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ADVANCING PHARMACY WITH VIRTUAL DIGITAL TECHNOLOGIES

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ABSTRACT

Digitalization of the healthcare sector promises to revolutionize patient healthcare globally. This helps in improving health of a patient simple gadgets and tools. They are different technologies of cybertools including artificial intelligence, block chain, virtual and augmented reality. Such technologies will communicate together in real-time, it helps in diagnoses and treatment. It is important benefits that cyber based digital health technologies can take patient care, data is secured easily and secured in health care sector. The digital transformation and digitalization in the field of pharmacy as a profession must embraced and develop in order to ensure the sustainability in pharmacy practice and revolutionize patient health care globally. As we know that the technological innovation has become an integral aspect of our daily life, patients will now have a broader range and more mindful healthcare choices and experience a new era of medical healthcare with a patient-centric culture. This review provides information about the benefits and challenges of cyber-based health inventions, a look on how technologies can be transitioned from research focused towards real-world health care and applications to change treatment pathways for patients worldwide.Computer vision, especially deep learning, is one of the key :
Emerging technologies that help digitize the fields of medicine, biology,and manufacturing.

KEYWORDS :
Telecommunication, Artificial intelligence, Electronic health, Quantum counting cybernetics, Block chain and precision and Personalized medicine

INTRODUCTION

Technological advancement is creating great opportunity within the pharmaceutical field, to facilitate the development and delivery of medicines in a highly streamlined, efficacious, and innovative manner. Having a set of global development goals enables identification of commonalities across all areas of the profession, as well as some unique attributes in each area. Patient-facing technologies are similarly experiencing substantial innovation. Whereas patients have long been required to visit a pharmacy to collect their prescriptions, rapid delivery of medicines to patients houses is becoming commonplace.

The growing acceptance of virtual medical appointments and advancements in telecommunication also make it more likely for patients to have online consultations with pharmacy professionals than ever before. These strategies have been of paramount importance to maintain patient safety during the COVID-19 pandemic, which forced a move away from face-to-face interactions Digital health care has become, more than ever, common practice in hospitals, community pharmacies, and other sites of pharmaceutical care delivery, as well as an integral part of pharmaceutical research and development [2].

To ensure the sustainability of pharmacy practice and to provide health for all, pharmacy as a profession must embrace the digital transformation that has been changing health care at a rapid pace [1]. An advancing technological boon over the past few decades has seen the advent of virtual technologies such as Artificial Intelligence (AI), Quantum computing, Block-chain, Telecommunication, Internet of Things (IoT), and virtual reality (VR) etc [1]. For example, AI-guided drug discovery is now employed in many pharmaceutical companies due to its speed, resource-saving potential, and ability to work constantly [21].

The research aims at investigating and describing the readiness, adaptability, and responsiveness of pharmacy education programmes to train the current and future pharmaceutical workforce on digital health and to identify the digital health knowledge and skill gaps of the existing pharmaceutical workforce.

Once a medicine has been licensed, delivering it to patients in a safe, secure, and supportive manner is an imperative task. Over 10% of low- and middle-income countries (LMICs) are affected by counterfeit medicines, leading to substandard treatments, safety concerns, and economic loss to legitimate suppliers.Growing acceptance of virtual medical appointments and advancements in telecommunication also make it more likely for patients to have online consultations with pharmacy professionals than ever before.Few industries have the potential to be changed so profoundly by digital technology as healthcare [3], providing pharmacists and pharmaceutical sciences across the world with new opportunities to provide and improve pharmaceutical care.

New career paths are appearing in pharmacy, and these career paths
are digital ones. The FDA is approving growing numbers of digital products to monitor and treat patients, building on a growing acceptance of wearable products to monitor health, health apps to guide daily activities, smart pill dispensers to monitor and improve adherence, and much more. “Technology is changing the patient journey,” said timothy aungst.There are multiple challenges to the implementation of digital health education [4]
healthcare has the lowest level of digital innovation compared to other industries, such as media, finance, insurance and retail, contributing to limited labour productivity growth [8].

Pharmacists are highly skilled medication experts who can directly
effect public health.The overarching goal of public health is to advance the health of individuals, communities, and populations.Pharmacists have also become increasingly involved in screening patients for social determinants of health and performing required interventions or referrals as part of clinical–community linkages The broad umbrella of digital health includes multiple overlapping technologies, approaches, audiences, and uses:

1.platforms for healthcare systems, clinics, and other enterprise settings, including pharmacy
2.technology platforms and support systems for clinicians and support staff
3.patient-facing products that capture, store, or transmit health data.

The following are highlighted areas to be evaluated and addressed before widespread digital health education in the healthcare professions can be initiated:

- Lack of standards: there are currently little to no best practices in terms of what digital health education is required for healthcare professionals.
- Lack of trained academics: one of the most considerable limitations is that there is a shortage of academics in the healthcare environment with both experience and knowledge to propagate digital health education at large [5]. While interest is building, like the issue around standardization, it is challenging to determine to what extent an academic is sufficiently up to date and trained to develop that knowledge in others.
- Partnerships: healthcare education institutions cannot teach digital health topics alone. By its nature, digital health is an interdisciplinary endeavour spanning multiple-market sectors and requires expertise in fields of science and backgrounds that are not traditionally thought of being directly related to medicine. This includes issues such as regulatory oversight and validation of the technology in health but also implications of behavioural sciences, user interface/user experience design, mathematical insight on artificial intelligence (AI)/machine learning construction, gamification design, and more.
- Materials and samples: teaching digital health involves other issues regarding the technological needs for hands-on instruction. Similar issues now challenge healthcare academics to integrate electronic health records constructs into their teaching and course work to mimic current practice; identifying and then utilizing digital health technologies as teaching material will prove a logistical hurdle [6].
- Laboratory spaces: Lastly, in relation to the acquisition of devices and software for teaching just mentioned, the creation of a digital health space to house relevant technologies to be utilized may be an issue.

