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MEDICAL DATA, DIGITAL HEALTH AND ETHICAL PERSPECTIVE

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13.1 Introduction

Medical data refers to information related to a patient's medical history, treatments, and health status. This can include personal identifying information, such as name and date of birth, as well as medical records, test results, and imaging studies. Digital health refers to the use of digital technologies, such as electronic health records, telemedicine, and mobile health apps, to improve healthcare delivery, increase access to care, and support population health management.

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There are several ethical considerations related to the use of medical data and digital health technologies. One major concern is the issue of privacy. Medical data is often sensitive and personal in nature, and there are strict laws and regulations in place to protect the privacy of this information. There is also the risk of data breaches, which can result in the unauthorized release of medical data.

Another ethical consideration is the issue of Informed Consent. Patients have the right to know how their medical data will be used and have the ability to make decisions about whether or not to allow their data to be collected and shared.

There are also concerns related to equity and access to care. Digital health technologies have the potential to increase access to care for underserved populations, but there are also concerns about the digital divide and the potential for some groups to be left behind. Overall, the use of medical data and digital health technologies presents both opportunities and challenges, and it is important to carefully consider the ethical implications of these technologies to ensure that they are used in a responsible and beneficial manner.

13.2 Role of Digitalisation in Modern World

Digitalization has had a major impact on the modern world, transforming the way we communicate, work, and access information. Some of the ways in which digitalization has impacted the modern world include:

Communication: Digitalization has revolutionized the way we communicate, with the proliferation of email, social media, and messaging apps. These technologies have made it easier for people to stay connected and communicate with one another, regardless of location.

Education: Digitalization has had a major impact on education, with the availability of online courses and the use of educational technology

in the classroom. These tools have made it possible for students to access educational resources from anywhere, at any time.

Work: Digitalization has transformed the way we work, with the rise of remote work and the use of digital tools to manage tasks and collaborate with colleagues. These technologies have made it possible for people to work from anywhere and have also changed the nature of work itself.

Entertainment: Digitalization has impacted the way we access and consume entertainment, with the rise of streaming services and the proliferation of digital content.

Shopping: Digitalization has transformed the way we shop, with the rise of e-commerce and the availability of online marketplaces. These technologies have made it easier for people to shop from the convenience of their own homes and have also changed the way that businesses sell their products.

Healthcare: Digital health refers to the use of digital technologies to improve healthcare delivery, increase access to care, and support population health management. These technologies can include electronic health records (EHRs), telemedicine, mobile health apps, and other digital tools that are used to support the delivery of healthcare.

Digital health technologies have the potential to transform the way that healthcare is delivered, by making it more efficient, effective, and accessible. For example, EHRs can help to reduce errors and improve the accuracy of a patient's medical record, telemedicine can increase access to care for underserved populations, and mobile health apps can help patients to manage their own health. Overall, digitalization has had a significant impact on the modern world and has the potential to continue shaping the way we live and work in the future.

13.3 Medical Science and Role of Digitalisation

13.3.1 Sectors

Digitalization has played a significant role in the field of medicine and has had a major impact on the way that healthcare is delivered. Some of the ways in which digitalization has impacted medical science include:

Electronic health records (EHRs): Digitalization has made it possible to create electronic health records, which are digital versions of a patient's medical history that can be accessed and updated by authorized healthcare providers. EHRs can improve the accuracy and completeness of a patient's medical record and can also help to reduce errors and improve the efficiency of healthcare delivery.

Telemedicine: Digitalization has enabled the use of telemedicine, which allows healthcare providers to deliver care remotely using video conferencing and other digital technologies. Telemedicine can improve access to care, particularly for patients in rural or underserved areas.

Mobile health apps: There are many mobile health apps available that can help patients to manage their own health, such as by tracking their activity levels or monitoring their chronic conditions.

Clinical decision support: Digitalization has made it possible to use data and analytics to support clinical decision-making. For example, algorithms can be used to identify patterns and trends in patient data, which can help to inform treatment decisions.

Digitalization has had a major impact on the field of medicine and has the potential to improve the efficiency, effectiveness, and accessibility of healthcare.

13.3.2 Digitalisation in Dentistry

Digital technology has revolutionized many aspects of dentistry, making it more efficient and accurate, and improving patient care. Some examples of how digital technology is being used in dentistry include:

Digital radiography: Digital x-rays allow for the creation of high-quality images that can be easily stored and shared with other healthcare professionals.

Computer-aided design (CAD) and computer-aided manufacturing (CAM): These technologies allow dentists to create highly precise and accurate dental restorations, such as crowns and bridges, using digital scans of a patient's mouth.

Electronic health records (EHRs): Many dental practices now use electronic health records to store patient information, including medical and dental history, treatment plans, and x-rays. EHRs make it easier for dentists to access and share patient information.

Dental implants: Digital technology is being used to design and create custom dental implants that are more accurate and have a higher success rate.

Tele-dentistry: With the use of videoconferencing software, dentists can provide consultation and treatment remotely, making it easier for patients to access dental care.

The use of digital technology in dentistry has greatly enhanced the accuracy and efficiency of treatment and has improved the patient experience.

13.3.3 History of Digitalization in Healthcare

The use of digital technologies in healthcare has a long history, dating back to the 1950s with the development of the first electronic medical records (EMRs). However, it was not until the late 1990s and early 2000s that EMRs began to be widely adopted, with the development of more advanced technologies and the increasing use of the internet.

In the past two decades, there has been a rapid expansion of digital technologies in healthcare, including the widespread adoption of electronic health records (EHRs), the development of telemedicine, and the proliferation of mobile health apps. These technologies have trans-

formed the way that healthcare is delivered, increasing the efficiency and effectiveness of healthcare delivery and increasing access to care.

However, the use of digital technologies in healthcare has also raised a number of ethical considerations, including issues related to privacy, informed consent, and the potential for technology to disrupt the patient-provider relationship.

13.4 Electronic Health Records (EHR)

An electronic health record (EHR) is a digital version of a patient's medical history that can be accessed and updated by authorized healthcare providers. EHRs can include a wide range of information, including demographics, medical history, medications, test results, and imaging studies.

