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Health/NURSING Informatics & Technology

(Computer for Nurses)

As per the Revised Syllabus for BSc Nursing

Semester II



R Sreevani

JAYPEE

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Principles of Health Informatics

UNIT 2

INTRODUCTION

Health informatics (HI) also known as healthcare informatics, medical informatics, biomedical informatics or health information system is a relatively new, interdisciplinary field in the healthcare industry.

It encompasses knowledge, skills and tools that enable information to be collected, managed, used and shared to support delivery of healthcare and promote health.

Meaning and Definitions

To understand the meaning of health informatics we first need to define informatics. The term 'informatics' is derived from the French word *'informatique'*. It includes:

- **Science of information:** It studies the analysis, collection, classification, manipulation, storage, retrieval, movement, dissemination, and protection of information. It also deals with acquiring information from raw data systematically.
- **Information processing:** It relates to how the information can be used and what methods are applied to transform healthcare information into useful and usable knowledge.
- **Engineering of information systems:** It refers to engineering of systems that involve input of data and its transformation to information using appropriate methods. It also refers to complementary networks of hardware and software used to collect, filter, process, create and distribute data.

  Informatics studies structure, behavior, interactions of natural and artificial systems that store, process and communicate information. Informatics thus does not refer to computer science or computational methods though many of the methods it employs may be related to computer science.
- **Information and communication technology (ICT):** It refers to communication technologies and services used in various applications. It describes these computer, communication and multimedia technologies used to receive, process, store, display and disseminate information. ICT is an umbrella term often used to describe communication within applications in a specific domain. For example, ICT in Health Care.
- **Health informatics:** Health informatics has been defined by the World Health Organization (WHO) as "an umbrella term used to encompass the rapidly evolving discipline of using computing, networking and communications—methodology and technology—to support the health-related fields such as medicine, nursing, pharmacy and dentistry".

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'A field that concerns itself with the cognitive, information processing, and communication tools of medical practice, education and research including information science and technology to support these tasks.'

—Edward H Shortliffe

'Medical informatics is the application of computer technology to all fields of medicine —medical care, medical teaching and medical research.' *—Morris F Collen*

'Medical informatics attempts to provide theoretical and scientific basis for the application of computer and automated information systems to biomedicine and health affairs, studies biomedical information and knowledge—their storage, retrieval, and optimal use for problem-solving and decision-making.' *—Donand AB Lindberg*

ELEMENTS IN HEALTH INFORMATICS

The key elements in health informatics are acquisition, storage and retrieval, communication, manipulation and display **(Fig. 2.1)**.

1. ***Acquisition:*** It deals with capturing of data generated in the course of providing health care. Various ways to acquire information in clinical environment are as follows **(Fig. 2.2)**:
   - *Observation and clinical examination:* Healthcare providers collect crucial information from patients using systematic evaluation procedures. They also use their natural senses to collect as much information as possible while examining the patients. For example, inspection, palpation, etc.

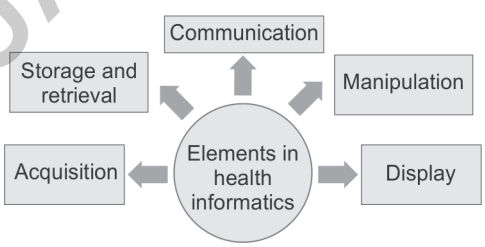

Fig. 2.1: Elements in health informatics

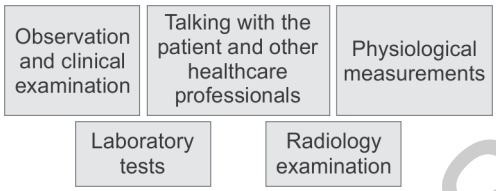

Fig. 2.2: Ways to acquire information in clinical environment

   - *Talking with the patient and other healthcare professionals:* Considering the fact that nurses spend a considerable amount of time with the patient, their observations can serve as a valuable input for the doctor. A nurse is in the best position to observe even small changes or events like loss of appetite, change in skin color or consciousness. Such inputs can be of significant importance as the physician may not be in place to observe it all. Thus, interactions between nurses and doctors can be of great importance.
   - *Physiological measurements:* These may range from simple tests such as measurement of body temperature with a clinical thermometer and measurement of blood pressure to more complicated tests such as measuring the heart function by taking an electrocardiograph (ECG). Majority of such tests are carried out by nurse practitioners.
   - *Laboratory tests:* Laboratory tests involve analysis of samples extracted from patients. For instance, it may involve analysis of blood, urine or tissue samples extracted from patients. These are run both during routine health check-ups (blood, urine, tissue samples) and also during hospitalization to help shape a diagnosis (enzyme concentration, antibody tests).
   - *Radiology exams:* It includes a variety of imaging techniques used to diagnose/treat diseases such as X-ray, ultrasound, computed tomography (CT), positron emission tomography (PET), magnetic resonance imaging (MRI).