Importance of Digitalization-Digital transformation :

Integrating digital technologies into pharmaceutical processes enables companies to improve manufacturing operations, reduce costs, and increase production quality.
Because digitalization comes with these significant benefits, it offers businesses that embrace it a clear competitive advantage over pharmaceutical companies that have not digitalize their operations.there is more potential of existing digital solutions to improve healthcare quality and analyzed the emerging trend in digital medicine to evaluate the research question of how stakeholders apply and manage digital technologies for business purposes [9]
By prioritizing digitalization in their supply chains, pharma companies can experience greater outcomes for their businesses that will set them apart from other organizations.
The evolving roles of pharmacists within the healthcare team demands utilization of a range of digital technologies and requires digital literacy skills among pharmacists. There is a lack of research regarding digital health skills and related training among pharmacy students and pharmacists. To date, a limited number of studies have been conducted to explore the status of inclusion of digital health training in pharmacy schools and to assess the skills and competencies of pharmacists in digital health. Very limited research, mostly from countries such as the United States, Canada and the United Kingdom, was found related to digital health in the pharmacy curriculum [21,22,23], while no studies were found which explored the status of digital health in the pharmacy curriculum at a global level.
As digital technologies take over the world, pharmaceutical companies must stay up to speed to survive. As the benefits of digital transformation abound, here we are going to focus on the following aspects to get a lucid idea:

Increased Visibility :
Digital technologies enable companies to make more informed business decisions by increasing their supply chain operations visibility. With digitalization, organizations can fully integrate their supply chains to improve manufacturing processes through more responsive and adaptive operations.
These changes result in greater accuracy, inventory levels, manufacturing efficiency, and service, allowing businesses to make faster and more effective business decisions. Digitalization also delivers greater visibility across value chains for pharmaceutical manufacturers.
This increased data visibility leads to valuable insights that these businesses can use to learn from their existing processes and improve their drug designs.

Cost Reductions :

Digital transformation helps to lower per-capita costs in the pharma industry. In manufacturing plants, digitalization often involves machine learning, artificial intelligence, and machine-to-machine communication.

These digitalize processes promote seamless manufacturing operations, automated corrective actions, and better preventive maintenance.

As a result, pharmaceutical companies experience fewer errors and malfunctions. By preventing equipment breakdowns, digitalization minimizes repair expenses, liabilities, and downtime, leading to greater cost savings.

Improving Efficacy :

Forty percent of executives listed operational efficiency as a top benefit of digital transformation. Pharmaceutical companies can increase their manufacturing efficiency and productivity through digital transformation.

Digitalization allows businesses to collect data across their entire facilities, giving decision-makers key insights into their companies' overall operational efficiency. They can also analyze these insights to pinpoint process inefficiencies and determine how to improve these areas.

In addition to increasing efficiency through insight analysis and implementation, digitalization also enables pharma companies to automate various aspects of their manufacturing processes. That means they can achieve more work in less time while using fewer resources and manual labor.

Greater Flexibility :

Digital transformation in the pharma industry allows for more flexible manufacturing processes, improving medication and vaccine production speeds when compared to traditional fixed processes. Unlike fixed production processes, flexible manufacturing lets companies produce new drugs in facilities that use single-use materials, allowing them to bypass equipment cleaning validation for current machines.

This adaptability saves companies manufacturing time, enabling them to send drugs and vaccines to market for customers faster. Digitalization in the pharmaceutical industry also allows for flexible manufacturing equipment. Companies can adjust these machines to accommodate changing patient demands while improving patient safety through robotics and automation. Flexible manufacturing helps companies better achieve medication compliance.

Higher Product quality :

Pharmaceutical companies gather procedural data to ensure product quality. However, many of these organizations rely on paper documentation in their facilities, creating gaps in the quality assurance process. Studies show that it takes pharmaceutical companies a minimum of 6 months to onboard quality management staff because of the high number of systems and data sources they must use to do their jobs, along with a lack of real-time data access.

While paper documentation through manual spreadsheets and reports is time-consuming and prone to errors, data collection and management through digitalized technologies improve process efficiency and reduce the risk of mistakes. Digital transformation helps pharma companies collect information from numerous sources, standardize it, and analyze it to improve quality assurance. It also allows real-time monitoring across a plant's processes and production levels to close quality gaps and improve reporting workflows.

All these digitalization capabilities enable pharmaceutical companies to improve quality control, reliability, and efficiency, resulting in higher-quality products.

Increased Control :

When manufacturing pharmaceutical products, every process must be meticulously monitored, such as product development, equipment cleaning, and packaging labeling. That is because a single error in these processes can render an entire batch of products unusable, costing companies time, money, and resources. In addition, faulty batches can cause serious harm to consumers, resulting in lawsuits and reputational damage to companies.

Digitalization in the pharma industry helps organizations better control their manufacturing processes with greater product monitoring, visualization, and remote data access, allowing them to identify and improve packing processes. As a result, they can pinpoint and address errors before they impact product batches, leading to higher profitability and cost savings.

Competitive Advantages:

Integrating digital technologies into pharmaceutical processes enables companies to improve manufacturing operations, reduce costs, and increase production quality. Because digitalization comes with these significant benefits, it offers businesses that embrace it a clear competitive advantage over pharmaceutical companies that have not digitalized their operations.

By prioritizing digitalization in their supply chains, pharma companies can experience greater outcomes for their businesses that will set them apart from other organizations.

Increased Customer Expectations:

In the industry 4.0 era, customers have access to a vast amount of health information through online sources. They feel more in control of their health with devices such as fitness trackers and smartwatches. A study showed that about 85% of people felt confident about being responsible for their health and fitness through online sources of information.

Pharmaceutical companies are investing more in patient engagement than ever before. Another survey suggested that digital technology is the path to better understanding customers and strengthening customer relationships.

Increased External competition:

The current world is being driven by big data. Other than the internal competition, the pharmaceutical industry also faces external threats. Huge tech giants such as Apple and IBM are entering the healthcare industry with high-tech devices and online health communities, which gives them access to vast amounts of health data. As a result, pharmaceutical companies need to focus more on digital solutions to remain competitive.

Counterfit Market:

The counterfeit drug problem has beenaggravatingacross the globe.