The use of EHRs can improve the accuracy and completeness of a patient's medical record and can also help to reduce errors and improve the efficiency of healthcare delivery. For example, EHRs can help to prevent prescribing errors by providing a complete list of a patient's medications and allergies and can also help to reduce duplication of tests by making test results and imaging studies available to all providers.

13.4.1 Role of EHR

The role of electronic health records (EHRs) is to store and manage a patient's medical history in a digital format. EHRs can include a wide range of information, including demographics, medical history, medications, test results, and imaging studies.

The use of EHRs can improve the accuracy and completeness of a patient's medical record and can also help to reduce errors and improve the efficiency of healthcare delivery. For example, EHRs can help to prevent prescribing errors by providing a complete list of a patient's medications and allergies, and can also help to reduce duplication of

tests by making test results and imaging studies available to all providers.

Overall, the role of EHRs is to improve the quality and efficiency of healthcare delivery by providing access to accurate and comprehensive patient information.

13.4.2 Components of EHR

An electronic health record (EHR) is a digital record of a patient's medical history and treatment. The components of an EHR system typically include:

Demographic information: This includes basic information about the patient, such as their name, age, address, and insurance information.

Medical history: This includes information about the patient's medical conditions, allergies, medications, and immunizations.

Progress notes: Progress notes are written records of a patient's treatment, including notes from doctors, nurses, and other healthcare providers.

Medications: This includes a list of the medications that the patient is currently taking, as well as information about their dosage and frequency.

Laboratory test results: This includes the results of any laboratory tests that have been performed, such as blood tests, urine tests, and imaging studies.

Imaging studies: This includes the results of any imaging studies that have been performed, such as x-rays, CT scans, and MRIs.

Immunizations: This includes a record of any immunizations that the patient has received.

Care plans: Care plans are written plans for a patient's treatment, including goals and objectives for their care.

Overall, an EHR system typically includes a wide range of information about a patient's medical history and treatment, which is used to support clinical decision-making and improve the quality of care.

13.4.3 Models of Electronic Health Records

There are several different models for electronic health records (EHRs), including:

Single provider EHRs: These are EHR systems that are used by a single healthcare provider, such as a doctor's office or a hospital. Single provider EHRs are typically owned and managed by the provider and are used to manage patient records within that specific organization.

Shared EHRs: These are EHR systems that are shared by multiple healthcare providers, such as a group of doctors who belong to the same practice. Shared EHRs can be owned and managed by a third party, or they can be owned and managed by the providers themselves.

Regional EHRs: These are EHR systems that are used by multiple healthcare providers within a specific region, such as a county or a state. Regional EHRs are typically owned and managed by a third party and are used to facilitate the exchange of patient information between providers within the region.

National EHRs: These are EHR systems that are used by healthcare providers across the country. National EHRs are typically owned and managed by a third party and are used to facilitate the exchange of patient information between providers across the country.

Overall, the choice of EHR model will depend on the needs and resources of the healthcare organization or region.

13.4.4 Types of EHR

There are several different types of electronic health records (EHRs), including:

Web-based EHRs: These are EHR systems that are accessed through a web browser, and do not require the installation of software on a local computer. Web-based EHRs are typically hosted by a third party and can be accessed from any location with an internet connection.

Client-server EHRs: These are EHR systems that are accessed through a local client application, which connects to a server that stores

the EHR data. Client-server EHRs may require the installation of software on a local computer but can also be accessed remotely through a web-based interface.

Hybrid EHRs: These are EHR systems that combine elements of web-based and client-server models. Hybrid EHRs may be accessed through a local client application or a web-based interface and may store data on both a local server and a remote server.

Standalone EHRs: These are EHR systems that are used by a single provider or practice and are not connected to any other EHR systems. Standalone EHRs may be web-based, client-server, or hybrid in nature.

13.4.5 Worldwide Examples of EHR

There are many examples of electronic health record (EHR) systems being used worldwide. Some examples include:

The National Health Service (NHS) in the United Kingdom: The NHS has implemented a national EHR system called the Electronic Patient Record (EPR), which is used by hospitals and other healthcare providers across the country. The EPR stores a wide range of patient information, including demographics, medical history, medications, test results, and imaging studies.

The Veterans Health Administration (VHA) in the United States: The VHA operates the largest EHR system in the world, called the Veterans Health Information Systems and Technology Architecture (VistA). VistA is used by hospitals and other healthcare providers within the VHA to manage patient records and support clinical decision-making.

The National E-Health Transition Authority (NEHTA) in Australia: NEHTA is responsible for implementing the National EHR system in Australia, called the Personally Controlled Electronic Health Record (PCEHR). The PCEHR is a web-based system that allows patients to access and manage their own health information and is also used by healthcare providers to access patient records and share information.

The Singapore Health Services (SingHealth) in Singapore: SingHealth operates the Integrated Health Information Systems (IHiS), which is a comprehensive EHR system that is used by hospitals and other healthcare providers in Singapore. The IHiS stores a wide range of patient information and is also used to support clinical decision-making and population health management.

There are many examples of EHR systems being used worldwide, and these systems have the potential to improve the quality and efficiency of healthcare delivery.

13.4.6 Indian prospect of EHR

In India, electronic health records (EHRs) are being implemented in some hospitals and healthcare facilities, although the adoption of EHRs has been slower compared to other countries. Some challenges to the implementation of EHRs in India include a lack of standardization, concerns about data security and privacy, and limited funding.

Despite these challenges, there are a number of initiatives underway to promote the adoption of EHRs in India. For example, the National Health Portal of India is a web-based platform that allows patients to access and manage their own health information and is also used by healthcare providers to access patient records and share information. Additionally, the government of India has launched the National EHR Project, which aims to create a national EHR system that will be used by hospitals and other healthcare providers across the country.

The adoption of EHRs in India is in the early stages, but there is potential for EHRs to improve the quality and efficiency of healthcare delivery in the country.

13.4.7 Advantages and Disadvantages of EHR

There are both advantages and disadvantages to the use of electronic health records (EHRs). Some of the potential advantages of EHRs include:

1. Improved accuracy and completeness of patient records:
2. Improved efficiency of healthcare delivery:
3. Increased access to patient information:
4. Improved population health management: However, there are also some potential disadvantages to the use of EHRs, including:
5. Initial costs: Implementing an EHR system can be expensive, and may require a significant investment in hardware, software, and training.
6. Ongoing maintenance and support: EHR systems require ongoing maintenance and support, which can also be costly.
7. Privacy and security concerns: EHRs store sensitive personal and medical information, and there are concerns about the security and privacy of this data.
8. User adoption: EHRs require healthcare providers to change the way they work, and there may be resistance to the adoption of new technology.

