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HealthCare Data Analytics

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Introduction

- An Electronic Health Record (EHR) is a digital version of a patient's medical history.
- It is a longitudinal record of patient health information generated by one or several encounters in any healthcare providing setting. The term is often used interchangeably with EMR (Electronic Medical Record) and CPR (Computer-based Patient Record).
- It encompasses a full range of data relevant to a patient's care such as demographics, problems, medications, physician's observations, vital signs, medical history, immunizations, laboratory data, radiology reports, personal statistics, progress notes, and billing data. The EHR system automates the data management process of complex clinical environments and has the potential to streamline the clinician's workflow.
- It can generate a complete record of a patient's clinical encounter, and support other care-related activities such as evidence-based decision support, quality management, and outcomes reporting.
- An EHR system integrates data for different purposes.
- It enables the administrator to utilize the data for billing purposes, the physician to analyze patient diagnostics information and treatment effectiveness, the nurse to report adverse conditions, and the researcher to discover new knowledge

- EHR has several advantages over paper-based systems. Storage and retrieval of data is obviously more efficient using EHRs.
- It helps to improve quality and convenience of patient care, increase patient participation in the healthcare process, improve accuracy of diagnoses and health outcomes, and improve care coordination.
- It also reduces cost by eliminating the need for paper and other storage media.
- It provides the opportunity for research in different disciplines.
- In 2011, 54% of physicians had adopted an EHR system, and about three-quarters of adopters reported that using an EHR system resulted in enhanced patient care

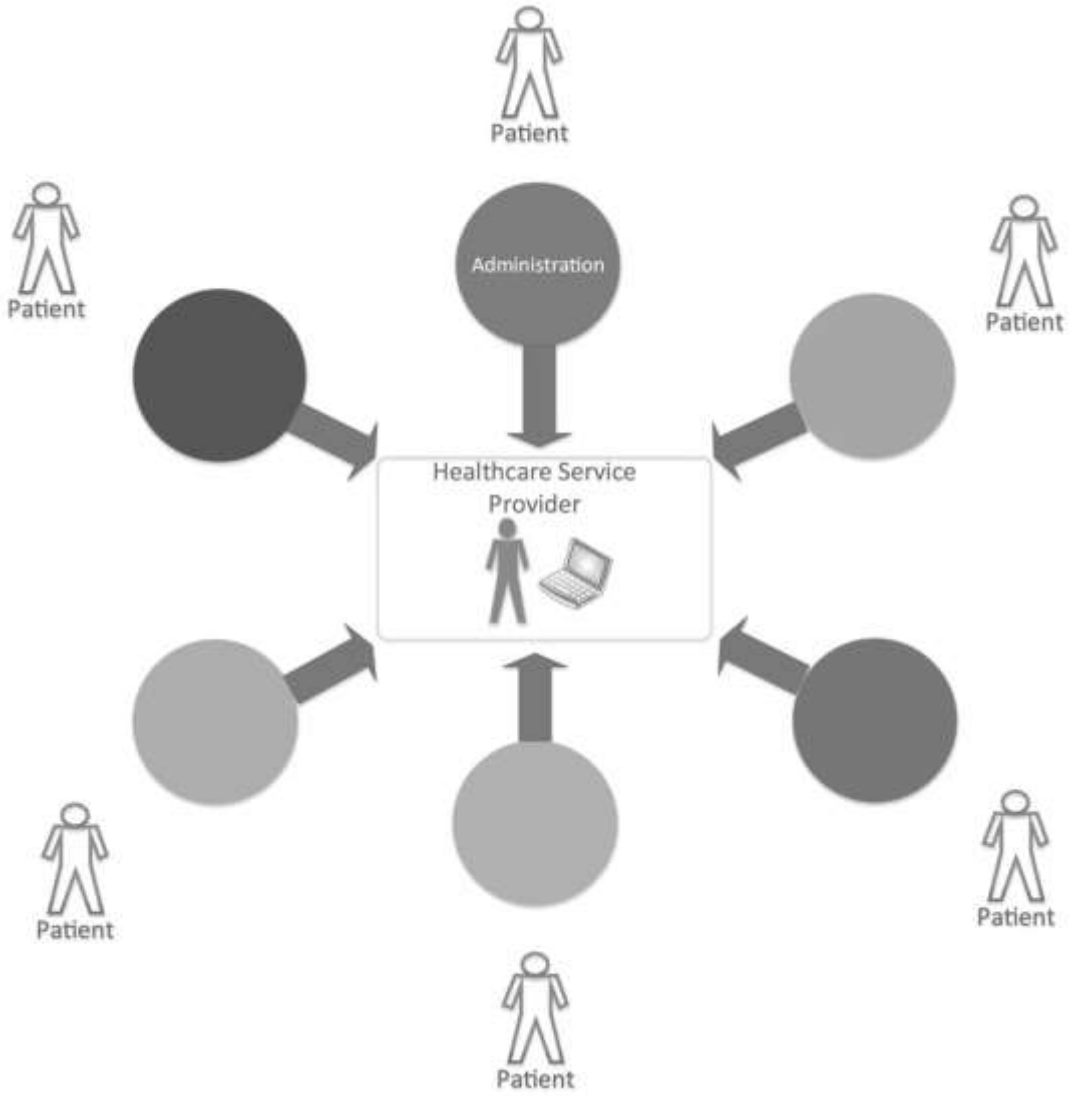
- Usually, EHR is maintained within an institution, such as a hospital, clinic, or physician's office.
- An institution will contain the longitudinal records of a particular patient that have been collected at their end.
- The institution will not contain the records of all the care provided to the patient at other venues.
- Information regarding the general population may be kept in a nationwide or regional health information system.
- Depending on the goal, service, venue, and role of the user, EHR can have different data formats, presentations, and level of detail.