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2. **Storage and retrieval:** Healthcare related data can be stored by direct entry into electronic medical records (and consequent storage in relational databases in the backend) or using sensors to perform measurements and transmitting the data via a communication module to interoperable systems or scanning handwritten documents and using optical character recognition (OCR) technologies. Healthcare professionals retrieve information using search tools available in graphical user interfaces or electronic medical records.
3. **Communication:** Acquired health information is communicated from the point of data collection to storage for analysis and across subsections of a hospital information system. However, it involves the use of communication protocols and interoperability standards which should not only be technically compatible but also be able to achieve seamless data exchange.
4. **Manipulation:** Data needs to be manipulated, combined and aggregated for statistical and healthcare analytics purposes. It may range from calculating a patient's age to generating prediction models. It may also refer to different forms of data representation depending upon the requirement of the end user.
5. **Display:** It refers to the way data may be displayed for the purpose of easy understanding. It not only includes displaying of information via physical output devices such as monitors, printers, etc., but also via user-friendly interfaces such as human computer interactions and functional dialogue systems.

HEALTH INFORMATION SYSTEM

Health information system management is the primary function of any health informatics professional. The term health information system is used to describe any system that employs computer hardware and software to capture, store, manage and transmit information associated with the health of individuals. Basic types of information systems are **(Fig. 2.3)**:

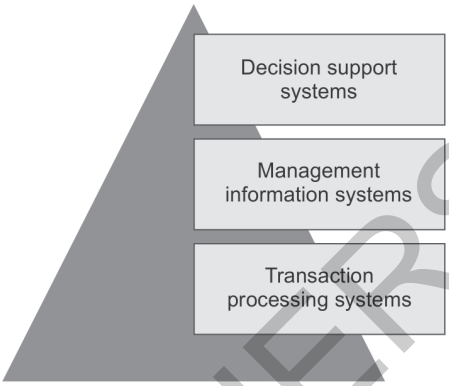

Fig. 2.3: Basic types of information system

- **Transaction processing systems:** It is a type of information system that collects, stores, modifies and retrieves the data transactions of an organization. Examples, patient billing system, hospital admission and discharge system.
- **Management information systems:** It is a set of systems and procedures that gather data from a range of sources, compile it and present it in a readable format. These software systems provide management tools for organizing and evaluating departments and their staff. Examples, emergency department, laboratory information system.
- **Decision support systems:** It is a computerized program used to support determinations, judgments and courses of action in an organization. These computer systems in addition to gathering data, use analytical models and tools to improve the outcome of decision-making tasks. Example, clinical decision support system.

Types of Health Information Systems

Healthcare organizations have various systems working together within a broader information technology environment. The various health information systems are presented in **Figure 2.4**.

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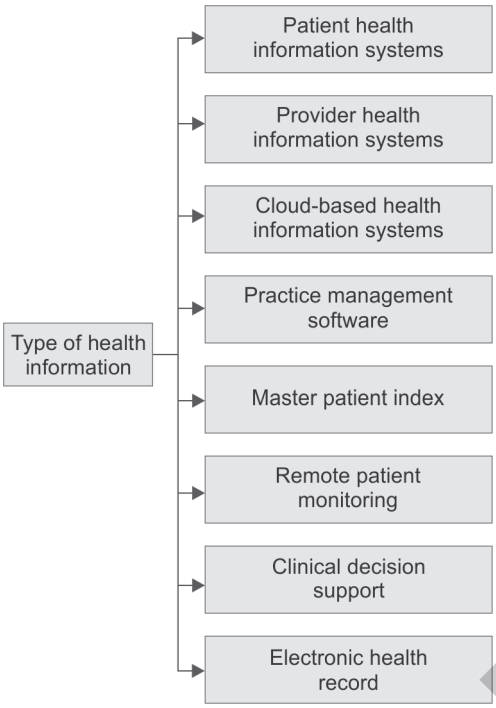

Fig. 2.4: Types of health information systems

- **Patient health information system/patient portals:** These are primarily web portals (websites or apps) wherein patients can log into their personal accounts to access medical history which may include details of their previous doctor visits. These portals help the patients to view lab test results, physician orders, nurse's notes, recommended medicines and follow-ups. It allows the patients to be a part of their own treatment and know the status of payments or insurance benefits. These portals often enable doctors and nurses to transmit confidential messages to patients, be it sharing of lab reports or simply recap the discussion had during the previous visit. There is also an option to message their provider securely and confidentially and pose follow-up questions.
- **Provider health information systems:** These systems contain information on population health, trends in the hospital or any other data relating to treatment decisions.
- **Cloud-based health information systems:** These systems make available common records across various departments and facilities thereby allowing each provider in the chain to access the same information. They also play an important role in collaborative care. It thus provides a clear picture of the patient's treatment history, minimizes redundant treatments and keeps all providers on the same page.
- **Practice management software:** These are mostly used by the front office managers of hospital set-up to automate administrative work such as keeping track of appointments, generating and dispatching bills, etc.
- **Master patient Index:** This system provides an entry for every registered patient whose individual files are linked across various databases thereby consolidating all the information connected to the patient treatment history.
- **Remote patient monitoring or telehealth:** It helps in keeping a track of patient's vital signs, blood pressure and other biometrics even when the patient has returned home. This is made possible with the help of sensors which the patients may wear inconspicuously and unobtrusively at home, school or work. The sensors transmit information back to the provider automatically. It allows the providers to monitor patients with conditions even such as diabetes remotely. It also permits the providers to determine when a patient may require further clinical intervention.
- **Clinical decision support (CDS):** It enables the providers to access and evaluate data from clinical and administrative subsystems. Information thus collected helps the providers to make prudent decisions about the likely clinical treatment. For example, the CDS information can help a provider prepare a diagnosis or predict on how different medications will interact. While CDS system relies on trends from

