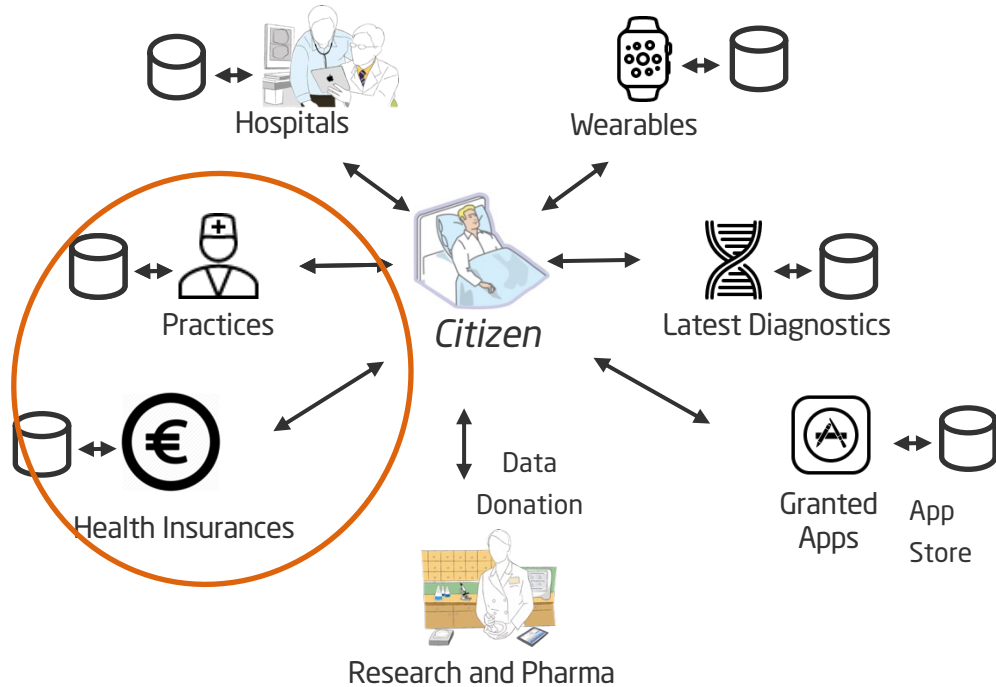
<https://docplayer.org/39401235-Health-data-platform-hdp-projektplanung-konzeptstand-und-umsetzung-martin-peuker-danilo-schmidt.html>

... and that's reality

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Sources of Digital Health Data: Practices and Health Insurances



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31

How to connect to Practice Information Systems: Example: LifeTime App



- Aim: Integrate with existing practice information systems seamlessly
- Comes as bundle: hardware + software
- Interface: Provides virtual printer + wifi connectivity via access point
- Data is stored on the smartphone of the user

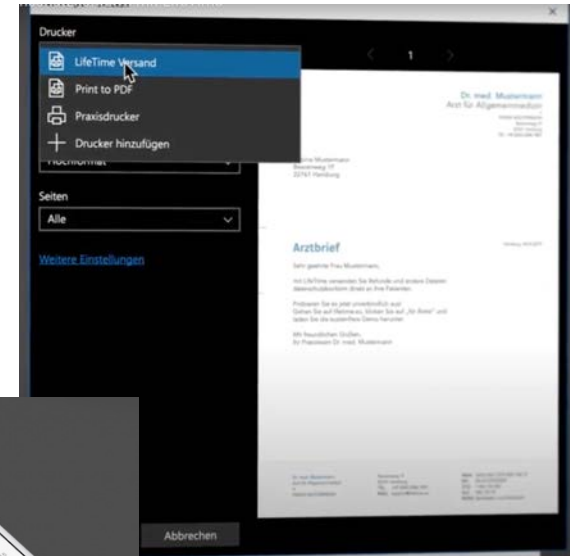
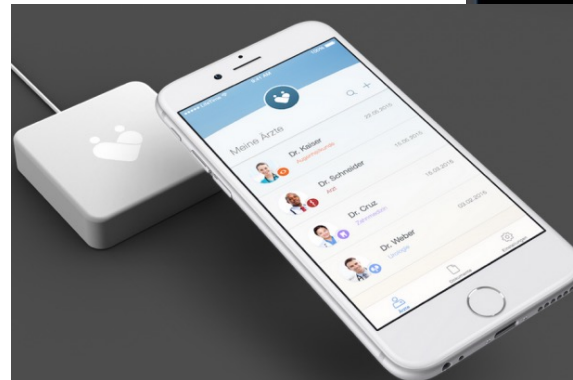


Befunde und Bilder direkt auf das Smartphone

Bei uns können Sie alle Dokumente, wie z.B. Befunde, Laborberichte oder Bilder ab sofort auch digital mit nach Hause nehmen und das ganz einfach per Smartphone.

Laden Sie sich am besten schon vor Ihrem Termin die LifeTimeApp herunter, denn weniger Papier bedeutet mehr Nachhaltigkeit, mehr Transparenz und eine bessere Übersicht.

» [Zur LifeTime App](#)



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32

gematik's Telematics Infrastructure: German Communication Backbone b/w Healthcare Actors

- How to guarantee interoperability with existing/future solutions?
- Interop Council for Digital Health in Germany est. 2021



INTEROP COUNCIL
for digital health in Germany



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34

German Electronic Health Insurance Card / Elektronische Gesundheitskarte (eGK)

WIRTSCHAFT GESUNDHEITSKARTE

728 Millionen Euro Kosten – und bislang kein N

Veröffentlicht am 27.06.2013 | Lesedauer: 2 Minuten

12. April 2018, 19:28 Uhr Elektronische Gesundheitskarte

14 Jahre, zwei Milliarden technische Probleme



Ärzte sollen künftig Patientendaten untereinander austauschen können, (Foto: Bernd Thissen/dpa)

NACH INTERVENTION DER DATENSCHÜTZER

E-Rezept-Abruf via eGK: Wie geht es weiter?