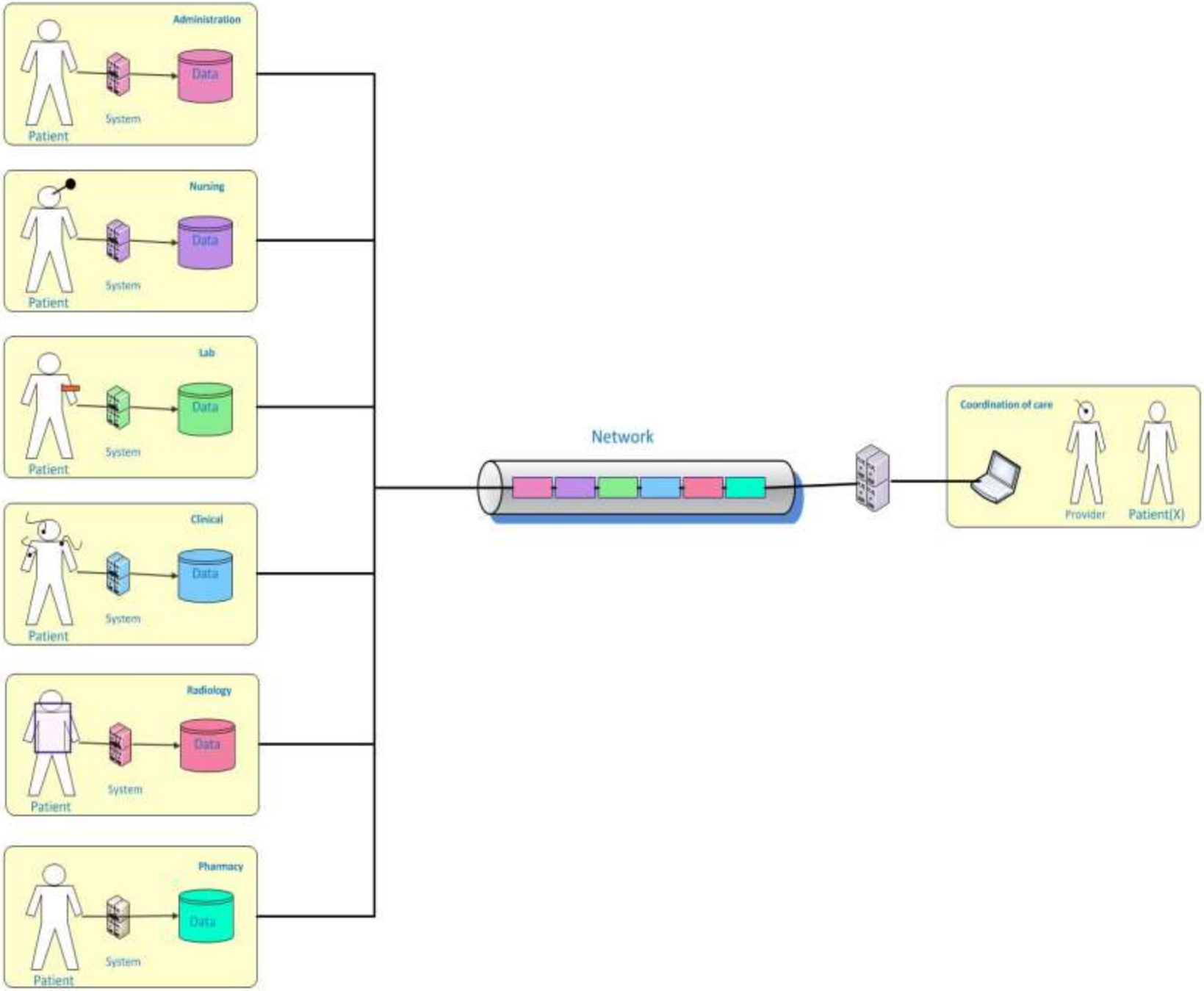
History of EHR

- The first known medical record can be traced back to the fifth century B.C. when Hippocrates prescribed two goals for medical records:
  - A medical record should accurately reflect the course of disease.
  - A medical record should indicate the probable cause of disease.