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an entire patient population, the providers can use the filtered information to take the best possible decision for each individual patient.

- **Electronic health record:** The electronic medical record is essentially a digitalized version of the paper chart that provides a long-term holistic view of the patient's health. It includes the following information:
  - Patient testing and treatment history
  - Demographic data
  - List of medications administered
  - History of present illness

Essentials of Health Information Systems and Technology

Health information systems can benefit a healthcare organization in numerous ways. The essentials of health information system includes both hardware and software requirements.

- Effective implementation of health information systems requires a secure wireless network connecting all associated devices and enabling the access and sharing of information from anywhere within the organization.
- It requires workstations for the healthcare providers such as doctors, nurses, technicians and administrators to access records from. These may include desktops, laptops and tablets.
- It requires employee training, best practices for maintaining network security and ensuring patient privacy, data encryption and backup to safeguard data from cyberattacks, hackers or system failures. It also requires cyber insurance to protect the organization from legal liability in the event that patient data is compromised.

Most of the larger hospital settings are likely to have an information technology team led by a chief information officer. Health information system provides an option for the decision makers to make the best possible use of resources to achieve optimal patient outcomes as efficiently as possible.

APPLICATIONS OF HEALTH INFORMATICS

Following are the applications of health informatics **(Fig. 2.5)**:

- **Translational bioinformatics:** It includes research on the development of novel techniques for the integration of biological and clinical data and the evolution of clinical informatics methodology to encompass biological observations.
- **Clinical research informatics**: It includes use of informatics in the discovery and management of new knowledge relating to health and disease. It manages the information related to clinical trials and also involves informatics related to secondary research use of clinical data.
- **Clinical informatics**: It is the application of informatics and information technology to deliver healthcare services. It is concerned with information use in health care by clinicians.
- **Consumer health informatics**: It analyzes consumer's needs for information, studies and implements methods for making information accessible to consumers and integrates consumer's preferences into health information systems.

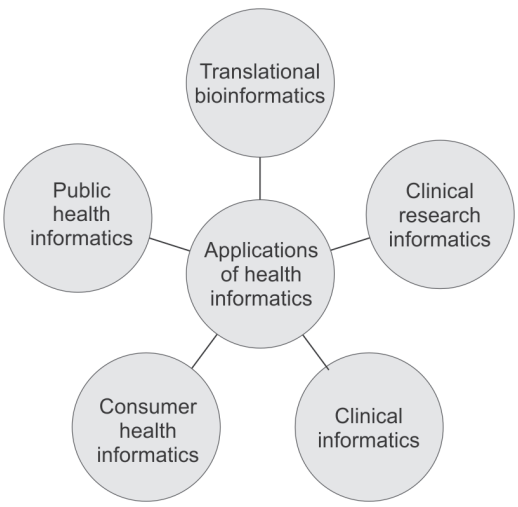

Fig. 2.5: Applications of health informatics

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- **Public health informatics**: It is the application of informatics in the area of public health including surveillance, reporting and health promotion.

OBJECTIVES OF HEALTH INFORMATICS

Health informatics is the intersection of information science, computer science, and health care. It studies resources, devices and methods required to optimize acquisition, storage, retrieval and use of information in health. The main objectives of health informatics are:

- To provide solutions for problems related to data, information and knowledge processing.
- To study the general principles of processing data, information and knowledge in medical and health care.
- To provide a structure for pooling, communicating and applying clinical evidence.

NEED FOR HEALTH INFORMATICS

- To organize, store and manage health data while using electronic health records.
- To have easy access to patient information so as to help physicians and nurses arrive at quick solutions.
- To make an appropriate healthcare decision. Better information leads to better decisions.
- To communicate with policymakers for policy planning. Healthcare, health management, health policy and health planning all depend on having good information to make decisions.
- To enable better collaboration and co-ordination among healthcare providers.
- To streamline medical quality assurance processes.
- To improve cost-efficiency in healthcare delivery.
- To increase accuracy and efficiency in practice management.
- To advance patient care and life sciences research, health professions education and public health.