Overall, the use of EHRs can offer many potential advantages, but it is important to carefully consider the costs and potential challenges associated with implementing an EHR system.

13.5 Telemedicine in Healthcare

Telemedicine is the use of video conferencing and other digital technologies to deliver healthcare remotely. Telemedicine can be used for a wide range of healthcare services, including consultations, diagnoses, and follow-up care.

Telemedicine has the potential to improve access to care, particularly for patients in rural or underserved areas who may have limited access to in-person medical care. Telemedicine can also be convenient for patients, as it allows them to receive care from the comfort of their own home.

However, telemedicine also has some limitations, such as the inability to perform hands-on examinations or tests, and the potential for technical issues to disrupt the consultation. Additionally, there are some concerns about the potential for telemedicine to disrupt the patient-provider relationship, and about the potential for telemedicine to be used as a substitute for in-person care in all cases.

Overall, telemedicine can be a useful tool for increasing access to care and improving the efficiency of healthcare delivery, but it is important to carefully consider the potential limitations and ethical considerations of telemedicine.

13.5.1 Virtual Health Care, Telehealth and Telemedicine

The terms Virtual Health Care, Telehealth and Telemedicine are sometimes used interchangeably but there are some clear differences. While many of their aspects were already in existence and in use, their role has become more widely recognised and more accepted. As per studies the e-health market in India is expected to grow at a CAGR of 31% during 2025 with a potential of USD 5.5 billion*.

Considering a huge geographical area that our country encompasses, reaching out with a provision of In-person healthcare is challenging considering the limited resources'- Health application can be utilised as a mode to save the cost and effort specifically of rural patients, as this can reduce the out of pocket of travelling while conserving time. Hence, mainstreaming forms of e health services in health systems will curtail inequity and barriers to access.

13.5.2 Understanding the terms

Telemedicine is the ways that a patient and physician can communicate for diagnosis and treatment without being in the same location. It can be provided by hospitals / doctors themselves or by intermediaries between them. It is an effective way of providing care for non- emer-

gency ailments. Example: e-Sanjeevani initiative by MOHFW (Ayushman Bharat scheme of govt. of India.)

Telehealth is a broader term. It includes the use of various technologies and telecommunication to deliver and facilitate not just diagnoses and treatment to patients but also provide healthcare education via telecommunications or any of the health information services that use remote communication.

Virtual Healthcare is a term embracing several healthcare aspects, including telehealth, telemedicine, digital healthcare. It is powered by digital infrastructure and technologies including various information and communication technologies to provide health-related services.

13.5.3 Difference between Telemedicine, Telehealth and Virtual Healthcare

Literature suggests that telemedicine is a subset of telehealth, which is a subset of virtual healthcare.

Telemedicine focusses on clinical services via two-way live audio-visual transmission between a healthcare expert and the patient whereas, Telehealth includes telemedicine and other non-clinical services such as health education, support to Public Health administration etc. Virtual healthcare combines telehealth and a other health approaches including e-triage, replacement therapies, remote patient monitoring, Treatment Optimization, and guided patient care.

13.5.4 Benefits of Virtual Health Care

Wherever implemented, virtual healthcare benefits have been well documented***. It Strengthens Self Care Model, Beneficial towards achieving wider goal of “Health for All”, Expands Quality of Patient Care, Encourages accessible and affordable Health Care.

13.5.5 SWOT Analysis

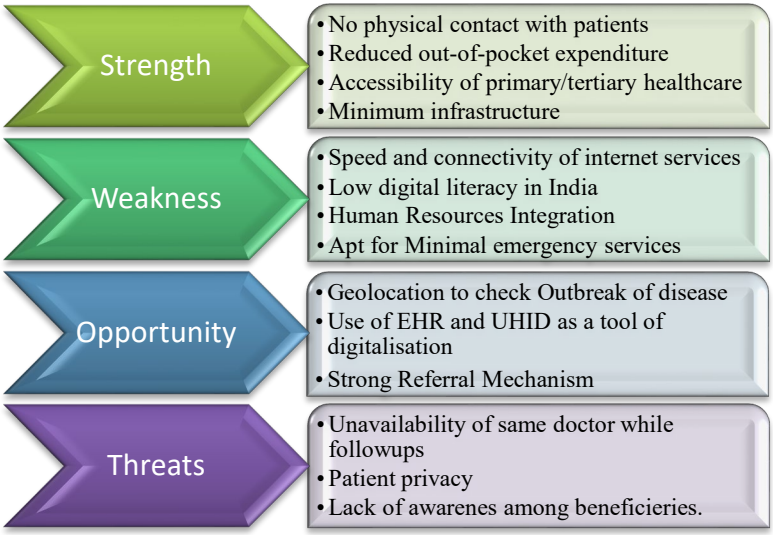
While Virtual Healthcare is a very rewarding proposal for healthcare policy makers, it has its own set of challenges.

Strengths: No physical contact with patients, Reduced out-of-pocket expenditure, Accessibility of primary and tertiary healthcare, Minimised infrastructure

Weaknesses: Dependant on speed and connectivity of internet services, Low digital literacy in India, lack of awareness among beneficiaries, Human Resources Integration, apt for Minimal emergency services

Opportunities: Geolocation can be used to check early Outbreak of disease. EHR and UHID as a tool of digitalisation, Strong Referral Mechanism.

Threats: Unavailability of same doctor for follow-ups, Patient privacy and data security, Lack of regulation would lead to misinformation, self-medication.



Considering developing countries' Health-Care Delivery System Virtual Health Care can help in reaching to grassroots level with virtual specialist visits and tele-ICU coverage in alliance with local rural health systems to extend access to services. It can also enable academic medical centers at district levels and empower home based and rural caregivers. The evolving technology and socio-economic acceptance have provided the perfect opportunity to drive and realize the goal of affordable and accessible healthcare for all.

13.5.6 Telemedicine Components

The components of a telemedicine portal typically include:

Video conferencing software: Telemedicine portals use video conferencing software to enable real-time consultations between patients and healthcare providers.