Although these two goals are still appropriate, EHR has a lot more to offer.
Modern EHR can provide additional functionalities that could not be performed using paper-based systems.

Components of EHR




Administration
Data
System
Patient
Nursing
Data
System
Patient
Lab
Data
System
Patient
Clinical
Data
System
Patient
Radiology
Data
System
Patient
Pharmacy
Data
System
Patient
Network
Coordination of care
Provider
Patient(X)

- The main purpose of EHR is to support **clinical care and billing**.
- This also includes other functionalities, such as improving the quality and convenience of patient care, improving the accuracy of diagnoses and health outcomes, improving care coordination and patient participation, improving cost savings, and finally, improving the general health of the population.
- Most modern EHR systems are designed to integrate data from different components such as administrative, nursing, pharmacy, laboratory, radiology, and physician' entries, etc.
- Electronic records may be generated from any department.
- Hospitals and clinics may have a number of different ancillary system providers; in that case, these systems are not necessarily integrated to the main EHR system.
- It is possible that these systems are stand-alone, and different standards of vocabularies have been used.
- If appropriate interfaces are provided, data from these systems can be incorporated in a consolidated fashion; otherwise a clinician has to open and log into a series of applications to get the complete patient record.
- The number of components present may also vary depending on the service provided. Figure shows different components of an EHR system.

- Administrative System Components
  - Administrative data such as patient registration, admission, discharge, and transfer data are key components of the EHR.
  - It also includes name, demographics, employer history, chief compliant, patient disposition, etc., along with the patient billing information.
  - Social history data such as marital status, home environment, daily routine, dietary patterns, sleep patterns, exercise patterns, tobacco use, alcohol use, drug use and family history data such as personal health history, hereditary diseases, father, mother and sibling(s) health status, age, and cause of death can also be a part of it.
  - Apart from the fields like “comments” or “description,” these data generally contain <name-value> pairs. This information is used to identify and assess a patient, and for all other administrative purposes.
  - During the registration process, a patient is generally assigned a unique identification key comprising of a numeric or alphanumeric sequence.
  - This key helps to link all the components across different platforms.

- For example, lab test data can create an electronic record; and another record is created from radiology results.
- Both records will have the same identifier key to represent a single patient.
- Records of a previous encounter are also pulled up using this key.
- It is often referred to as the medical record number or master patient index (MPI).
- Administrative data allows the aggregation of a person's health information for clinical analysis and research.

- Laboratory System Components & Vital Signs
  - Generally, laboratory systems are stand-alone systems that are interfaced to the central EHR system.
  - It is a structured data that can be expressed using standard terminology and stored in the form of a name-value pair.
  - Lab data plays an extremely important part in the clinical care process, providing professionals the information needed for prevention, diagnosis, treatment, and health management.
  - About 60% to 70% of medical decisions are based on laboratory test results.
  - Electronic lab data has several benefits including improved presentation and reduction of error due to manual data entry.
  - A physician can easily compare the results from previous tests.
  - If the options are provided, he can also analyze automatically whether data results fall within normal range or not.

- The most common coding system used to represent the laboratory test data is Logical Observation Identifiers Names and Codes (LOINC).
- Many hospitals use their local dictionaries as well to encode variables.
- A 2009–2010 Vanderbilt University Medical Center data standardization study found that for simple concepts such as “weight” and “height,” there were more than five internal representations.
- In different places there are different field names for the same feature and the values are stored with different units (e.g., kilograms, grams, and pounds for weight; centimeters, meters, inches, and feet for height).
- Vital signs are the indicators of a patient’s general physical condition.
- It includes pulse, respiratory rate, blood pressure, body temperature, body mass index (BMI), etc.
- A typical EHR system must provide the option to accommodate these kinds of variables.