PRINCIPLES OF HEALTH INFORMATICS

According to the American Medical Informatics Association (AMIA), health informatics applies principles of computer and information sciences to the advancement of patient care and life sciences research, health professions education and public health. The main principles of health informatics are:

- The health information system should be developed in a coordinated manner to facilitate interconnectivity.
- Recognize the needs of primary health care.
- Guarantee all privacy and confidentiality requirements.
- Serve the needs of both the individual patient and healthcare professional needs.
- Improve effectiveness and efficiency of healthcare services/delivery.
- Enable quality assessment and quality improvement.

BENEFITS OF HEALTH INFORMATICS

Health informatics applies information technology to healthcare delivery in a systematic manner. It deals with resources, devices and methods required to optimize the collection, storage, retrieval and communication of health-related data. It focuses on problem-solving, decision-making and assuring highest quality care in all basic and applied areas of biomedical sciences. The benefits of health informatics are depicted in **Box 2.1**.

- **Reduces healthcare cost and time:** Health care costs are expensive and also wasteful as half of all the medical expenditures are related to repeated procedures, expenses associated with traditional methods of sharing information, delays in care and errors in care or delivery. With an electronic and connected system in place much of misuse can be restricted with timely care being delivered to reduce malpractice claims and errors. Earlier incompetence and obstruction can be replaced with better communication and efficiency.

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Box 2.1: Benefits of health informatics

- Reduces health care cost and time
- Provides ease in decision-making
- Improves health care quality, outcome and safety
- Shares knowledge
- Improves access to information
- Reduces error rates
- Improves diagnoses and treatment
- Reduces the length of hospital stays
- Reduces mortality
- Improves delivery of care
- Empowers patients
- Increases coordination
- Improves communication
- Maintains data confidentiality and patient privacy
- Improves compliance of accreditation standards
- Improves education
- Accelerates research

Application of computer science and information technology to the many different facets of healthcare creates great efficiencies by minimizing and automating labor-intensive or time-consuming tasks and lowering healthcare costs.

- **Ease in decision-making:** Electronic record system enables physicians and nurses to make better and quicker decisions through on-line access to evidence-based results, assists in placing orders and receives alerts for significantly abnormal test results. This results in fewer errors being made and fewer resources being consumed. Having information at the right time supports clinical decision-making.
- **Improves healthcare quality, outcome and safety:** Quality of care delivered and access to knowledge and information are two important factors that can reduce errors and improve positive outcomes. Technology improves quality and safety in key areas. Nurses can receive alerts regarding patient care to prevent orders from being missed. Sharing of data can aid in decision-making with the patients. The most significant achievement of health informatics is the way it promotes improved outcomes. Electronic medical records result in quality care as the medical team is able to provide better diagnoses with little chance for errors. With manual jobs getting automated, doctors and nurses are able to spend more time with the patients thereby improving efficiency. This results in saving of time and money for hospitals, clinics and providers, so also for patients, insurance companies and the Government. Electronically generated reminders for screening and follow-up improve patient treatment adherence by 10 to 15%.
- **Shares knowledge:** Medicine is referred to as a "practice" as the healthcare providers are always learning and honing their skills. Health informatics provides an easier way to share knowledge on patients, diseases, therapies and medicines. As the knowledge is passed back and forth between providers and patients, the practice of medicine gets better thus aiding everyone with the chain of care.
- **Improves access to information:** Access to information for patients and providers can improve the quality of decision-making besides reducing errors resulting from missing documentation. Health informatics makes it possible for multiple users to share information concurrently within and outside the hospital for various purposes. Through Electronic Health Records (EHR) information can be shared between providers caring for the patients, third party payers and reporting agencies such as public health. Patients have real-time access to their health information. With mobile applications available, patients can carry all the information they need in the palm of their hands. Some even allow messaging services directly to their clinicians, offering a convenient way to access their doctor without scheduling

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an appointment. The use of communication technology based on the Internet makes it possible to provide health and social care to a patient directly even from a remote location.

- **Reduces error rates**: Health informatics reduces medication errors to ensure patients receive accurate prescriptions based on the information found in patient records. Having these processes automated through quality information systems managed by informaticists reduces errors, making care more effective and efficient.
- **Improves diagnoses and treatments**: Automated data sorting can help drive preventive care enabling clinicians to more readily identify patients with higher risks. This provides proper assessment and treatment even before a more severe health concern occurs.
- **Reduces the length of hospital stays**: Having the necessary tools to detect early patient risks can help the clinician provide treatment without requiring extended hospital stays. Informatics systems maintain data that equip healthcare providers with access to real-time patient records and medical information in an attempt to drive critical decision-making so as to provide the best patient care.
- **Reduces mortality**: Studies have suggested that introduction of information technology in hospitals reduces mortality and complications.
- **Improves delivery of care**: Delivery of care for various conditions can be improved as there is lesser trial and error on combining team-based practice with EHR.
- **Empowers patients**: Telehealth services allow patients to hold non-emergency appointments with their health care providers facilitating easier and more convenient healthcare delivery to more patients. This option will continue to benefit patients with limited mobility and those with limited access to transportation and nearby healthcare facilities. Patients are able to access their EHRs and review prescriptions and laboratory results to improve self-care. This access to one's own health history allows the patient to play an important role in personal health care and get empowered. Patients with access to healthcare portals are able to educate themselves about the diagnoses and prognoses while keeping a track of medications and symptoms. They are able to better interact with doctors and nurses resulting in better outcomes. It makes the patient feel that they are a precious part of their own healthcare team.
- **Increases co-ordination**: With patients receiving care from many different people in one hospital stay, health care is getting increasingly specialized. Patients are involved in many different conversations regarding care which may include medical tests, therapies, medication, discharge instructions, etc. Unless these conversations are held in a combination with one another newer problems may arise affecting care adversely. This requires increased co-ordination for which health informatics is the only way forward.
- **Improves communication**: It facilitates enhanced communication between providers and between providers and patients.
- **Maintains data confidentiality and patient privacy**: Health informatics professionals are using block chain technology to find new methods for data encryption. This ensures that patients and doctors do not have to worry about data breaches and compromised data and that the records are completely safe. They can also see which health providers have viewed their files allowing them to monitor privacy.
- **Improves administrative functions**: For a leader to be able to shape the policy of an organization he has to be equipped with up to date and relevant data. Being able to understand the activities taking place in the organization, the authorities can determine education needs, improve quality programs and create a culture