Patient portal: A patient portal is an online platform that allows patients to access their medical records, schedule appointments, and communicate with their healthcare providers.

Scheduling and appointment management: Telemedicine portals often include features to manage appointments and schedule consultations between patients and healthcare providers.

Electronic health records (EHRs): EHRs are digital records of a patient's medical history and may be integrated with a telemedicine portal to provide healthcare providers with access to a patient's medical history during a telemedicine consultation.

Payment processing: Telemedicine portals may include features for processing payments for telemedicine consultations and other healthcare services.

Overall, telemedicine portals typically include a range of features and tools to enable the delivery of healthcare services remotely through video conferencing and other digital technologies.

13.5.7 Advantages and Disadvantages of Telemedicine

There are both advantages and disadvantages to the use of telemedicine in healthcare. Some of the *potential advantages of telemedicine* include:

- Improved access to care: Telemedicine can improve access to care, particularly for patients in rural or underserved areas who may have limited access to in-person medical care.
- Convenience for patients: Telemedicine allows patients to receive care from the comfort of their own home, which can be convenient for patients who have mobility issues or difficulty traveling.
- Improved efficiency of healthcare delivery: Telemedicine can reduce the need for patients to travel to see a healthcare provider, which can save time and resources.
- Potential cost savings: Telemedicine can reduce the need for patients to travel to see a healthcare provider, which can lead to cost savings for patients and healthcare systems.
- However, there are also some *potential disadvantages to telemedicine*, including:
- Limited ability to perform hands-on examinations or tests: Telemedicine relies on video conferencing and other digital technologies, which can limit the ability of healthcare providers to perform hands-on examinations or tests.
- Potential for technical issues: Telemedicine relies on technology, which can be subject to technical issues that can disrupt consultations.
- Potential to disrupt the patient-provider relationship: Telemedicine can disrupt the traditional patient-provider relationship, which may be problematic for some patients and providers.
- Limited availability in some areas: Telemedicine may not be available in all areas, due to a lack of infrastructure or other barriers.
- Overall, telemedicine can offer many potential advantages, but it is important to carefully consider the potential limitations and chal-

lenges of telemedicine in order to ensure that it is used in a responsible and beneficial manner.

13.5.8 Telemedicine worldwide portals

Some *examples of telemedicine portals* that are available worldwide include:

- Teladoc: Teladoc is a telemedicine platform that allows patients to connect with healthcare providers for consultations, diagnoses, and treatment recommendations. Teladoc is available in the United States and other countries, and can be accessed through a website or mobile app.
- Doctor on Demand: Doctor on Demand is a telemedicine platform that allows patients to connect with healthcare providers for consultations, diagnoses, and treatment recommendations. Doctor on Demand is available in the United States and other countries, and can be accessed through a website or mobile app.
- Amwell: Amwell is a telemedicine platform that allows patients to connect with healthcare providers for consultations, diagnoses, and treatment recommendations. Amwell is available in the United States and other countries, and can be accessed through a website or mobile app.
- NHS 111: NHS 111 is a telemedicine service offered by the National Health Service (NHS) in the United Kingdom. NHS 111 allows patients to access healthcare advice and guidance through a website or phone line.
- Health at Hand: Health at Hand is a telemedicine service that is available in the United Kingdom and other countries. Health at Hand allows patients to connect with healthcare providers for consultations, diagnoses, and treatment recommendations.

Overall, there are many telemedicine portals that are available worldwide, which enable patients to access healthcare services remotely through video conferencing and other digital technologies.

13.5.9 Telemedicine portal in India

Some examples of telemedicine portals in India include: Practo, Lybrate, DocsApp, mHealth India. Overall, there are many telemedicine portals available in India, which enable patients to access healthcare services remotely through video conferencing and other digital technologies.

13.6 Mobile Health Applications

Mobile Health, also known as mHealth apps, are apps that are designed to support health and wellness and can be used on a smartphone or other mobile device. Mobile health apps can be used for a wide range of purposes, including tracking fitness, managing chronic conditions, and providing healthcare information.

Some *examples of mobile health apps* include:

Fitness tracking apps: These apps allow users to track their exercise and physical activity, and may include features such as step counting, calorie tracking, and workout tracking.

Chronic condition management apps: These apps are designed to help users manage chronic conditions such as diabetes or hypertension and may include features such as medication reminders and tracking of symptoms.

Health information apps: These apps provide users with information about various health topics, such as nutrition, mental health, and disease management.

Telemedicine apps: These apps allow users to connect with healthcare providers for consultations, diagnoses, and treatment recommendations.

Mobile health apps can be a useful tool for supporting health and wellness, but it is important to carefully consider the quality and reliability of the information provided by these apps.

13.6.1 Advantages and Disadvantages of Mobile Health Applications

- Some of the potential advantages of mHealth apps include:
- Convenience: mHealth apps can be accessed from a smartphone or other mobile device, which makes it convenient for users to track their health and access healthcare information on-the-go.
- Improved self-management of chronic conditions: mHealth apps can help users manage chronic conditions such as diabetes or hypertension, by providing tools such as medication reminders and symptom tracking.
- Increased access to healthcare information: mHealth apps can provide users with access to a wide range of healthcare information, including information about diseases, treatments, and healthy living.
- Increased engagement in healthcare: mHealth apps can help to increase engagement in healthcare, by providing users with tools and resources to support their health and wellness.
- However, there are also some potential disadvantages to consider with mHealth apps, including:
- Quality and reliability of information: Not all mHealth apps provide accurate and reliable information, and it is important for users to carefully evaluate the quality of the information provided by these apps.
- Privacy and security: mHealth apps may collect and store sensitive personal and medical information, and there are concerns about the privacy and security of this data.
- User adoption: Not all users may be comfortable using mHealth apps, and there may be barriers to adoption for some users.
- Overall, mHealth apps can offer many potential advantages, but it is important to carefully consider the potential limitations and challenges of these apps in order to ensure that they are used in a responsible and beneficial manner.

13.7 Clinical Decision Support Systems (CDSS) A clinical decision support system (CDSS) is a computerized system that is designed to assist healthcare providers in making clinical decisions. CDSSs can be used to support diagnosis, treatment, and management of patients, and can be integrated into electronic health record (EHR) systems or other healthcare information systems.