STUTTGART - 05.10.2022, 14:45 UHR



Es gilt noch einiges zu klären, bis in der Apotheke E-Rezepte mittels eGK abgerufen werden können. (Foto: Schelbert)

Chips für elektronische Gesundheitskarten sind Mangelware

Stand: 01.08.2022 12:44 Uhr

Weltweit sind elektronische Chips Mangelware. Das bekommen nun auch Krankenkassen in Niedersachsen zu spüren. Der Engpass wirkt sich auf die Auslieferung der elektronischen Gesundheitskarten aus.

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35

German Electronic Health Insurance Card / Elektronische Gesundheitskarte (eGK) (cont'd)

- Mandatory for public health insurance
- Key component for data exchange in German healthcare system
- Stores personal (health) information, e.g. photo, name, birthdate, address, **insurance number**, etc. (see back of your card for stored details)
- (Future) applications: emergency details, electronic medication plan, e-prescription, etc.



Source: Barmer

German Electronic Health Insurance Card / Elektronische Gesundheitskarte (eGK) (cont'd)

- Mandatory for public health insurance
- Key component for data exchange in German healthcare system
- Stores personal (health) information, e.g. photo, name, birthdate, address, **insurance number**, etc. (see back of your card for stored details)
- (Future) applications: emergency details, electronic medication plan, e-prescription, etc.



Source: Barmer

What is special about the German health insurance number?

Neue Gesundheits-App für 13 Millionen Versicherte startet

APP VIVY

Tohuwabohu um Gesundheitsdaten

Frank Meßing

17.09.2018 - 18:53 Uhr

Sind meine Daten in der neuen Gesundheits-App sicher?

AKTUALISIERT AM 17.09.2018 - 16:37

Flickenteppich nützt niemandem

Die elektronische Gesundheitskarte kommt nicht voran. Nun preschen einzelne Krankenkassen mit einer App vor. Es droht ein Flickenteppich, meint unser Kommentator.

GESUNDHEITS-APP

Warum man Vivy nicht nutzen sollte

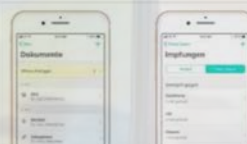
17. September 2018 um 17:22 Uhr | Lesedauer: Eine Minute

Vivy – Deine digitale Gesundheitsassistentin

<https://www.vivy.com/>

Vivy ist deine smarte Gesundheits-App. Vivy kombiniert Gesundheitsakte und persönliche Assistentin. Über Vivy | Vivy - Vivy für Fachkreise · So funktioniert Vivy

Schlagzeilen



Gesundheits-App Vivy startet für Millionen Krankensichere

Heise vor 1 Tag

[Mehr zu vivy app](#)

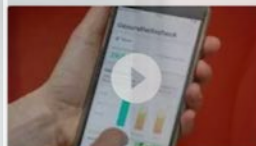
Sind meine Daten in der neuen Gesundheits-App Vivy sicher?

FAZ - Frankfurter Allgem... vor 3 Stunden

Gesundheits-App Vivy startet für 13 Millionen Versicherte

FAZ - Frankfurter Allgem... vor 3 Stunden

Videos



15 Krankenkassen machen mit: "Vivy" bringt Patientenakten aufs Smartphone

n-tv - vor 17 Stunden



Neue Apps: DAK App und Vivy - So geht die Registrierung

DAK - Gesundheit YouTube - vor 1 Tag

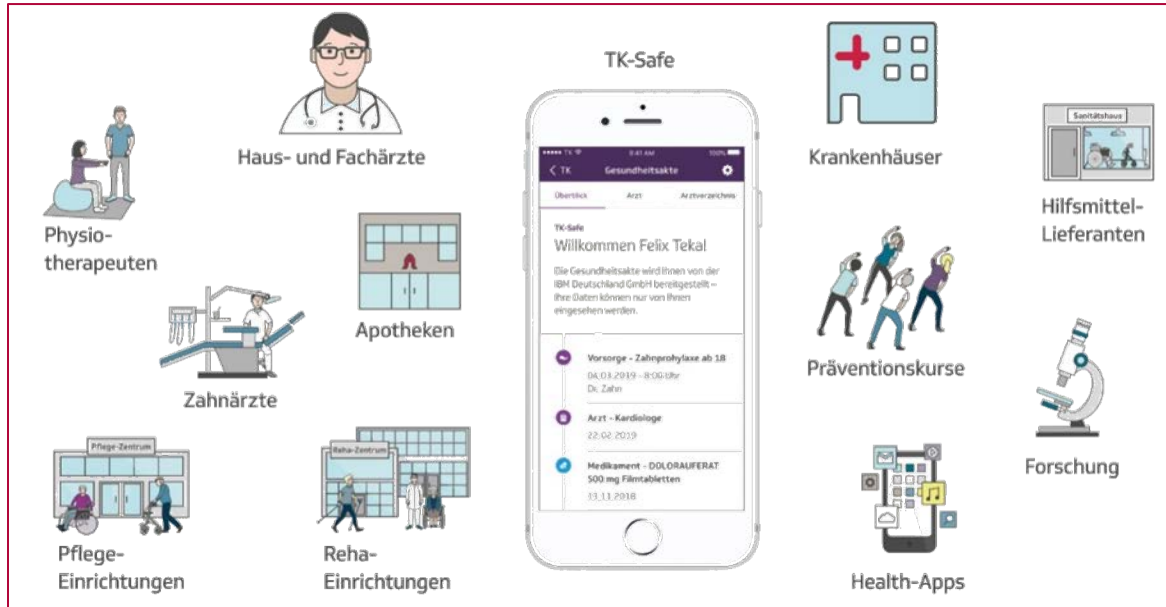


Vivy - Ist die digitale Gesundheits-App sinnvoll? Pro und Contra ... tagesschau

YouTube - vor 16 Stunden

German Electronic Health Card: German Patient Apps

- German equivalent to EHR
- Were provided by health insurance companies due to missing working alternatives
- Discontinued 2022 due to public availability of gematik's solution