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of safety and accountability for the staff. Health informatics helps streamline administrative tasks that healthcare professionals usually handle such as filling paper work, processing billing codes and verifying insurance information. Electronic health records make it easy to not only create backup in digital format but also access it from anywhere and anytime with proper permission.

- **Improved compliance of accreditation standards**: Most electronic health record related software packages come with preset documentation standards for providers and staff.
- **Improves education**: Healthcare technology has many facets of patient and staff education incorporated in the patient record. Educative tools as regards procedures, medications and disease processes are available in electronic health records.
- **Accelerates research**: Health informatics also aids in accelerating research and solving public health challenges.

LIMITATIONS OR DISADVANTAGES

Despite the growing benefits of health informatics, some of the identified potential limitations or disadvantages with technology are presented below **(Fig. 2.6)**.

- **Impersonalization of care:** One of the main criticisms of approaching patient care through information and technology is that it results in lesser personal care and lack of empathy. Knowing the patient becomes a function of the data available and algorithms rather than the interaction in real time and space thereby enhancing the risk of miscommunication.
- **Cyber security risks:** As technology has a major role to play, the risk related to breach of protected health information is very high. Patient data and other private information is susceptible to network hackers. The additional risk of alteration in data leading to wrong healthcare decisions also cannot be ruled out. Alteration of device functionality can lead to adverse events.

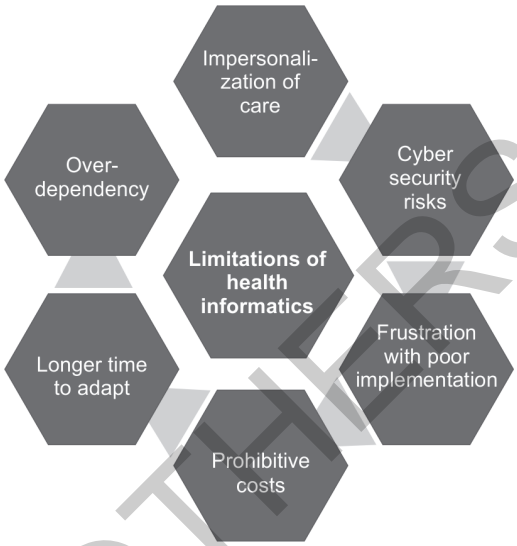

Fig. 2.6: Limitations of health informatics

- **Frustration with poor implementation:** Too much reliance on technology may not result in desired outcomes and at times also be counterproductive especially if the Artificial Intelligence (AI) implementation is poor. Clinicians may end up spending more time struggling with technology rather than providing the needed patient care.
- **Prohibitive costs:** Costs associated with sophisticated health technology, upgrades, maintenance and support, changes in workflow, lower revenues associated with temporary loss of productivity and ongoing training and support for end users can serve as a disincentive for hospitals to adopt and implement EHR. Higher input costs may make quality health care inaccessible to a sizeable population which is living below the poverty line.
- **Longer time to adapt:** As technology is constantly evolving, there can be new softwares, upgrades and ways of doing things. In order to keep up with it and maintain the competitive edge, the healthcare staff will be required to continually evolve and

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change the way they work. This can be a real struggle for the older staff.

- **Over-dependency:** With increasing dependence on data and technology and no way to revert to manual methods the cost and impact of system downtime (accumulated time during which the system is not performing in accordance with the required standard of performance) can rise rapidly. Such failures can erode the confidence and damage the reputation of the healthcare unit.

TRENDS FOR THE FUTURE

The field of health informatics expanded significantly in the decades following its first practical use in the 1950s when dental data was collected by the National Bureau of Standards. In 2009, the Health Information Technology for Economic and Clinical Health (HITECH) Act was created to promote and expand the adoption of health information technology—focusing mainly on the use of electronic health records (EHRs) by healthcare providers. Today, the International Medical Informatics Association (IMIA) oversees member organizations involved in health informatics worldwide.