CDSSs typically use algorithms and other decision-making tools to provide healthcare providers with recommendations or alerts based on a patient's medical history and other relevant information. For example, a CDSS may provide a recommendation for a particular treatment based on a patient's symptoms and medical history or may alert a healthcare provider to potential drug interactions or allergies.

CDSSs can be a useful tool for improving the quality and efficiency of healthcare delivery, but it is important to carefully consider the potential limitations and ethical considerations of these systems. Some potential limitations of CDSSs include the risk of over-reliance on the system, the potential for errors or biases in the algorithms used by the system, and the need for healthcare providers to maintain their clinical judgment and expertise.

13.7.1 Components of CDSS

The components of a CDSS system typically include:

Knowledge base: The knowledge base is the collection of data and information that is used by the CDSS to support clinical decision-making. This may include information about diseases, treatments, and other relevant medical knowledge.

Algorithms and decision-making tools: The CDSS use algorithms and other decision-making tools to analyse the data in the knowledge base and provide recommendations or alerts to healthcare providers.

User interface: The user interface is the way that the CDSS presents information and recommendations to the healthcare provider. This may

include a graphical user interface, a natural language interface, or other means of presenting information.

Integration with other systems: CDSSs may be integrated with other healthcare information systems, such as electronic health records (EHRs), to access relevant patient data and provide recommendations to healthcare providers.

13.7.2 CDSS Models

There are several different models for clinical decision support systems (CDSSs), which can be classified based on the way that the CDSS is integrated into the healthcare system and the way that it provides recommendations or alerts to healthcare providers. Some common models for CDSSs include:

Standalone CDSS: A standalone CDSS is a self-contained system that is not integrated with other healthcare information systems. Standalone CDSSs may be accessed by healthcare providers through a separate user interface, and may provide recommendations or alerts based on a patient's medical history and other relevant data.

EHR-integrated CDSS: An EHR-integrated CDSS is a CDSS that is integrated with an electronic health record (EHR) system. EHR-integrated CDSSs may provide recommendations or alerts to healthcare providers as they are entering data into the EHR or may be accessed through the EHR user interface.

Order entry CDSS: An order entry CDSS is a CDSS that is integrated with an order entry system and provides recommendations or alerts to healthcare providers as they are entering orders for tests, medications, or other treatments.

Clinical guidelines CDSS: A clinical guidelines CDSS is a CDSS that is based on clinical guidelines or protocols and provides recommendations or alerts to healthcare providers based on these guidelines.

13.7.3 Examples of CDSS system

There are many examples of clinical decision support systems (CDSSs) that are used in healthcare settings. Some examples of CDSSs include:

UpToDate: UpToDate is a CDSS that provides recommendations and alerts to healthcare providers based on the latest clinical knowledge and guidelines. UpToDate is accessed through a standalone user interface and is used by healthcare providers in many countries around the world.

Epocrates: Epocrates is a CDSS that provides recommendations and alerts to healthcare providers related to medications, drug interactions, and other clinical topics. Epocrates is accessed through a mobile app and is used by healthcare providers in many countries around the world.

Medscape: Medscape is a CDSS that provides recommendations and alerts to healthcare providers related to diagnoses, treatments, and other clinical topics. Medscape is accessed through a standalone user interface and is used by healthcare providers in many countries around the world.

Clinical Practice Guidelines: Clinical Practice Guidelines is a CDSS that provides recommendations and alerts to healthcare providers based on clinical guidelines and protocols. Clinical Practice Guidelines is accessed through a standalone user interface and is used by healthcare providers in many countries around the world.

13.7.4 Advantages and Disadvantages of CDSS system

Clinical decision support systems (CDSSs) can offer several advantages, but there are also some potential disadvantages to consider. Some of the *potential advantages of CDSSs* include:

- *Improved patient safety:* CDSSs can help to reduce the risk of errors and adverse events in healthcare, by providing recommendations and alerts to healthcare providers based on a patient's medical history and other relevant information.

- *Improved quality of care:* CDSSs can help to improve the quality of care that patients receive, by providing recommendations and alerts based on evidence-based guidelines and best practices.
- *Increased efficiency:* CDSSs can help to improve the efficiency of healthcare delivery, by providing recommendations and alerts to healthcare providers in real-time, and by reducing the need for manual searches for information.
- *Increased patient engagement:* CDSSs can help to increase patient engagement in their own care, by providing patients with access to their medical records and other relevant information.
- However, there are also some *potential disadvantages of CDSSs* to consider, including:
- *Over-reliance on the system:* There is a risk that healthcare providers may become overly reliant on CDSSs and may lose their clinical judgment and expertise.
- *Potential for errors or biases:* CDSSs may contain errors or biases in the data or algorithms that they use, which could lead to incorrect recommendations or alerts.
- *Lack of interoperability:* CDSSs may be isolated systems that are not integrated with other healthcare information systems, which could lead to a lack of interoperability and inefficiencies.
- *Cost:* Implementing and maintaining a CDSS can be costly, and may require significant investment in hardware, software, and staff training.

13.8 "Frontier Technologies" in Healthcare

The "frontier technologies" are a group of new technologies that take advantage of digitalization and connectivity which enable them to combine to multiply their impacts. Artificial intelligence (AI), the Internet of things (IoT), big data, blockchain, 5G, 3D, printing, robotics, drones, gene editing, nanotechnology and solar photovoltaic.

Frontier technologies have huge potential for improving people's lives and protecting the planet. During the COVID-19 pandemic, for example, AI and big data have been used for screening patients, monitoring the outbreaks, tracking, and tracing cases of the disease, predicting its evolution, and assessing infection risks. Other examples have ranged from the use of IoT to monitor the quality of groundwater in Bangladesh, to the use of drones for delivering medical supplies to remote communities in Rwanda and Ghana.

13.8.1 Metaverse and Healthcare

The Metaverse in Medicine can be defined as the medical Internet of Things facilitated using AR and VR glasses. Metaverse is evolving; it holds new potential in healthcare that combines technologies like AI, VR, AR, Internet of Medical Devices, Web 3.0, intelligent cloud, edge, and quantum computing along with robotics to provide new directions to healthcare. Swift information sharing between clinicians would mean that underlying causes of ill health could more quickly be established. Monitoring of patient activity in the metaverse means factors such as compliance could more easily be tracked, which would further assist with diagnosing and treating illness.