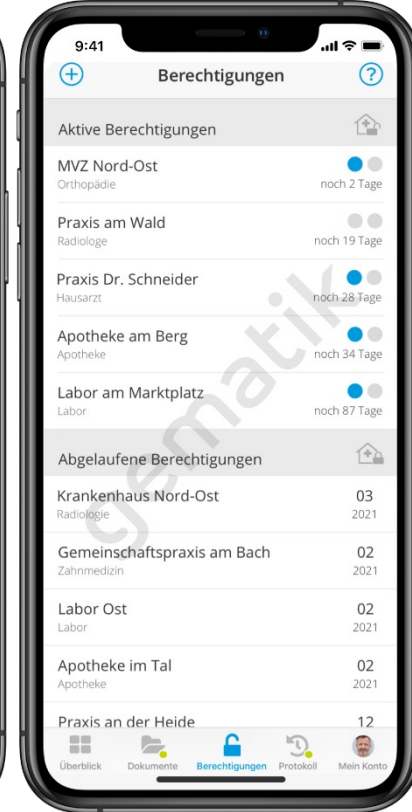


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39

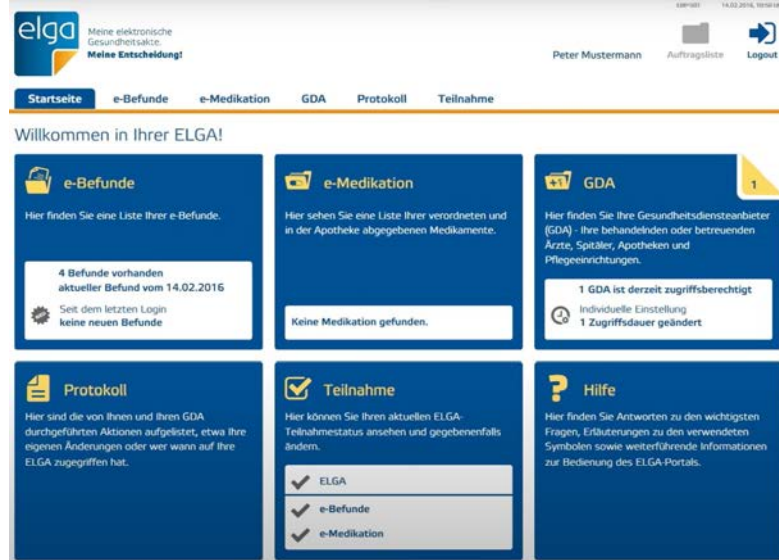
German Electronic Patient Record: Elektronische Patientenakte (ePA)

- Germany 2023: Health insurances have to provide access to gematik's ePA.
- Lookup your health insurance and its corresponding app for accessing your ePA at:
<https://www.gematik.de/anwendungen/e-patientenakte/epa-app>
- Download app, register app with your health insurance card, access your ePA (even after switching insurances).



Austrian Electronic Health Record / Elektronische Gesundheitsakte (ELGA)

- Interoperable document exchange platform for patients based on HL7 (Clinical Document Architecture)
- Data added by physicians and healthcare providers
- Managed by patients
- Currently supports: medication, discharge letters, laboratory and radiology findings and medication data, rollout should be finished by end of 2022
- e-card serves as access key for citizens
- Opt-out service (3.4%), all other Austrians granted access by default
- All Austrian doctors and hospitals have to use ELGA



The screenshot shows the ELGA patient portal interface. At the top, there is a navigation bar with the ELGA logo and the text 'Meine elektronische Gesundheitsakte' and 'Mehre Entscheidung!'. The user's name 'Peter Mustermann' and a 'Logout' button are visible. Below the navigation bar, there are tabs for 'Startseite', 'e-Befunde', 'e-Medikation', 'GDA', 'Protokoll', and 'Teilnahme'. The main content area is titled 'Willkommen in Ihrer ELGA!' and contains six panels: 'e-Befunde' (4 Befunde vorhanden, aktueller Befund vom 14.02.2016), 'e-Medikation' (Keine Medikation gefunden), 'GDA' (1 GDA ist derzeit zugriffsberechtigt), 'Protokoll' (Hier sind die von Ihnen und Ihren GDA durchgeführten Aktionen aufgelistet), 'Teilnahme' (Hier können Sie Ihren aktuellen ELGA-Teilnahmestatus ansehen), and 'Hilfe' (Hier finden Sie Antworten zu den wichtigsten Fragen).

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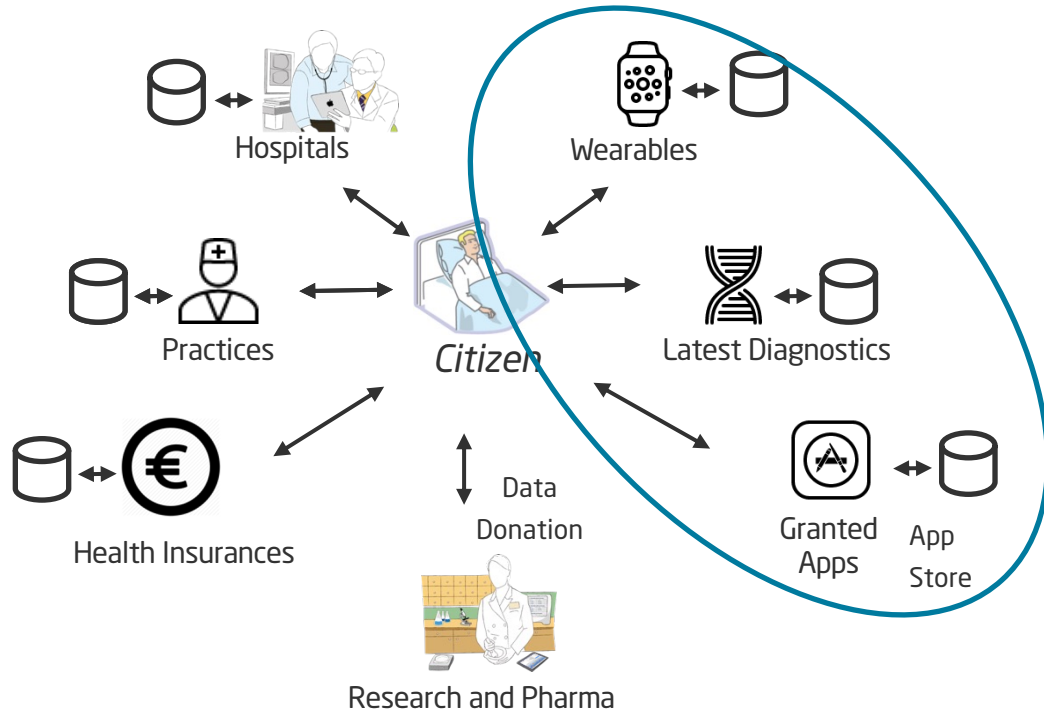
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Digital Health, Winter
2023
41