Radiology System Components

- In hospital radiology departments, radiology information systems (RIS) are used for managing medical imagery and associated data. RIS is the core database to store, manipulate, and distribute patient radiological data.
- It uses Current Procedural Terminology (CPT) or International Classification of Diseases (ICD) coding systems to identify procedures and resources.
- Generally, an RIS consists of patient tracking, scheduling, result reporting, and image tracking capabilities.
- RIS is usually used along with a picture archiving communications system (PACS), which is a medical technology for providing economical storage and convenient access to the digital images.
- An RIS can generate an entire patient's imagery history and statistical reports for patients or procedures. Although many hospitals are using RIS, it may or may not be integrated with the central EHR system

Pharmacy System Components

- In hospitals and clinics, the pharmacy department's responsibility is to maintain the inventory, prescription management, billing, and dispensing medications.
- The pharmacy component in HER will hold the complete medication history of a patient such as drug name, dosage, route, quantity, frequency, start and stop date, prescribed by, allergic reaction to medications, source of medication, etc.
- Pharmacists serve an important public health role by administering immunizations and must have the capabilities to document these services and share this information with other healthcare providers and public health organizations.
- They assure safe and effective medication and supporting patient-centered care. Pharmacies are highly automated in large hospitals.
- Again, it may be independent of central EHRs.
- The Food and Drug Administration (FDA) requires all the drugs to be registered and reported using a National Drug Code (NDC).
- Coding systems used are NDC, SNOMED, and RxNorm.

Computerized Physician Order Entry (CPOE)

- Computerized Physician Order Entry (CPOE) is a very important part of EHRs. It is a system that allows a medical practitioner to enter medical orders and instructions for the treatment of a patient.
- For example, a doctor can electronically order services to laboratory, pharmacy, and radiology services through CPOE.
- Then it gets propagated over a network to the person responsible for carrying out these orders.
- As a digital system, CPOE has the potential to reduce medicationrelated errors. It is possible to add intelligent rules for checking allergies, contradictions, and other alerts.
- The primary advantages of CPOE are the following: overcomes the issue of illegibility, fewer errors associated with ordering drugs with similar names, more easily integrated with decision support systems, easily linked to drug-drug interaction warning, more likely to identify the prescribing physician, able to link the adverse drug event (ADE) reporting systems, able to avoid medication errors like trailing zeros, create data that is available for analysis, point out treatment and drug of choice, reduce under- and overprescribing, and finally, the prescriptions can reach the pharmacy quicker.
- While ordering, a professional can view the medical history, current status report from a different module, and evidence-based clinical guidelines. Thus, CPOE can help in patient-centered clinical decision support

- If used properly, CPOE decreases delay in order completion, reduces errors related to handwriting or transcriptions, allows order entry at point-of-care or off-site, provides error checking for duplicate or incorrect doses or tests, and simplifies inventory and positing of charges. Studies have shown that CPOE can contribute to shortened length of stay and reduction of cost.
- There are some risks involved in adopting CPOE as well.
- It may slow down interpersonal communication in an emergency situation. If each group of professionals (e.g., physicians and nurses) works alone in their workstations, it may create ambiguity about the instructions.
- These factors led an increase in mortality rate by 2.8%–6.5% in the Children's
- Hospital of Pittsburgh's Pediatric ICU when a CPOE system was introduced.
- Frequent alerts and warnings may also interrupt workflow. The adaptation rate of CPOE is slow. It may be partly due to physicians' doubt about the value of CPOE and clinical decision support.

Clinical Documentation

- A clinical document contains the information related to the care and services provided to the patient.
- It increases the value of EHR by allowing electronic capture of clinical reports, patient assessments, and progress reports.
- A clinical document may include
  - Next page ……..

A clinical document may include

- Physician, nurse, and other clinician notes
- Relevant dates and times associated with the document
- The performers of the care described
- Flow sheets (vital signs, input and output, and problems lists)
- Perioperative notes
- Discharge summaries
- Transcription document management
- Medical records abstracts
- Advance directives or living wills
- Durable powers or attorney for healthcare decisions
- Consents (procedural)
- Medical record/chart tracking
- Release of information (including authorizations)
- Staff credentialing/staff qualification and appointments documentations
- Chart deficiency tracking
- Utilization management
- The intended recipient of the information and the time the document was written
- The sources of information contained within the document

- Well-documented medical records reduce the re-work of claims processing, compliance with CMS (Centers for Medicare and Medicaid Services), Tricare and other payer's regulations and guidelines, and finally impacts coding, billing, and reimbursement.
- A clinical document is intended for better communication with the providers.
- It helps physicians to demonstrate accountability and may ensure quality care provided to the patient.
- A clinical document needs to be patient centered, accurate, complete, concise, and timely to serve these purposes.
- The clinical document architecture (CDA) is an XML-based electronic standard developed by the Health Level 7 International (HL7) to define the structure.
- It can be both read by human eyes and processed by automatic software.

Question ?