Digital technology has significant implications in the fight against counterfeit medicine. These solutions include the use of technologies such as Block chain and Radio Frequency Identification (RFID) tags to trace the origin of the medicine and make the supply chain more transparent.

Discussion:

The accomplishing of public health through various methods such as research, policy, education, and prevention strategies usually characterized as primary (i.e., preventing the development of disease), secondary (i.e., the early detection of disease), or tertiary (i.e., slowing the progression of disease) [25,26,27]. Public health initiatives have improved not only the length but also the quality of life for community members and have often resulted in cost savings to healthcare systems and societies [25].

Pharmacists are highly skilled medication experts who can directly affect public health. Prominent organizations worldwide have supported roles for pharmacists in improving and protecting public health [28,29,30,31] as the profession continues to build upon and refine necessary competencies [32,33].

Due to the nature of their work, pharmacists impact both patient- and population-level health outcomes, spanning the "micro" to "macro" levels of influence in public health [29,30,34,35,36].

Enhancing Pharmacy Education in Preparedness for and to Responsiveness to Digital Health: Ways Forward

Building on the results of the survey, several areas for moving forward have been identified at the international level involving different stakeholder groups, i.e., academic institutions, educators, and students. These are described in more detail below.

1.Support of educators: train the teachers :

Key findings emanating from FIP's global report on digital health in pharmacy education [24] with regard to preparedness and responsiveness of academia are:

(1) Identification of competencies in digital health that are established in a needsbased pharmacy and pharmaceutical sciences education, which meets existing and emerging requirements relevant to a broad dimension of pharmaceutical scenarios; and
(2) A positive responsiveness to prepare students for digital health.

2.Digital Health Initiatives from Pharmacy Schools: Sharing Best Practices :

One of the objectives of the FIP report was to describe good practices on course descriptions, examples of assignments, and learning activities on digital health from pharmacy and pharmaceutical sciences schools. The various educational initiatives from pharmacy schools may help to build digital health competencies; to explore good practices on course descriptions, assignments, and learning activities on digital health; and to identify steps to develop similar initiatives in digital health at other institutions.

3.Developing an FIP Global Curriculum and Training Resources Toolkit for Digital Health Education :

The FIP report indicates the global need for educational resources and standards for digital health in pharmacy education. As a way forward, building on the findings of the report, FIP is going to design and develop a global curriculum and training resources toolkit for digital health in initial pharmacy education that includes baseline digital health literacy and the integration of digital health with professional practice. FIP's global curriculum and training resources toolkit will promote the mindsets and behaviors needed for the digital reform in education, as there might be cultural, regulatory, or systematic barriers preventing its adoption. The developed curriculum and training resources will provide for a broader perspective and include areas such as governance, ethics, and security to provide safe ways of working with new technologies.

4.Way Forward for Pharmacy Students by the International Pharmaceutical Students' Federation (IPSF) :

Digital health education is vital for equipping students with empowering skills, such as inter-professional collaboration, knowledge about digital health tools, and becoming familiarized with health systems and entrepreneurship. The IPSF, the leading international advocacy organization for pharmacy and pharmaceutical sciences students and recent graduates, is working on different projects and activities to emphasize the importance of digital health literacy through webinars, professional development programmes, and workshops. Each region has led its own initiatives.
The IPSF is advocating for stronger curricular activities and extracurricular projects related to digital health practices and education in pharmacy schools. In addition, in collaboration with FIP, the IPSF is hoping to support developing programmes dedicated to closing the gap between pharmacy education and digital health.

Need for New Technology Platforms :

Today, digital transformation in health is spreading and consolidating rapidly [7]. Most challenges related to Industry 4.0 adoption will be technical challenges that early adopters need to solve. The ability to implement AI systems requires new software and hardware infrastructure. AI-based automation systems require capturing, processing, and retrieving large amounts of stored and real-time data. The technical complexity of AI systems is based on the need to integrate numerous platforms and tools, incompatible data models, and different architectures. Modern computing paradigms combine Edge Computing with Artificial Intelligence (Edge AI) to overcome the limitations of the cloud by processing data in real-time with on-device machine learning. The advent of Edge AI allows the implementation of robust, distributed, large-scale AI systems. Especially in pharmaceutical AI applications, digital information is usually highly sensitive and requires integrated security and data protection. In most computer vision use cases, real-time and local data processing is needed to avoid sending videos to the cloud.
This includes major key technologies that are enabled in the developing of pharmaceutical sector.

ARTIFICIAL INTELLIGENCE :

Over the past few years, there has been a drastic increase in data digitalization in the pharmaceutical sector. However, this digitalization comes with the challenge of acquiring, scrutinizing, and applying that knowledge to solve complex clinical problems [37]. This motivates the use of AI, because it can handle large volumes of data with enhanced automation [38]. Artificial Intelligence (AI) has recently started to gear-up its application in various sectors of the society with the pharmaceutical industry as a front-runner beneficiary. This review highlights the impactful use of AI in diverse areas of the pharmaceutical sectors viz., drug discovery and development, drug repurposing, improving pharmaceutical productivity, clinical trials, etc. to name a few, thus reducing the human workload as well as achieving targets in a short period. Crosstalk on the tools and techniques utilized in enforcing AI, ongoing challenges, and ways to overcome them, along with the future of AI in the pharmaceutical industry, is also discussed. According to the McKinsey Global Institute, the rapid advances in AI-guided automation will be likely to completely change the work culture of society [39,40].

The use of artificial intelligence (AI) has been increasing in various sectors of society, particularly the pharmaceutical industry. In this review, we highlight the use of AI in diverse sectors of the pharmaceutical industry, including drug discovery and development, drug repurposing, improving pharmaceutical productivity, and clinical trials, among others; such use reduces the human workload as well as achieving targets in a short period.

Artificial intelligence-integrated drug discovery and development has accelerated the growth of the pharmaceutical sector, leading to a revolutionary change in the pharma industry.Involvement of AI in the development of a pharmaceutical product from the bench to the bedside can be imagined given that it can aid rational drug design [41]; assist in decision making; determine the right therapy for a patient, including personalized medicines; and manage the clinical data generated and use it for future drug development. Different applications of AI in drug discovery and development are summarized.