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LIFTOFF

Sources of Digital Health Data: Consumer Market Apps, Non-Medical Devices and Tests



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Digital Health, Winter
2023
43

Apple to launch 'techn healthcare service' Verily: Google-Schwester kann Herzkrankheiten durch einen Augen-Scan vorhersagen

Veröffentlicht am 19. Februar 2018 von Jens

Following Amazon's lead, iPhone maker creat health service for employees

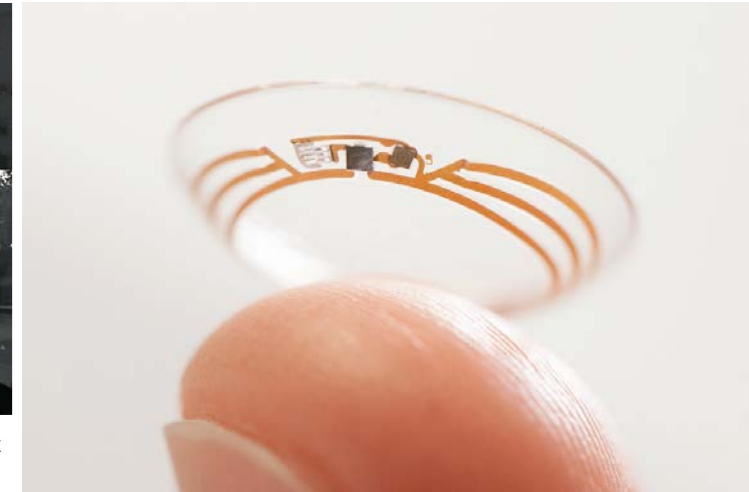
Alphabet

Die Alphabet-Tochter und Google-Schwester Verily beschäftigt sich mit der Gesundheit des Menschen und sucht nach Möglichkeiten, Erkrankungen frühzeitig zu erkennen und zu behandeln. Dazu wird der menschliche Körper wie eine gigantische Datenquelle behandelt, aus der sehr viel herausgelesen werden kann. Jetzt ist es den Forschern mithilfe von Künstlicher Intelligenz gelungen, durch einen Augenscan das Risiko eines Herzleidens vorherzusagen.

<https://www.googlewatchblog.de/2018/02/verily-google-schwester-herzkrankheiten/>



<https://www.theguardian.com/technology/2018/feb/27/apple-launching-technology-enabled-healthcare-service>



▲ Two healthcare centres are planned to open in the spring within Santa Clara County, Californian, near Apple Park (above) and Infinite Loop headquarters. Photograph: Justin Sullivan/Getty Images

Alphabet in Healthcare Google Health

For consumers



Learn more about skin concerns.

[DermAssist](#) →

Meet your health and fitness motivation.

[Fitbit](#) ↗

Participate in health research.

[Google Health Studies](#) →

Find helpful health information and care.

[Google Search](#) ↗

Find supportive stories and authoritative information.

[YouTube](#) ↗

For a healthy and active life.

[Google Fit](#) ↗

For caregivers



Using AI to help prevent blindness.

[ARDA](#) →

Empowering clinicians to transform care delivery.

[Care Studio](#) →

Transform your organization with AI-powered, health-focused solutions.

[Google Cloud](#) ↗

[Explore caregivers](#)

For communities



Providing tools for data-driven insights.

[Tools](#) →

Assisting researchers and scientists.

[Research](#) →

Sharing critical information.

[Informing communities](#) →

[Explore communities](#)

For researchers



Improving the accuracy of genomic analysis.

[Genomics](#) →

Assisting clinicians with AI-enabled tools.

[Imaging & diagnostics](#) →

Sharing our work to collaboratively advance healthcare.

[Publications](#) →

[Explore researchers](#)

Google Health

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2023
45

Alphabet in Healthcare



- “Study watch” as interventional medical device
- Purpose: Sensor / data collection



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46



CHAPTER 1

Clinical Care Apps

Get to know great apps that can transform patient care in your institutions.



CHAPTER 3

Medical Research

Conduct big data research with changing impact.



CHAPTER 5

Institution Profiles

See how healthcare professionals are innovating patient care.



CHAPTER 2

Patient Health Management

Learn how to connect with and educate patients in revolutionary ways.



CHAPTER 4

Devices on Your Network

Securely manage devices, apps, and data on your institution network.