Healthcare though for ages has been employing the paper-based system, it is now fast becoming obsolete due to its limited functionality and emergence of various data-capturing techniques. The challenge however comes from managing and streamlining large volumes of data. Some of the emerging trends include:

- Health data experts can utilize the health informatics data to track and draw insights for drawing public health management programs.
- Health informaticians can use newer technologies to perform predictive analysis about the likelihood of individual patients and larger patient population getting certain diseases.
- Digitization of healthcare in clinical settings will help in revolutionizing approaches at all levels of care with emphasis on precision medicine and person-centered care.
- Health informatics will provide greater interoperability, i.e., an ability to access, exchange, integrate and cooperatively use data in a coordinated manner both within and across organizational, regional and national boundaries enabling better care coordination, patient outcomes and reduced costs.
- The newer trends will empower the patients by providing them access to their health information.
- Existing and developing technologies can be used to support open, proactive, two-way communication between hospitals, clinicians, patients, vendors and other healthcare stakeholders.
- Focus is on offering a robust heath data infrastructure by providing faster, more interoperable and accessible patient records, reduction in errors, reduction in redundant testing, production of more complete and accurate healthcare records.
- Newer technologies which are at the core of successful health informatics are able to distinguish between large amounts of data and meaningful data at breakneck speeds enabling its seamless integration within an organization.

The rapid evolution of healthcare informatics has made it a critical component of the modern concept of public health and national healthcare policy.

USE OF DATA, INFORMATION AND KNOWLEDGE FOR MORE EFFECTIVE HEALTHCARE AND BETTER HEALTH

Health informatics is a scientific discipline that deals with the collection, storage, retrieval, communication and optimal use of health-related data, information and knowledge. This discipline utilizes methods and technologies of information science for the purpose of problem-solving, decision-making and assuring quality health care in all areas of biomedical sciences. Data, information and

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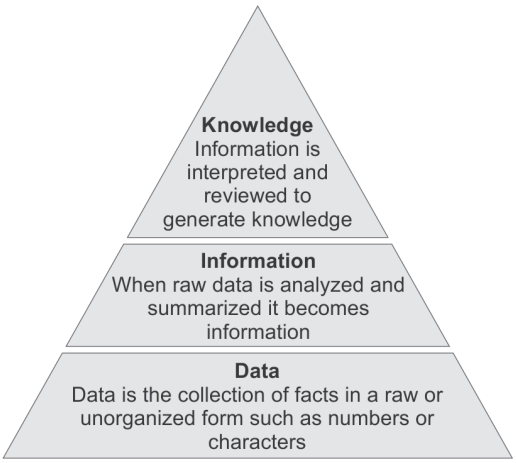

Fig. 2.7: Central concepts in health informatics

knowledge are central concepts in health informatics **(Fig. 2.7)**.

- **Data:** Data is the collection of facts in a raw or unorganized form such as numbers or characters acquired from many sources. It requires cleaning and processing. Without context and analysis, data has little meaning. Data in its simplest form consists of raw alphanumeric values.
- **Information:** When raw data is analyzed and summarized it transforms to information. Information can be defined as either data organized into meaningful unions or data placed in context with relevance, purpose and meaning. Unlike data, information has various purposes in creating knowledge, decision-making and guiding further actions. Information is useful data that has been processed in a way to improve the knowledge of the person using the data. Information is essentially processed data.
- **Knowledge:** Information is interpreted and reviewed to generate knowledge. It is combined with intelligence, evidence and qualitative data and presented to form decision-making. Knowledge is the justifiable belief based on data and information. Knowledge itself may be processed to generate decisions. Knowledge is needed to produce actionable information that can lead to impact.

Use of Data, Information and Knowledge for Effective Health Care

Data is the basic element of cognition on which all constructs are based and stored in information systems. Information and knowledge are derived from data. Attaching meaning to data transforms them into semantic data or information. Knowledge at the next level implies contextualized information (adding related information to something to make it more useful). This can mean including background information, patterns, trends, outliers, and more to help a reader make sense of what the data is really saying.

Types of Data in Healthcare Sector

Healthcare organization collects, processes and analyzes different types of data. Various types of data in healthcare sector are presented in **Figure 2.8**.

- **Clinical data:** It refers to information about patient care. It is collected from the patient during care or observed or obtained from electronic medical records, hospital information system, image centers, laboratories, pharmacies, physician's notes, physiological monitoring, etc. Examples are medical history, surgical interventions, investigation reports, etc. Clinical data can further be classified into narrative (recorded by clinician), numerical measurements (blood pressure and temperature), coded data (selected from a controlled terminology system), recorded

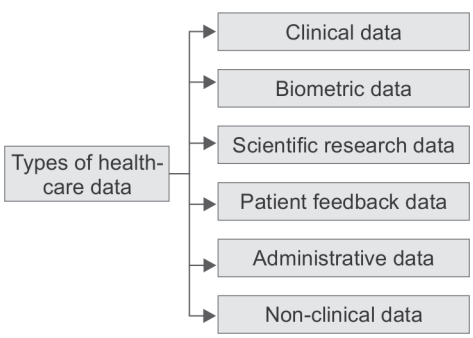

Fig. 2.8: Types of healthcare data

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signals (EKG, EEG), pictures (radiographs, photographs and other images).