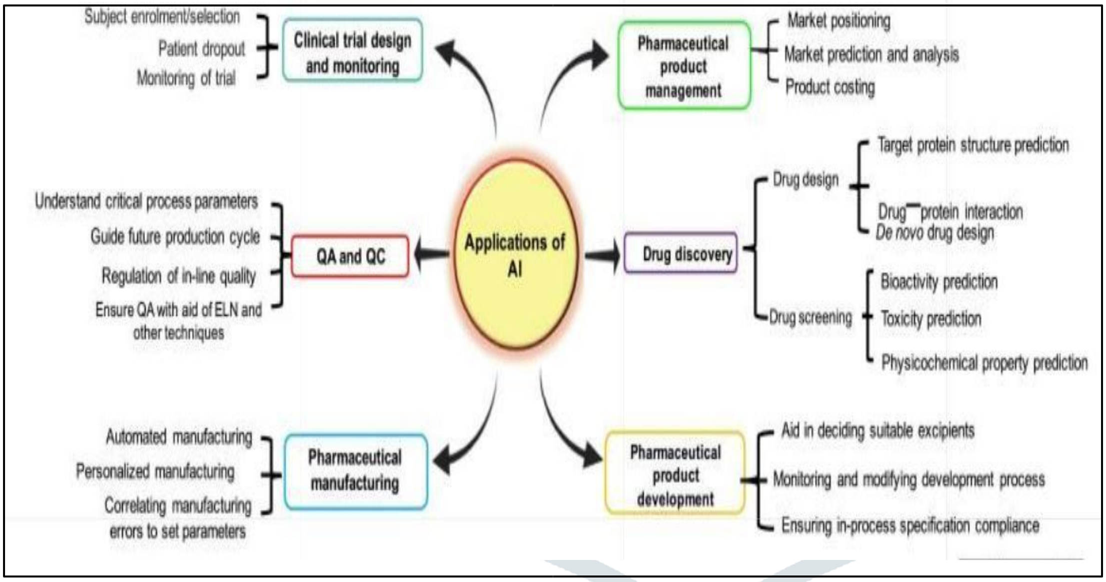

Table-1:Applications Of AI

Applications of AI in Advancing pharmacy and digital transformation :

- **Dosage Error Reduction**

■Medical fallacies such as surgical errors, laboratory errors, medication events, documentation/computer errors, and healthcare-associated infections are some of the causes of death which can be avoided to a large extent.

■The wrong medication or improper dosage can also be fatal in some cases. Currently, to overcome the medical error due to incorrect dosage, some studies are using AI to predict the dosage of medicines, specifically in the case of chronic conditions in which the patient follows medication regimens for months and years.

■AI-powered dosing algorithms are expected to provide significant improvements in dose efficiencies by reducing the adverse drug events in some critical diseases. Currently, Dosis, a San Francisco company is offering an artificial intelligence-powered personalized dosing platform to manage chronic drug regimens.

- **AI in advancing pharmaceutical product development**

The discovery of a novel drug molecule requires its subsequent incorporation in a suitable dosage form with desired delivery characteristics. In this area, AI can replace the older trial and error approach. Various computational tools can resolve problems encountered in the formulation design area, such as stability issues, dissolution, porosity, and so on, with the help of QSPR. Decision-support tools use rule-based systems to select the type, nature, and quantity of the excipients depending on the physicochemical attributes of the drug and operate through a feedback mechanism to monitor the entire process and intermittently modify it.

a. **AI in market positioning :**

Market positioning is the process of creating an identity of the product in the market to attract consumers to buy them, making it an essential element in almost all business strategies for companies to establish their own unique identity [42,43].

With the help of technology and e-commerce as a platform, it has become easier for companies to get a natural recognition of their brand in the public domain. Companies exploit search engines as one of the technological platforms to occupy a prominent position in online marketing and help in the positioning of the product in the market, as also confirmed by the Internet Advertising Bureau. Companies continuously try to rank their websites higher than those of other companies, giving recognition to their brand in a short period [44].

Other techniques, such as statistical analysis methods, particle swarm optimization algorithms (proposed by Eberhart and Kennedy in 1995) in combination with NNs, provided a better idea about markets. They can help decide the marketing strategy for the product based on accurate consumer-demand prediction [45].

b. **AI in market prediction and analysis :**

The success of a company lies in the continuous development and growth of its business. Even with access to substantial funds, R&D output in the pharmaceutical industry is falling because of the failure of companies to adopt new marketing technologies [46]. The advances in digital technologies, referred to as the 'Fourth industrial revolution', is helping innovative digitalized marketing via a multi criteria decision-making approach, which collects and analyzes statistical and mathematical data and implements human inferences to make AI-based decision-making models explore new marketing methodology [47].

AI also helped in a comprehensive analysis of the fundamental requirements of a product from the customer's point of view as well as understanding the need of the market, which aid in decision-making using prediction tools. It can also forecast sales and analyze the market. AI-based software engages consumers and creates awareness among physicians by displaying advertisements directing them to the product site by just a click [48]. In addition, these methods use natural language-processing tools to analyze keywords entered by customers and relate them to the probability of purchasing the product [49,50].

- **Other applications:**

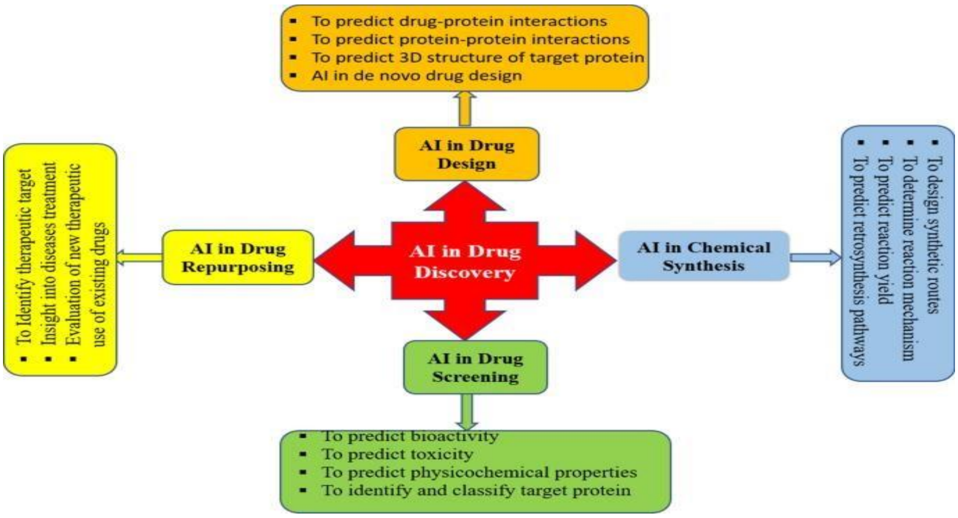

Figure-1:AI In Drug Discovery

Tele-Pharmacy:

Tele-medicine refers to delivering health care and public education in rural and remote areas .Tele-pharmacy is a subset of Tele-medicine in which pharmacies use telecommunication technology to provide patient care. Tele-pharmacy can potentially improve pharmaceutical care service delivery by reducing medication errors and adverse drug events.Furthermore,it has the potential to benefit remote and rural areas with limited access to health professionals and facilities. Pharmacists today want to extend their profession to provide more services to the rural community while also rising patient outcomes. As a result, Tele-pharmacy services such as medication orders, medication history reviews, dispensing drugs, remote patient consultation, therapeutic drug monitoring, and medication therapy management are becoming more common. These services can be provided using eHealth tools like mobile consultation, software applications, and automated dispensing machines. It can be used as an educational tool for learning students and medical staff [12]

In any tele-pharmacy model, pharmacist can play an active role in the delivery of pharmacy services. The pharmacist involving in tele-pharmacy models ensures high quality care for the community particularly areas such as medication reviews and patient counseling.A 2013 study of the impact of tele-pharmacy services has shown that the involvement of pharmacists in the remote review of medication orders when the hospital pharmacy was closed resulted in a decreased number of adverse drug events reported. Adverse drug events and other medication error contribute to several thousand deaths each year.

The American Telemedicine Association divides telemedicine into three categories: storage-promotion, remote monitoring, and interactive services. The first category includes medical data, such as medical photographs, cardiograms, etc., which are transferred through new technologies to the specialist doctor to assess the patient's condition and suggest the appropriate medication. Remote monitoring allows remote observation of the patient. This method is used mainly for chronic diseases like heart disease, asthma, diabetes, etc. Its interactive services enable direct communication between the patient and the treating doctor [11].

The most common obstacles to the spread of telemedicine are found in the high cost of equipment, the required technical training of staff and the estimated time of a meeting with the doctor, which can often be longer than the use of a standard doctor [13]. At present, there are Telemedicine centres that mediate between the patient and the hospital or doctor. However, many factors make this communication impossible [14]. However, many challenges are regularly mentioned and responsible for the need for more longevity in many efforts to adopt telemedicine. One such challenge is the complexity of human and cultural factors. Some patients and healthcare workers resist adopting healthcare models that differ from traditional approaches or home practices.In contrast, others need to have the appropriate educational background in Information and Communication Technologies to make effective use of telemedicine approaches [15].In any case, the technological challenges are related to legal issues. In addition, the systems used are complex, and there is a possibility of malfunction, which could cause software or hardware failure. The result is an increase in patient morbidity or mortality as well as the liability of healthcare providers [16].

Electronic Health Records (EHRs):

Digital health technology and pharmacy informatics encompasses a wide range of tools, including mobile applications, electronic health records (EHRs), prescribing, digital therapeutics, consumer wearable technology, and bots, to name just a few. These digital health technologies are revolutionizing health care, in various degrees, across the United States and the world [51]. The uptake and use of digital technologies are advancing rapidly, even more so in the last year due to the 2019 corona-virus (COVID-19) pandemic [52]. Electronic health records are an important piece of pharmacy informatics education and often integrate with other types of digital technology. Efficient use of EHRs is integral to pharmacy students being practice ready. Healthcare professionals must recognise the online information they seek and engage with patients to evaluate online health information and support joint healthcare-making [10]

The overriding reason for us to use these technologies is to have all of the information we need for patient care, for education, and for practice management readily accessible at the point-of-care. It should not matter whether the computer terminal is in our office, at our clinic workstation, in the examination room, at home, or at the hospital bedside. Oncologists need support for their clinical decisions that is patient-specific, as well as timely reminders. Electronic links across care settings should facilitate collaborative, coordinated approaches among caregivers and enhance the tracking and monitoring of the quality of our care activities. Other important reasons to use EHRs include reduction of medical errors, reduction of lost or redundant paperwork and support for reimbursement for our work. EHRs can also help the oncology community contribute fully to the development of an efficient national health care system that is based upon evidence-based medicine and responsive to the needs of all constituents. If the National Health Information Infrastructure is activated, EHR implementation should allow us and our patients to participate.

Security Of E-Health:

The possibility of the patients looking at the electronic patient folder in a cloud environment, through mobile devices anytime and anywhere, is significant. On the one hand, the advantages of cloud computing are essential, and on the other hand, a security mechanism is critical to ensure the confidentiality of this environment. Five methods are used to protect data in such environments:

(1) users must encrypt the information before storing it
(2) users must transmit information through secure channels
(3) the user ID must be verified before accessing data
(4) the information is divided into small portions for handling and storage, retrieved when necessary
(5) digital signatures are added to verify that a suitable person has created the file to which a user has access.

On the other hand, users of these environments will implement self-encryption to protect data and reduce over-reliance on providers [17].

Education impact of E-Health：

But all this would only be feasible with the necessary education of both users and patients [18]. As the volume and quality of evidence in medical education continue to expand, the need for evidence synthesis will increase [19]. On the other hand, Brockers C. et al. argued that digitalisation changes jobs and significantly impacts medical work. The quality of medical data provided for support depends on telemedicine's medical specialisation and knowledge. Adjustments to primary and further education are inevitable because physicians are well trained to support their patients satisfactorily and confidently in the increasingly complex digitalisation of healthcare.The ultimate goal of the educational community is the closest approach of students to the issues of telemedicine and e-health, the creation of a spirit of trust, and the acceptance and transmission of essential knowledge [20].