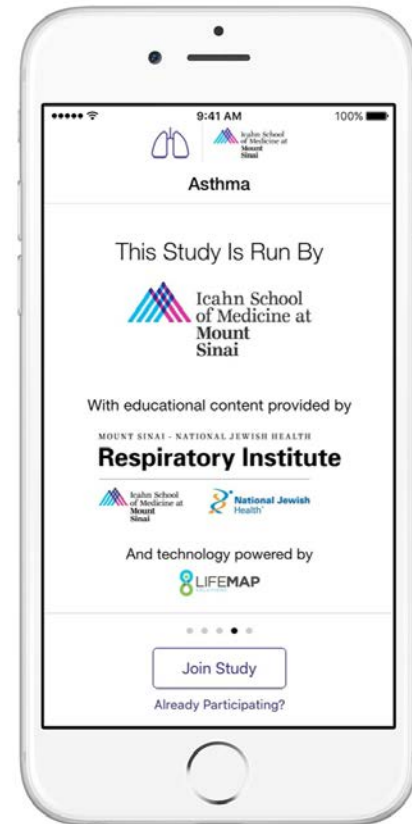
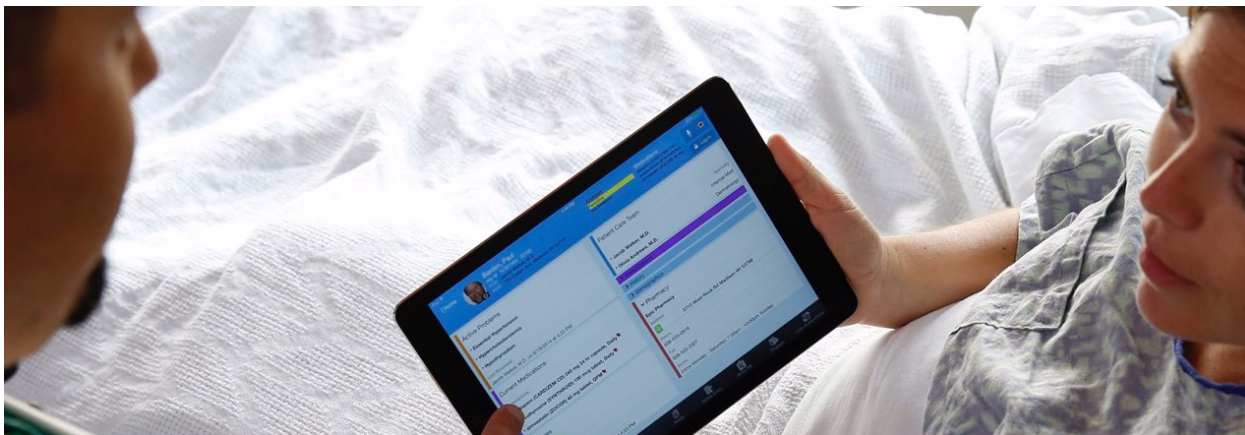


CHAPTER 6

Resources

Explore tools and programs to get the most from iPhone, iPad, and Apple Watch.





- Technology provider (hard- and software)
- Direct user access
- Provides software development kits



Concussion Tracker

NYU Langone Medical Center

[Weitere Infos im App Store ↗](#)



PPD ACT

University of North Carolina,
National Institute of Mental Health

[Weitere Infos im App Store ↗](#)



Mole Mapper

Oregon Health & Science University

[Weitere Infos im App Store ↗](#)



SleepHealth

University of California San Diego,
American Sleep Apnea Association

[Weitere Infos im App Store ↗](#)



ResearchKit



CareKit

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2023

49

What is the Pattern?

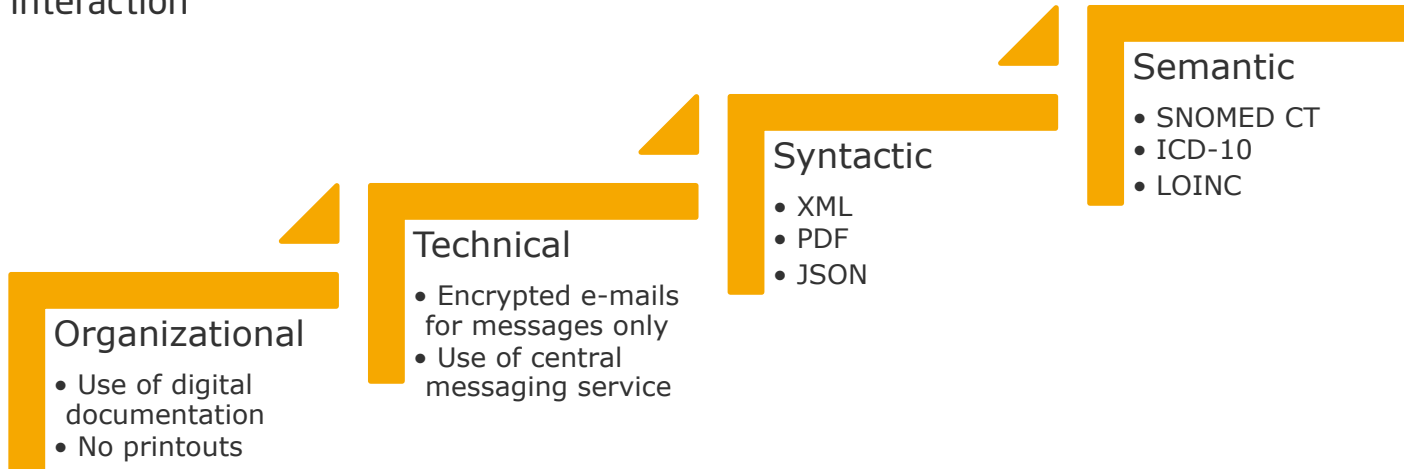
- Number of (active) product users defines market value of company
- Companies try to establish a barrier platform between individual actors of the market, e.g., citizens and providers
- Platform operators acquire fine-grained data per user
- Use platform to control flow of communication and data to derive insights
- Enables data-driven market segmentation
- Provide segment-specific targeted therapy offers



Standard, der

Wortart: Substantiv, maskulin

- Recap FAIR principles := Findable, Accessible, Interoperable, Reusable
- **Interoperability** := Ability of software/hardware components to exchange data with other components (in particular of other vendors) seamlessly, i.e. w/o manual human interaction