- **Biometric data:** Data provided from various devices that monitor weight, pressure, heart rate, oxygen saturation, glucose level, etc.
- **Scientific research data:** Data from scientific research activities and results of research, drug trials, new inventions, etc.
- **Patient feedback data:** Data provided by patients may include description of preferences, level of satisfaction, information from systems for self-monitoring of their activity, exercises, sleep, meals consumed, etc.
- **Administrative data:** It refers to information that is collected, processed and stored in automated information systems. This data includes admission details, claims information, physician office visits, etc.
- **Non-clinical data:** It refers to information not directly related to patient treatment but still influencing the way professionals use healthcare facilities and resources.

The above generated data is stored in paper and digital form. It is also difficult to apply traditional tools and methods for management of unstructured data. Advanced analytical tools and technologies are needed to manage healthcare data.

Information and Knowledge Process in Health Care

Healthcare organizations are constantly generating health-related data. The primary purpose of health information systems is to help organizations capture this data, interpret it and put it to practical use. After the data is collected, it must be analyzed for making necessary decisions and changes in the organizations.

Information and knowledge process refers to organizational processes that ensure the availability of information and knowledge for professionals within an organization through the following four elements **(Fig. 2.9)**:

- **Information collection:** Information is collected from the patient during care or observed or obtained from electronic medical records, hospital information system, image centers, laboratories, pharmacies, physician's notes, physiological monitoring, etc. Examples are medical history, surgical interventions, investigation reports, etc.
- **Information transfer and storage:** Patient information in health care is mediated through information technology in electronic patient records. Electronic patient records enable easy storage and retrieval of patient information. Through this process information is integrated for knowledge creation and sharing.
- **Knowledge creation and sharing:** Knowledge is created through the collection of experience, the generation of new understanding by combining research findings. Knowledge sharing is an activity in which people make knowledge available to another or others. It can result in the construction of common meanings and the creation of new knowledge.
- **Information and knowledge use:** It refers to meaningful and purposive actions of knowledge use in practice and decision-making by various professionals in a health organization with expected positive organizational and patient outcomes.

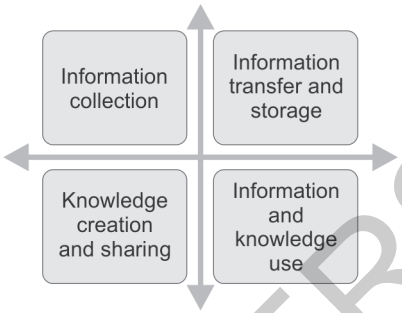

Fig. 2.9: Elements in information and knowledge process

Healthcare Big Data Analytics Applications

Medical facilities use both structured and unstructured data in their practice. While the structured data has a predetermined schema that is extensive, free form and comes in a

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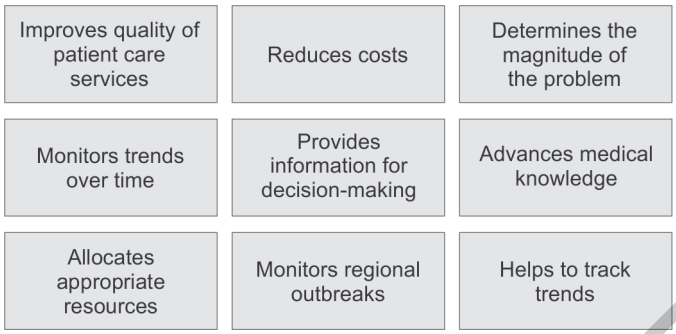

Fig. 2.10: Benefits of healthcare data management

variety of forms, the unstructured data referred to as Big data does not fit into the typical data processing format. Big data refers to massive amount of data sets that cannot be stored, processed or analyzed using traditional tools. It remains stored but is not analyzed. It requires a specific technology and method to transform it into value. Integrating data stored in both structured and unstructured formats can add significant value to an organization. Applications of big healthcare data analysis are as follows:

- **Diagnosis:** Identification of disease causes
- **Patient treatment:** Selecting treatment options
- **Precision medicine:** Treatment adjusted to a specific patient-personalized medicine
- **Preventive medicine:** Predictive analytics for disease prevention
- **Telemedicine:** Patient health monitoring
- **Health population support:** Big data monitoring to capture disease trends, outbreaks, etc.
- **Medical research:** Data-driven medical research
- **Cost reduction:** Greater insight into medical data translating into better patient care resulting in long-term savings

Benefits of Healthcare Data Management

A healthcare knowledge management system can create a more efficient flow of information between all healthcare providers, which can ultimately lead to increased efficiency and productivity. Various benefits of healthcare data management are presented in **Figure 2.10**.