Automation :

Automation is being used effectively to digitally transform a pharmaceutical supply chain.

➢ Automation in drug manufacturing:

Automation is being implemented and used to improve the manufacturing process of medicine and other pharmaceutical products. Robots can replace human tasks such as mixing chemicals and packaging medicine. This not only reduces errors in the process but also reduces the risk of contamination and biohazard.

➢ RPA (Robotic Process Automation):

RPA can be used to streamline the patient recruitment process of drug trials. Additionally, RPA can help improve regulatory affairs by gathering and verifying documents according to regulatory standards.

- GAM Pharmaceuticals[1] used RPA to automate 22 rule-based processes across different business platforms (e.g., company website, spreadsheets, ERP). They were able to save BR$120k per year on manual tasks, Increase the speed of responding to customer requests.

Block Chain Technology:

The pharmaceutical industry is one of many industries that have digitally transformed with block chain technology. Few of the major challenges faced by the Pharma Industry worldwide are Lack of transparency, difficulty of tracking items, sale of counterfeit drugs and the distribution of expired and banned medicines. Several of these issues have been resolved using block chain technology.

➢ Impacts of block chain technology on the pharmaceutical industry:

The financial industry has changed due to block chain's innovation. Especially in this context, it is fascinating to see how technological advances and the implications are employed in other sectors. However, block chain is gaining a lot of opportunity and traction within the pharmaceutical industry, given the significant investments made by these companies in development, research, as well as manufacturing.

Block chain technology, which enables user authentication, proof of work, and smart contracts, may alter how businesses manage and store data by ensuring security and transparency for all the concerned stakeholders. However, drug development in the pharmaceutical sector involves following procedures and protocols, for instance, the requirement to move data from one department to another, the necessity to transfer pharmaceuticals to wholesale distributors before delivering them to patients, and the need to protect the integrity of patient’s data.

➢ Benefits of block-chain in the pharmaceutical industry:

The overall advantages of block chain tech implementations are immense, ranging from complete regulatory compliance across the sector to data security throughout the supply chain. But building a genuinely connected, multinational business is not simple, especially for pharmaceutical firms. A company interested in block chain must carefully consider how it will educate itself, assess the technology, and determine whether the system will be a valuable asset for its products.

New approaches to block chain technology are beginning to be explored in the pharmaceutical sector, such as cloud-based networks that permit comprehensive visibility and collaboration among all supply chain participants.

Other solutions use the vast amounts of data in the system to connect cloud-based networks with decision-support software. Both strategies will ultimately raise the quality of the sector by enhancing product shelf life, reducing inventory, and boosting profit margins. Many pharmaceutical companies have already developed successful techniques to stay ahead of the competition.

Computer Vision In Pharma :

Computer vision provides the ability to automate a wide range of complex tasks which traditionally depend on trained operators. Compared to other sensor technologies, camera solutions are highly efficient, contact less, have a minimal operational footprint that impacts existing processes and equipment while providing a great amount of information. Compared to traditional machine vision systems, deep learning allows using conventional cameras and a very flexible and scalable system design. There are numerous applications of computer vision during the pharmaceutical production process. One of the most urgent problems from the point of view of industry productivity and competitiveness is automatic inspection. Early detection of defects in the production process means lower cost and faster feedback

on the production line with the goal of eliminating the causes of defects. Example applications include label detection, batch number monitoring, liquid medicine volume detection, and so on.

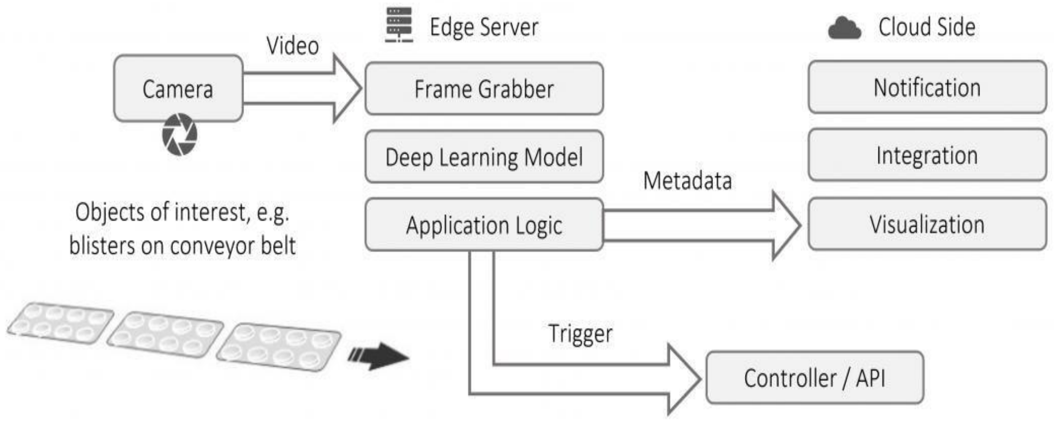

Figure- 2 Simplified diagram of a typical computer vision system

Applications:

1. Quality inspection of capsules using AI vision
2. Pharmaceutical bottle-packaging detection and counting
3. Automated defect detection for blister packaging
4. Blister package recognition and identification with Deep Learning
5. Detection and classification of imprinted pharmaceutical tablets
6. Infusion bag detection with Deep Learning models
7. AI vision inspection of cleaning in pharmaceutical manufacturing

●**Quality control and packaging**: Quality control and inspection in drug manufacturing and packaging can have various repetitive and error-prone tasks. Computer vision planted in manufacturing facilities can help increase inspection accuracy and precision.

●**Shipment tracking and drug traceability:** In the pharmaceutical sector, it is crucial to track the drugs during shipment and trace their origin in case of unknown side effects. Computer vision does this efficiently through shipping label inspection, bar-code detection and scanning, and serialization codes for enhanced traceability.

●**Physical document digitization:** Through computer vision technology, important pharmaceutical documents such as clinical trial documents, patient reports or medical records, and lab records can be automatically digitized.