- Recap FAIR principles := Findable, Accessible, Interoperable, Reusable
- **Interoperability** := Ability of software/hardware components to exchange data with other components (in particular of other vendors) seamlessly, i.e. w/o manual human interaction
 - **Organizational** := Define processes/procedures/regulations for data exchange, e.g. all medical documentation digital only
 - **Technical** := Select technologies to exchange data between A and B, e.g. e-mail
 - **Syntactic** := Use of compatible structures as formats for data, e.g. XML
 - **Semantic** := Share a compatible concepts/meanings/interpretations of data, e.g. terminologies, ontologies

Interoperability: Standards for Data Exchange

- Health Level 7 (HL7)
 - Clinical Document Architecture (CDA)
 - Fast Healthcare Interoperable Resources (FHIR)
- Digital Imaging and Communications in Medicine (DICOM)
- ISO/IEEE 11073
- Integrating the Healthcare Enterprise (IHE)



openEHR

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2023

54

Interoperability: Health Level 7

- Describes message and event types exchanged between application components
- Event-driven communication
- Example messages:
 - Admission Discharge Transfer (ADT)
 - Order entry message (ORM)



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2023
55

Interoperability: Health Level 7 (cont'd)

■ HL7 defines approx. 60 Admit, Discharge, Transfer (ADT) message types

```
MSH|^~\&|AcmeHIS|StJohn|ADT|StJohn|20050518073622||ADT^A01|MSGID  
20050518073622|P|2.3
```

```
EVN|A01
```

```
PID|||12001||Jones^John^^Mr.||19670822|M|||123 West  
St.^Denver^CO^80020^USA|| (850) 555-0809|||99345|460-99-2928
```

PID – Patient Info

```
PV1||I|Main^802^1|||^Quacker^John||IP|||||1|||||  
|||||20050518073622
```

PV1 – Visit Info

```
IN1|1|EPO|80|AETNA US HEALTHCARE|PO BOX 981114^""^EL  
PASO^TX^79998^""||1500004000001|AETNA SERVICES INC|19|AETNA US  
HEALTHCARE|""|""||2|SOUTAR^RENEE^D|3|19700722|13324 WHITE  
CEMETERY
```

IN1 & IN2
Insurance Info

```
RD^""^HANNIBAL^NY^130740000^""|||124705454|||1|  
F|225 GREENFIELD PARKWAY^^LIVERPOOL^NY^13088|185428
```

```
IN2|1||124705454||461-1200|||||
```

Event Description

A01	ADT/ACK - Admit/visit notification
A02	ADT/ACK - Transfer a patient
A03	ADT/ACK - Discharge/end visit
A04	ADT/ACK - Register a patient
A05	ADT/ACK - Pre-admit a patient
A06	ADT/ACK - Change an outpatient to an inpatient
A07	ADT/ACK - Change an inpatient to an outpatient
A08	ADT/ACK - Update patient information
A09	ADT/ACK - Patient departing - tracking
A10	ADT/ACK - Patient arriving - tracking
A11	ADT/ACK - Cancel admit/visit notification
A12	ADT/ACK - Cancel transfer
A13	ADT/ACK - Cancel discharge/end visit
A14	ADT/ACK - Pending admit
A15	ADT/ACK - Pending transfer
A16	ADT/ACK - Pending discharge
A17	ADT/ACK - Swap patients

<https://corepointhealth.com/resource-center/hl7-resources/hl7-adt>

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2023
56

Interoperability: Classifications, Terminologies, Coding Systems

- **Classification** := Arrangement of facts, terms, conditions according to a established criteria or concept to form a group or category.
 - International Classification of Diseases (ICD)
 - Anatomical Therapeutic Chemical (ATC)
- **Terminology** := Set of terms for a particular field not necessary arranged in groups
 - SNOMED CT: medical observations, findings, etc.
 - Unified Medical Language System (UMLS): maps vocabularies and terms of terminologies.
- **Coding System** := Unified definition of criteria and valid ranges
 - Unified Code for Units of Measure (UCUM): focus medicine and pharmacy
 - Logical Observation Identifiers Names and Codes (LOINC): encoding of sample details, procedures, lab results

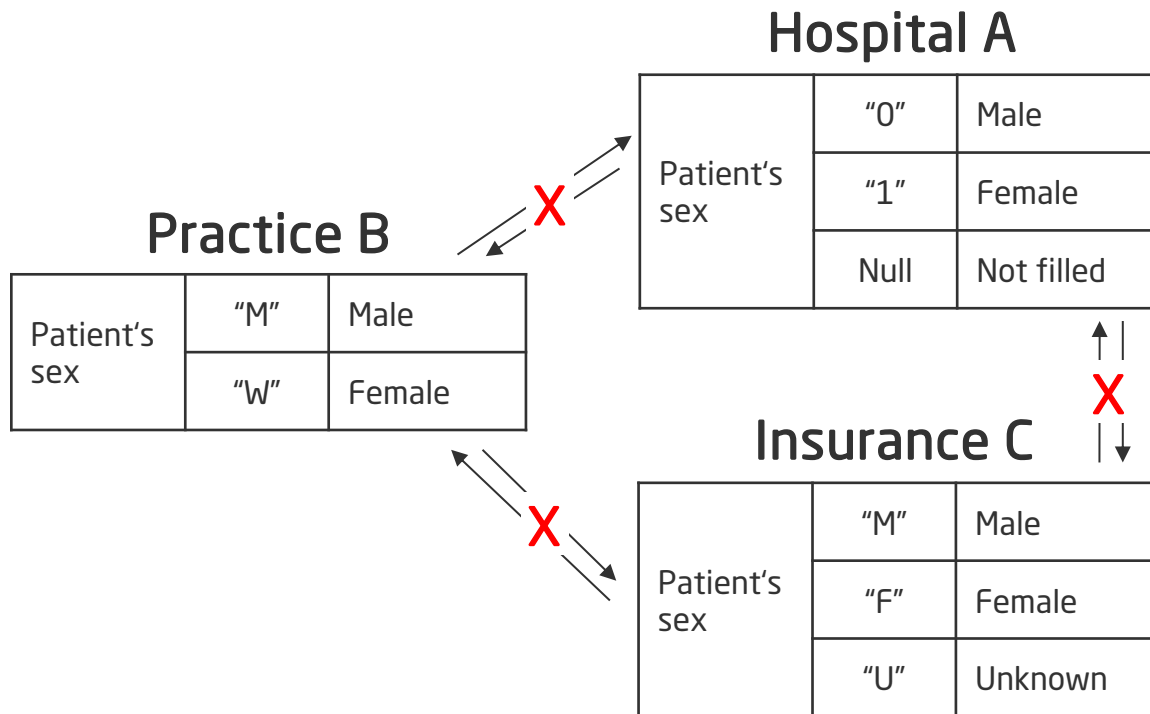
Interoperability: Example: Patient's Sex

Your task: Enable to digital exchange of details about the *biological sex* of patients.