- **Improves quality of patient care services:** Better data leads to better care. Immediate access to information allows for faster response and more effective treatment. Healthcare data management provides convenience to both the patient and the provider. With more complete documentation available for healthcare professionals patient can benefit from lower wait times, faster diagnoses, more efficient treatment, easier billing and insurance claims and better communication.
- **Reduces costs:** With more data available and the use of predictive modeling, healthcare professionals are equipped to be more proactive. This data not only helps in identification of unnecessary medical activities and procedures but also provides actionable insights making it easier to prevent readmissions, diagnose chronic conditions early, optimize treatments and improve care co-ordination. All these reduce healthcare costs.
- **Determines the magnitude of the problem:** Data describes what is known about the problem, place the problem in context, describe what already exists and identify gaps and population at high risk. It also helps in estimating disease prevalence and incidence.
- **Monitors trends over time:** Data provides a source of baseline information. Progress

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can be measured against this baseline information.

- **Provides information for decision-making:** Analysis of large volumes of data provides information on needs and resources. This helps in decision-making process of diagnosis and detection of more effective interventions for patients. By utilizing data in the health sector, medical providers and administrators can identify areas of risk or improvement within current pathways. With this information they can work to correct areas where patient care is lacking and increase the quality of overall patient experience. This can help improve patient care, promote strategic planning and utilize resources in a more efficient manner.
- **Advancement of medical knowledge:** Data helps in diagnosing rare illnesses, make connections between diseases and lifestyle choices, study the effects of treatment, etc. Through this data, healthcare professionals can analyze patient histories and similar case studies so as to hone their treatment decisions.
- **Allocates appropriate resources:** Through data analysis administrators can not only monitor patient footfalls in various departments but also allocate staffing and resources to where they are needed the most. This data is used to develop comprehensive care plans, improve patient outcomes and allocate organizational resources judiciously.
- **Monitors regional outbreaks:** Basic analysis of this data can reveal incidence and prevalence of diseases, track cases and monitor regional outbreaks. It also helps in prediction of occurrence of specific diseases or worsening of patient's condition.
- **Helps to track trends:** Collected data is stored and utilized to make a diagnosis and track trends following patient health condition.

The process of data analysis, patterns and trends allows health service providers to offer a more accurate and insightful diagnoses of patients and personalized treatment. It also helps to monitor patients, support medical research and health population, provide better quality of medical services and patient care, and reduce costs.



REVIEW QUESTIONS

Long Essays **(10 Marks)**

1. Write the meaning of data, information and knowledge. Explain their uses in effective health care.
2. What is the meaning of health informatics? Explain applications of health informatics.
3. Describe benefits of health informatics.

Short Essays **(5 Marks)**

1. Describe types of health information systems.
2. What are the essentials of health information system?
3. Narrate the need for health informatics in India.
4. Write the meaning of data, information and knowledge.
5. What is healthcare bigdata?

Short Answers **(2 Marks)**

1. What is information processing?
2. Meaning of information and communication technology.
3. Meaning of health informatics.
4. List the elements of health informatics.
5. What are the basic types of information systems?

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MULTIPLE CHOICE QUESTIONS

1. **What is the meaning of information processing?**
   a. It is related to methods applied to transform healthcare information into useable knowledge
   b. It is related to input of data and its transformation to information
   c. It is related to study of analysis, collection, classification and manipulation of information
   d. It is related to communication technologies that are used in various applications
2. **Following are the key elements of health informatics, except:**
   a. Acquisition b. Display
   c. Process d. Manipulation
3. **Which of the following deals with capturing of data generated in the course of providing health care?**
   a. Acquisition b. Display
   c. Process d. Manipulation
4. **Which of the computer programs is used to support determinations, judgments and courses of action in an organization?**
   a. Transaction processing system
   b. Management information system
   c. Decision support system
   d. Manipulation support system
5. **Which of the following is a web portal where the patient can log into his personal account to access his healthcare data?**
   a. Patient health information system
   b. Provider health information system
   c. Cloud-based health information system
   d. Master patient index
6. **Which of the following links individual files across various databases?**
   a. Telehealth
   b. Master patient index
   c. Electronic health record
   d. Remote patient monitoring
7. **Which of the following is a limitation of health informatics?**
   a. Maintains data confidentiality
   b. Empowers patients
   c. Cyber security risks
   d. Maintains data privacy
8. **Which of the following is a raw or unorganized form of facts?**
   a. Data
   b. Information
   c. Knowledge
   d. Characteristics
9. **Which of the following information can be categorized as non-clinical data?**
   a. Admission details of a patient
   b. Geographical reach to health organization
   c. Patient feedback about organization
   d. Laboratory results of a patient
10. **Which of the following refers to massive amount of data sets that cannot be stored, processed or analyzed using traditional tools?**
    a. Big data b. Electronic data
    c. Biometric data d. Clinical data

ANSWER KEY

1. a	2. c	3. a	4. c	5. a	6. b	7. c	8. a	9. b	10. a

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