Internet of Things (IoT)

Across the pharmaceutical value chain this figure shows the implementation of IoT technology in different segments.

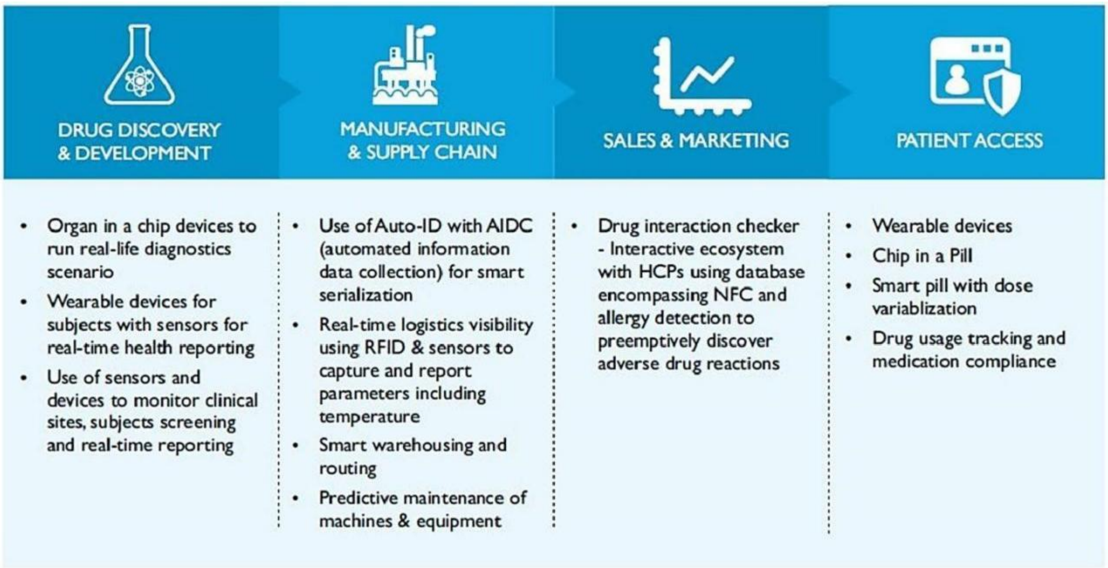

Table-2:Drug Discovery&Development

CONCLUSION

our review explains the analysis of the key technologies that are performing leading roles in the Developing and enhancing of Pharmacy field by incorporating the digital transformation, digitalization.The advancement of AI, along with its remarkable tools, continuously aims to reduce challenges faced by pharmaceutical sector.With the inclusion of AI in the manufacturing of pharmaceutical products, personalized medications with the desired dose, and other required aspects can be manufactured according to individual patient need . Using the latest AI-based technologies will not only speed up the time needed for the products to come to the market, but will also improve the quality of products and the overall safety of the production process, and provide better utilization of available resources.and also pharmacy students have limited knowledge and perceptions of the Tele-pharmacy system by incorporating pharmacy information system guidelines as part of their education. Along with that skills in using electronic health records are an important part of the use of technology in pharmacy. Incorporation of the EHR into skills-based curricula is needed across all pharmacy programs.

REFERENCES :

1.International Pharmaceutical Federation (FIP). The Fip Development Goals: Transforming Global Pharmacy; International Pharmaceutical Federation: The Hague, The Netherlands, 2020.

2.International Pharmaceutical Federation (FIP). FIP Digital Health in Pharmacy Education; International Pharmaceutical Federation: The Hague, The Netherlands, 2021.

3.World Economic Forum. Healthcare: Building a Digital Healthcare System. Available online: https://reports.weforum.org/ digital-transformation/healthcarebuilding-a-digital-healthcaresystem/ (accessed on 30 October 2020).

4.Aungst, T.D.; Patel, R. Integrating digital health into the curriculum— Considerations on the current landscape and future developments. J. Med. Educ. Curric. Dev. 2020, 7. [CrossRef] [PubMed]

5.Fernando, J.; Lindley, J. Lessons learned from piloting mHealth informatics practice curriculum into a medical elective. J. Am. Med. Inform. Assoc. 2018, 25, 380–384. [CrossRef] [PubMed]

6.Haghi, M.; Thurow, K.; Stoll, R. Wearable devices in medical internet of things: Scientific research and commercially available devices. Healthc. Inform. Res. 2017, 23, 4–15. [CrossRef] [PubMed]

7.Agarwal, R.; Gao, G.; DesRoches, C.; Jha, A.K. Research commentary—The digital transformation of healthcare: Current status and the road ahead. Inf. Syst. Res. 2010, 21, 796–809. [CrossRef]

8.Gopal, G.; Suter-Crazzolara, C.; Toldo, L.; Eberhardt, W. Digital transformation in healthcare—Architectures of present and future information technologies. Clin. Chem. Lab. Med. CCLM 2019, 57, 328–335. [CrossRef]

9.Kraus, S.; Schiavone, F.; Pluzhnikova, A.; Invernizzi, A.C. Digital transformation in healthcare: Analyzing the current state-ofresearch. J. Bus. Res. 2021, 123, 557–567. [CrossRef]

10. Diviani, N.; Fredriksen, E.H.; Meppelink, C.S.; Mullan, J.; Rich, W.; Sudmann, T.T. Where else would I look for it? A five-country qualitative study on purposes, strategies, and consequences of online health information seeking. J. Public Health Res. 2019, 8, 1–17. [CrossRef]

11. Sachpazidis, I. Image and Medical Data Communication Protocols for Telemedicine and Teleradiology. Ph.D. Dissertation, Technische Universität, Berlin, Germany, 2008.