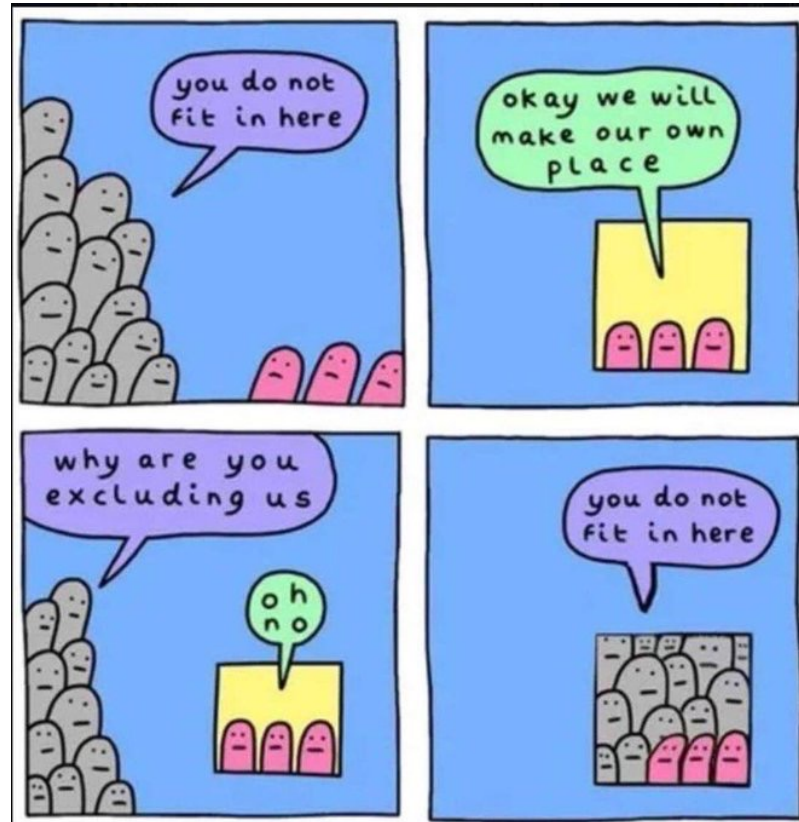
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58

Interoperability: Example: Patient's Sex (cont'd)



Interoperability: Example: Patient's Sex (cont'd)



Interoperability:

Example: Patient's Sex (cont'd)

- Just follow a standard, e.g. FHIR, right?

8.1.7 Patient Gender and Sex

Many systems and organizations only provide for a single attribute that aspires to represent all aspects of a patient's gender and sex with a single value. However, there are many considerations around sex and gender documentation and interoperability. Listed below are the various social and biological attributes that are relevant in the healthcare setting, as well as information on how each can be communicated.

- **Administrative Gender** - in order to interoperate with systems that use a single generic property, the basic [Patient.gender](#) property represents an administrative gender: the gender that the patient is considered to have for administration and record keeping purposes. This property is often used as an input to patient matching algorithms, for example.


In addition to this administrative gender, other kinds of gender or sex properties may be represented:

- **Clinical Sex** - a testable observation about a biological property of the patient. There are several different types of clinical sex, including karyotypic/genetic/chromosomal, gonadal, ductal, phenotypic, etc. Clinical sex observations should be represented using [Observation](#), qualified with the appropriate clinical codes from LOINC and/or SNOMED.
- **Clinical Gender** - an observation about the patient, often collected as part of social history documentation, and represented as an [Observation\(example\)](#) using, for example, the LOINC code [76691-5](#). Clinical gender observations can provide both history and confidentiality, where the [genderIdentity](#) extension does not.
- **Gender Identity** - an indication from the patient about what gender they consider themselves to be. This can influence how the patient prefers to be addressed by care providers and other individuals. The standard [genderIdentity](#) extension may be used to communicate this property. This extension is appropriate when the gender identity is openly known.
- **Sex assigned at Birth** - the sex assigned at birth, as documented on the birth registration. Some countries allow variations such as not yet determined, unknown, or undifferentiated, while others do not. Some countries also allow birth registration information to be updated. The US realm defines a US specific extension for this property. Alternatively, if you were representing this concept with an observation, you could use the LOINC code [76689-9](#).
- **Legal Sex** - regional and national entities often categorize citizens using a single legal sex value. The legal sex of a patient can vary from region to region and country to country. A single patient may have multiple legal sex values at the same time in different jurisdictions. In case where the [Patient.gender](#) administrative property is not sufficient to communicate legal sex, realm specific extensions should be used.

For veterinary use, the animal extension also includes the [genderStatus](#) which indicates sterility information.