13.8.2 Top three healthcare companies working on Metaverse

Latus Healthcare: It is developing a "virtual hospital". It comprises a virtual reality hospital environment, where treatments will at first be focused on physiotherapy services.

iMining: The first-ever hospital foundation to be launched in the Decentral and Metaverse.

Apollo hospitals: Apollo hospital group has announced a unique collaboration with '8chili Inc' to enable engagement within the metaverse

13.9. Use of AI in Healthcare

13.9.1 Applications

Artificial intelligence (AI) is being increasingly used in the healthcare industry to support a wide range of tasks and processes. Some of the ways in which AI is being used in healthcare include:

Clinical decision support: AI can be used to support clinical decision-making by analysing patient data and providing recommendations or alerts to healthcare providers based on evidence-based guidelines and best practices.

Diagnosis and treatment planning: AI can be used to support diagnosis and treatment planning by analysing patient data and providing recommendations for tests, medications, or other treatments.

Drug discovery and development: AI can be used to support the discovery and development of new drugs by analysing large datasets and identifying patterns and trends that may be relevant to drug discovery and development.

Population health management: AI can be used to support population health management by analysing data from large groups of people and identifying patterns and trends that may be relevant to public health.

Clinical trial recruitment: AI can be used to support clinical trial recruitment by identifying potential candidates for clinical trials based on their medical history and other relevant data.

Overall, AI has the potential to support a wide range of tasks and processes in the healthcare industry and has the potential to improve the quality and efficiency of healthcare delivery.

13.9.2 AI in Dental Field (PRM)

Clove Dental is a chain of dental clinics in India that provides a range of dental services, including preventive, diagnostic, and therapeutic treatments. The company has a network of over 350 dental clinics across the country.

PRM being the end-to-end solution that begins when a lead is identified, all interactions with that lead before he/she steps into the clinic are captured & followed up on and once appointments are booked patient relationship begins. The system has entire patient dental records from diagnosis to treatment to billing to standardized pricing & patient treatment specific communication.

All Patient / lead interactions are fully digitized in the system, this was the primary goal we set out implementing. This is a gold mine of information, which is helping us on our way to AI enablement of the system. The diagnostic engine developed in version 2.0 in Aug 2015 had AI logic built in which auto recommends treatments based on the diagnostic inputs provided by the dentist.

Treatments are broken into multiple stages & doctor engages with the patient in each stage for instance, specific messages, such as to stop taking blood thinners prior to a surgical procedure can be sent proactively.

The platform also supports Tele-dentistry to ensure that doctor- patient interactions can also occur remotely.

Main Modules

Lead capture
Lead management
Patient Appointments
Diagnosis & AI enabled treatment-planning support
Entire patient dental records of all treatments & procedures carried out
Standardized pricing, billing & invoicing details
Payment Reconciliation & Petty Cash Management
Treatment Stage based patient interactions & Relationship Management
Inventory & Consumables Management
Lab order Management
Feedback Management
Drs App (Internal Communication Platform)

Unique features

AI Enabled Diagnosis to Treatment Planning: Software recommends treatments as the doctor inputs the medical diagnosis/ findings, the AI logic in the system provides auto treatment recommendations, this helps clinicians plan comprehensive & predictable treatment plans for patients based their oral diagnosis.

Clinical Collaboration: the platform helps clinicians collaborate on a case as the patient records can be shared amongst clinicians for analysis and arriving at best possible treatment plan.

*Clinical Correlation for better case management***:** The system also allows case correlation with possible chronic conditions and its impact. It helps the clinicians minimize potential risks. The long-range data has helped develop predictive treatment models for patients suffering from chronic conditions e.g. a patient suffering from diabetes needing implant.

Treatment Lifecycle Management: Patient treatment mgmt. with Stage wise tracking of treatments against expected results, process management alongside pre and post treatment info sharing.

Case Reviews: The system enables case tracking against set standard protocols with flagging system to enable case review by an expert panel anonymously.

myClove App: Secured messaging platform to foster inter dentist and clinical collaboration.

Patient Support

Patient journey management including appointment scheduling & during treatment stage mgmt. with SMS or Email notifications.

Access to past treatment history: this unique platform allows patients access to their treatment record across all Clove Clinics.

Customer feedback and satisfaction audit is automated and is linked to treatment stage mgmt.

Integrated myClove app for appointment scheduling, petty expenses & patient files management.

Quality and Compliance

Computer Vision: AI driven Real time CCTV feed analysis of clinics & sterilization process monitoring for quality assurance & safety. (Dori)

Using computer vision: AI to track and patient counts using operatory at Clove Clinics

Complaint Redressal: Allows case specific reviews and redressals in case of customer complaints safeguarding both customer interests as well as provider liabilities.

Business Management

Integrations with aggregator platforms (Practo/JustDial) & Clove's consumer acquisition platform for automated lead management process.

Integrated with Order to Receipt to Consumption of Inventory via *Inventory Management System.*

CTI (Call Centre Software) integrated for a single view for call centre agents accessing leads and making outbound and receiving inbound calls.

Consumables Inventory management linked to cases done at the clinics, thus minimizing wastage and pilferage of consumables.

13.9.3 Organ Care Technology and Bio-printing

Example: The Organ Care System developed by Trans medics is a great example which is in use by the Ohio State University's Wexner Medical Centre. This device can keep a heart, lung, or liver outside of the body for several hours through proper care, heat, and provision of important nutrients. In addition to keeping organs alive outside of the body, other options should also be explored. Although it may sound like science fiction, 3D printed organs are a very real, although developing.

13.9.4. Concept of Smart Pills

One of the most profound applications for IoT technology in healthcare is the concept of a smart pill, which transforms The Internet of Things into The Internet of Bodies. Smart pills are edible electronics

that not only serve as pharmaceuticals but can provide care providers with valuable information about patients. The first smart pill approved by the FDA was released in 2017.

Technology, like art, is a soaring exercise of the human imagination and Technology will continue to improve in every area. Although security will improve across the industry, threats are always evolving that must be dealt with through prevention rather than response.

13.10 Ethical Perspective

13.10.1 Ethical criteria

There are several ethical considerations and principles related to the use of digital technologies in healthcare.

Privacy: The use of digital technologies in healthcare often involves the collection, storage, and sharing of sensitive personal health information. It is important to ensure that this information is protected and that patients are aware of how their data is being used.

Inequality: Not everyone has equal access to digital technologies, which means that certain groups may be disadvantaged when it comes to accessing healthcare services. It is important to ensure that digital healthcare solutions are designed in a way that is inclusive and equitable.

Accuracy: Digital technologies can be a useful tool for gathering and analysing health information, but it is important to ensure that the data they produce is accurate and reliable.

Autonomy: Patients have the right to make decisions about their own healthcare, and digital technologies should be designed in a way that respects and supports patient autonomy.

Security: Digital technologies can be vulnerable to cyber-attacks, which can have serious consequences in the healthcare context. It is important to ensure that digital healthcare systems are secure, and that patient data is protected.

Intelligibility, Transparency: Patients have the right to understand how their data is being used and to make informed decisions about their healthcare. It is important to ensure that digital healthcare solutions are transparent and that patients are provided with the information they need to make informed decisions.

Accountability: refers to the idea that individuals and organizations should be held responsible for their actions and decisions. In healthcare, this means that healthcare providers should be accountable for the quality of care they provide to their patients. Errors and liability are important considerations in healthcare, as mistakes can have serious consequences for patients. It is important for healthcare providers to be accountable for their actions and to have systems in place to prevent and address errors.

Accessibility refers to the ability of individuals to access the resources and services they need. In healthcare, this includes ensuring that healthcare services are available and accessible to all individuals, regardless of their location or financial status.

Regulation is an important aspect of healthcare, as it helps to ensure the quality and safety of healthcare services and products. However, it is also important to strike a balance between the need for regulation and the need to allow for innovation and flexibility in the healthcare sector.

Trusting algorithms is an important issue in healthcare, as algorithms are increasingly being used to inform decision-making about patient care. It is important to ensure that algorithms are transparent and explainable, and that they are not biased or discriminatory.

13.10.2 Art of curing to the science of measurement

Data protection is an important ethical issue in the healthcare industry, as health data is often sensitive and personal in nature. It is important for healthcare organizations to have strong measures in place to protect the privacy and confidentiality of health data, and to ensure that it is only accessed by authorized parties.

Equality of service availability is another ethical issue in healthcare, as not all individuals have equal access to quality healthcare services. This can be due to a variety of factors, including financial constraints, geographic location, and social and cultural barriers. Ensuring that all individuals have equal access to healthcare services is important for promoting fairness and justice.

The shift from the "art of curing" to the "science of measurement" in medicine has brought about significant changes in the patient-physician relationship. In the past, the patient-physician relationship was often more personal and focused on the individual needs of the patient. With the increasing emphasis on evidence-based medicine and the use of standardized protocols and guidelines, the patient-physician relationship has become more focused on the delivery of specific treatments and interventions. While this shift has brought about many benefits, it has also led to some concerns about the erosion of the personal and humanistic aspects of healthcare.

13.10.3 Social networking and doctor patient relationship

The impact of social networking sites on the doctor-patient relationship can be both positive and negative. On the positive side, social media can provide a convenient and accessible way for patients to connect with their healthcare providers, and can facilitate the exchange of information and support between patients and physicians. However, there are also potential negative impacts on the doctor-patient relationship. For example, social media can create additional expectations and demands on healthcare providers, and may lead to an erosion of boundaries between the personal and professional aspects of the relationship.

The development of e-health platforms to deliver care has the potential to increase access to healthcare services, particularly for individuals in underserved or rural areas. However, there are also potential risks and challenges associated with the use of e-health platforms. For example, there may be concerns about the security and confidentiality of health

data that is transmitted electronically, as well as the potential for technological failures or disruptions that could impact the delivery of care.

The use of online data and algorithms to inform health research has the potential to greatly advance our understanding of health and disease, and to improve the development of new treatments and interventions. However, there are also potential ethical issues to consider, such as the need to ensure that online data is collected and used ethically and in accordance with relevant laws and regulations.

The broader public health consequences of widespread social media use are not yet fully understood, and more research is needed to fully understand the potential impacts on health and well-being. However, it is possible that social media use may have both positive and negative effects on public health, depending on the specific circumstances and the ways in which social media is used.

13.10.4 Predictive and diagnostic uncertainty

Dealing with predictive and diagnostic uncertainty is a common challenge in healthcare, as it is not always possible to accurately predict the course of a patient's illness or to make a definitive diagnosis. In such cases, it is important for physicians to communicate with their patients about the limitations of their knowledge and to involve patients in decision-making about their care. This may involve discussing the potential risks and benefits of different treatment options, and helping patients to understand the uncertainty that exists.

In terms of the roles and responsibilities of patients and physicians, both parties have important responsibilities in the healthcare process. Patients have a responsibility to take an active role in their own healthcare, including by following their treatment plans, communicating with their physicians, and advocating for their own needs. Physicians, on the other hand, have a responsibility to provide high-quality care to their patients, to communicate effectively with their patients, and to involve patients in decision-making about their care.

The patient-physician relationship is a key aspect of healthcare, and it is important for both parties to work together in order to achieve the best outcomes. This may involve establishing open and honest communication, building trust, and ensuring that patients feel heard and respected. It is also important for physicians to be aware of their own biases and to strive to provide culturally competent care that is tailored to the individual needs and preferences of their patients.

13.10.5 EU Declaration of Cooperation on Artificial Intelligence

The appointment of the High-Level Expert Group on Artificial Intelligence (AI HLEG) in June 2018 was part of the European Commission's efforts to ensure an appropriate ethical and legal framework for artificial intelligence (AI). The group was made up of 52 experts from academia, civil society, and industry, but did not include representation from medical associations, physicians, or patients.

The goals of the AI HLEG were to develop recommendations for a European approach to AI that would ensure the development and uptake of trustworthy AI, while also protecting fundamental rights and values. To achieve these goals, the group focused on a number of key areas, including the development of ethical principles for AI, the creation of a framework for the responsible development and deployment of AI, and the establishment of a system for the ethical assessment of AI applications.