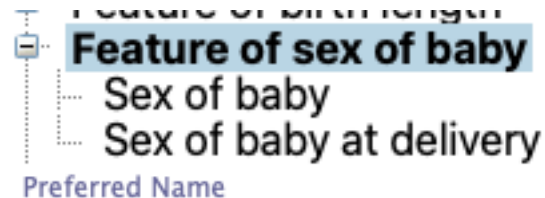
Interoperability: Example: Patient's Sex (cont'd)

- Just encode it, e.g. SNOMED CT

Details	Visualization	Notes (0)	Class Mappings (71)	
Preferred Name	Gender			
Synonyms	Gender (observable entity)			
ID	http://purl.bioontology.org/ontology/SNOMEDCT/263495000			
Active	1			
altLabel	Gender (observable entity)			
CASE SIGNIFICANCE ID	900000000000448009			
CTV3ID	XC00J			
cui	C0079399			
DEFINITION STATUS ID	900000000000074008			
Effective time	20020131			
Is interpreted by	Surgically transgendered transsexual, male-to-female Gender unknown Non-binary gender Surgically transgendered transsexual Feminine gender Gender unspecified Transgender identity Surgically transgendered transsexual, female-to-male Masculine gender Gender finding			
notation	263495000			
prefLabel	Gender			

Interoperability: Example: Patient's Sex (cont'd)

- Just encode it, e.g. SNOMED CT



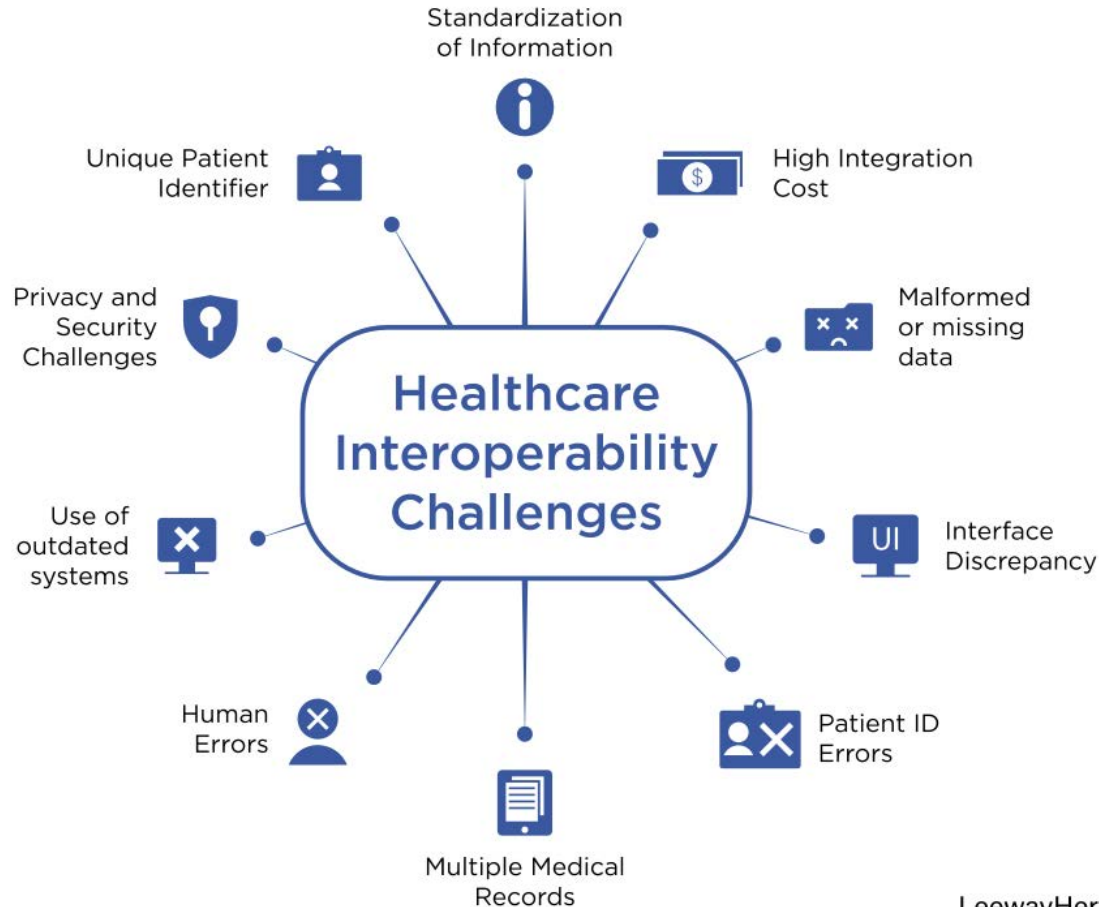
Details	Visualization	Notes (0)	Class Mappings (71)	🔗
Preferred Name	Gender			
Synonyms	Gender (observable entity)			
ID	http://purl.bioontology.org/ontology/SNOMEDCT/263495000			
Active	1			
altLabel	Gender (observable entity)			
	Feature of sex of baby			
	Feature of sex of baby (observable entity)			
	http://purl.bioontology.org/ontology/SNOMEDCT/364588003			

Is interpreted by	Gender unknown Non-binary gender Surgically transgendered transsexual Feminine gender Gender unspecified Transgender identity Surgically transgendered transsexual, female-to-male Masculine gender Gender finding
notation	263495000
prefLabel	Gender

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2023
13

Interoperability: Challenges



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64

Use of Personal Health Information



Use of Personal Health Information Examples

When	What	Covered by	Direction	Limitations
Course of treatment	Identifiable data, PHI	Treatment contract	Prospectively	By medical experts involved in treatment process only
Clinical trials	Specific data only	Patient consent	Prospectively	Pseudonymization required
Research	Subset of data	Patient consent	Prospectively / retrospectively	Use for specific purpose only
Research	Subset of data	Data de-identification	Retrospectively	Full anonymization required
After death	PHI	No explicit data protection	Retrospectively	Complex, e.g. disclosure of in-heritable diseases
Anytime	PHI	GDPR et al., right of self-disclosure	Retrospectively	No

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2023
66

What to Take Home?

- Variety of digital health data sources exist for decades
- No COTS in healthcare: Specific software solutions emerged over time
- Challenge: Interconnecting healthcare systems per hospital, country, worldwide...
- The implementation of open standards, vocabularies, terminologies, ontologies, etc. is not for free: it requires high efforts for all involved actors
- It pays off: Follow standards and you might gain interoperability in future!
- There is no right standards: just use either of them is better than any proprietary solution



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2023
67