The work of the AI HLEG was completed in 2019, and the group's recommendations were used as the basis for the development of the European Commission's "Ethics Guidelines for Trustworthy AI," which were published in April 2019. The guidelines provide a framework for the ethical development and use of AI, and are intended to help ensure that AI is developed and used in a way that is aligned with European values and principles.

Respect for human autonomy is the principle that individuals have the right to make decisions about their own lives and to have control

over their own bodies. This is an important principle in healthcare, as it means that patients have the right to make decisions about their own healthcare, including the right to accept or refuse treatment.

Prevention of harm is the principle that actions should be taken to prevent harm to individuals. In healthcare, this means taking steps to prevent harm to patients, such as by following best practices and guidelines for care, and by taking steps to ensure the safety of patients.

Fairness is the principle that individuals should be treated equally and justly, regardless of their personal characteristics or circumstances. In healthcare, this means ensuring that all individuals have equal access to healthcare services and resources, and that decisions about care are made in a fair and unbiased manner.

Explicability is the principle that information and decision-making processes should be clear and transparent. In healthcare, this means that healthcare providers should communicate clearly with their patients and should provide information that is easy for patients to understand. It also means that healthcare providers should be open and transparent about the decision-making processes that are used to guide patient care. These four principles are interrelated, as they all relate to ensuring that healthcare is provided in an ethical and responsible manner.

13.10.6 EU "White Paper on Artificial Intelligence"

The "White Paper on Artificial Intelligence - A European approach to excellence and trust" is a policy document published by the European Commission in 2020. The document outlines the Commission's approach to promoting the uptake of artificial intelligence (AI) and addressing the risks associated with certain uses of this technology.

The white paper emphasizes the need for a human-centric approach to AI, which means focusing on the needs and concerns of individuals and society, rather than just the technical capabilities of AI systems. To achieve this, the paper outlines a number of policy options, including the development of ethical principles and guidelines for AI, the creation of a

framework for the responsible development and deployment of AI, and the establishment of a system for the ethical assessment of AI applications.

The white paper also highlights the importance of ensuring the safety and reliability of AI systems, and of ensuring that AI is developed and used in a way that respects fundamental rights and values, such as privacy, non-discrimination, and transparency. Additionally, the paper emphasizes the need for a strong and diverse ecosystem for AI in Europe, including investments in research and development, and the development of skills and competencies in AI.

13.10.7 WHO "Recommendations on Digital Interventions for Health System Strengthening"

The World Health Organization (WHO) released "Recommendations on digital interventions for health system strengthening" in 2020, in order to assess the benefits, harms, acceptability, feasibility, resource use, and equity considerations of digital health interventions. The recommendations are intended to provide guidance to countries on how to use digital health interventions effectively, and to help ensure that these interventions are developed and used in a way that is aligned with the WHO's vision for a "Healthy Digital World."

The recommendations cover a range of topics related to digital health, including the use of digital health technologies for surveillance and monitoring, the use of digital health interventions to improve the delivery of healthcare services, and the role of digital health in addressing health inequalities. The recommendations also provide guidance on how to ensure the safety and effectiveness of digital health interventions, and on how to protect the privacy and confidentiality of patient data.

13.10.8 WHO Concept of Health Atlas

The World Health Organization (WHO) has established a number of initiatives to support the use of digital health technologies around the

world. One of these initiatives is the Digital Health Atlas, an online platform that is designed to collect, monitor, and coordinate digital health initiatives worldwide. The Digital Health Atlas is intended to be a resource for countries seeking to implement digital health interventions, and it includes information on a range of topics, including the benefits and challenges of using digital health technologies, and best practices for implementing these technologies.

In addition to the Digital Health Atlas, the WHO has also announced plans to establish a section on digital health to "enhance WHO's role in assessing digital technologies and support Member States in prioritizing, integrating, and regulating them." This section will be responsible for providing guidance and support to countries on the use of digital health technologies, and for conducting research and analysis on the benefits and risks of these technologies. The goal of this initiative is to help ensure that digital health technologies are developed and used in a way that is aligned with the WHO's vision for a "Healthy Digital World."

13.10.9 The World Medical Association (WMA) draft on “Ethical Considerations Regarding Health Databases and Biobanks

The World Medical Association (WMA) is a global organization that represents the interests of medical doctors worldwide. In 2013, the WMA released a draft of its "Ethical Considerations Regarding Health Databases and Biobanks," which provides guidance on the ethical issues related to the creation and use of health databases and biobanks.

The WMA draft outlines a number of ethical principles that should be considered in relation to health databases and biobanks, including the principle of respect for persons, the principle of beneficence, the principle of non-maleficence, the principle of justice, and the principle of respect for autonomy. The draft also includes recommendations on issues such as informed consent, confidentiality, and the use of data for research purposes.

The WMA draft on ethical considerations regarding health databases and biobanks is intended to provide guidance to medical professionals and other stakeholders on the ethical issues related to these types of data resources. It is not a legally binding document, but it is intended to serve as a reference for those involved in the creation and use of health databases and biobanks, and to help ensure that these resources are used in an ethical and responsible manner.

13.11 Conclusion

Digital health technologies offer the potential to transform healthcare systems by increasing access to health information and services, and by improving the efficiency and effectiveness of healthcare delivery. However, it is important to ensure that digital health interventions are designed and implemented in an ethical and fair manner, so that they do not create or exacerbate inequalities in access to healthcare.

Digital literacy is an important issue in the context of digital health, as individuals who are not familiar with digital technologies may have difficulty accessing and using digital health services. It is important for digital health providers to take this into account when designing and implementing digital health interventions, and to ensure that these interventions are accessible and user-friendly for all users.

Informed consent is also an important ethical consideration in digital health, as individuals need to be fully informed about the risks and benefits of using digital health services before they can make an informed decision about whether to use these services. Digital health providers should ensure that they obtain fully informed consent from users before collecting or using their data and should be transparent about how their data will be used.

Overall, it is important for all stakeholders in digital health, including digital health providers, policy makers, and healthcare professionals, to be aware of the ethical challenges and considerations associated with

digital health technologies, and to act in a way that promotes equity in access and fair equality of opportunity for all population groups. By doing so, digital health technologies can have a positive impact on healthcare and public health and can be regarded as:

"Just Digital Health"