12. Van't Haaff, C. Virtually On-sight. Just Can. Dr. 2009, 22, 22.

13. Moffatt, J.J.; Eley, D.S. Barriers to the up-take of telemedicine in Australia–a view from providers. Rural Remote Health 2011, 11, 116–121. [CrossRef]

14. Zdravkovi´c, S. Telemedicine: Perspectives and expectations. Arch. Oncol. 2008, 16, 69–73. [CrossRef]

15. Wootton, R.; Geissbuhler, A.; Jethwani, K.; Kovarik, C.; Person, D.A.; Vladzymyrskyy, A.; Zanaboni, P.; Zolfo, M. Long-running telemedicine networks delivering humanitarian services: Experience, performance and scientific output. Bull. World Health Organ. 2012, 90, 341–347D. [CrossRef]

16. Qaddoumi, I.; Bouffet, E. Supplementation of a Successful Pediatric NeuroOncology Telemedicine-Based Twinning Program by E-Mails. Telemed. E-Health 2009, 15, 975–982. [CrossRef]

17. Chiang, D.-L.; Huang, Y.-T.; Chen, T.-S.; Lai, F.-P. Applying time-constraint access control of personal health record in cloud computing. Enterp. Inf. Syst. 2020, 14, 266–281. [CrossRef]

18. . Hosseinzadeh, M.; Ahmed, O.H.; Ehsani, A.; Ahmed, A.M.; Hama, H.K.; Vo, B. The impact of knowledge on e-health: A systematic literature review of the advanced systems. Kybernetes 2021, 50, 1506–1520. [CrossRef]

19. Cook, D.A.; West, C.P. Conducting systematic reviews in medical education: A stepwise approach. Med. Educ. 2012, 46, 943–952. [CrossRef]

20. Brockes, C.; Grischott, T.; Dutkiewicz, M.; Schmidt-Weitmann, S. Evaluation of the education "Clinical Telemedicine/e-Health" in the curriculum of medical students at the University of Zurich. Telemed. E-Health 2017, 23, 899–904. [CrossRef] 21. Rodis, J.; Aungst, T.; Brown, N.; Cui, Y.; Tam, L. Enhancing Pharmacy Student Learning and Perceptions of Medical Apps. *JMIR Mhealth Uhealth* 2016, *4*, e55. [Google Scholar] [CrossRef] [PubMed][Green Version]

22. Park, J.Y.; Min, J. Exploring Canadian pharmacy students' e-health literacy: A mixed method study. *Pharm. Pract.* 2020, *18*, 1747. [Google Scholar] [CrossRef] [PubMed][Green Version]

23. MacLure, K.; Stewart, D. A qualitative case study of ehealth and digital literacy experiences of pharmacy staff. *Res. Soc. Adm. Pharm.* 2018, *14*, 555–563. Available online: https://www.sciencedirect.com/science/article/pii/S1551741117301882 (acc essed on 3 June 2021). [CrossRef] [PubMed]

24. International Pharmaceutical Federation (FIP). *FIP Digital Health in Pharmacy Education*; International Pharmaceutical Federation: The Hague, The Netherlands, 2021. [Google Scholar]

25. American Public Health Association. What is Public Health? Available online: https://www.apha.org/what-is-public-health (accessed on 15 February 2023).

26. CDC Foundation. What is Public Health? Available online: https://www.cdcfoundation.org/what-public-health (accessed on 15 February 2023).

27. Centers for Disease Control and Prevention. Picture of America: Prevention. Available online: https://www.cdc.gov/pictureofamerica/pdfs/picture_of_america_prevention.pd f (accessed on 15 February 2023).

28. International Pharmaceutical Federation (FIP). Strategic Plan 2019 to 2024. Available online: https://www.fip.org/file/4369 (accessed on 15 February 2023).

29. American Public Health Association. *Policy Statement Database: The Role of the Pharmacist in Public Health*; Policy Number 200614; American Public Health Association: Washington, DC, USA, 2006. [Google Scholar]

30. Cameron, G.; Chandra, R.N.; Ivey, M.F.; Khatri, C.S.; Nemire, E.R.; Quinn, C.J.; Subramaniam, V. ASHP Statement on the pharmacist's role in public health. *Am. J. Health Pharm.* 2021, *79*, 388–399. [Google Scholar] [CrossRef]

31. Public Health England. Pharmacy: A Way forward for Public Health. Available online: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/at tachment_data/file/643520/Pharmacy_a_way_forward_for_public_health.pdf (accesse d on 15 February 2023).

32. nternational Pharmaceutical Federation (FIP). The FIP Development Goals: Transforming Global Pharmacy. Available online: https://www.fip.org/file/4793 (accessed on 15 February 2023).

33. Warren, R.; Young, L.; Carlisle, K.; Heslop, I.; Glass, B. Public health competencies for pharmacists: A scoping review. *Pharm. Educ.* 2021, *21*, 731–758. [Google Scholar] [CrossRef]

34. Agomo, C.; Udoh, A.; Kpokiri, E.; Osuku-Opio, J. Community pharmacists' contribution to public health: Assessing the global evidence base. *Clin. Pharm.* 2018, *10*, 2053–6178. [Google Scholar]

35. Agomo, C.O. The role of community pharmacists in public health: A scoping review of the literature. *J. Pharm. Health Serv. Research.* 2012, *3*, 25–33. [Google Scholar] [CrossRef]

36. Strand, M.A.; DiPietro Mager, N.; Hall, L.; Martin, S.L.; Sarpong, D.F. Pharmacy contributions to improved population health: Expanding the public health roundtable. *Prev. Chronic Dis.* 2020, *17*, 200350. [Google Scholar] [CrossRef]

37. Ramesh A. Artificial intelligence in medicine. *Ann. R. Coll. Surg. Engl.* 2004;86:334–338. [PMC free article] [PubMed] [Google Scholar]

38. Miles J., Walker A. The potential application of artificial intelligence in transport. *IEE Proc.-Intell. Transport Syst.* 2006;153:183–198. [Google Scholar]

39. Smith R.G., Farquhar A. The road ahead for knowledge management: an AI perspective. *AI Mag.* 2000;21 17–17. [Google Scholar]
40. Lamberti M.J. A study on the application and use of artificial intelligence to support drug development. *Clin. Ther.* 2019;41:1414–1426. [PubMed] [Google Scholar]

41. Duch W. Artificial intelligence approaches for rational drug design and discovery. *Curr. Pharm. Des.* 2007;13:1497–1508. [PubMed] [Google Scholar]

42. Kalafatis S.P. Positioning strategies in business markets. *J. Bus. Ind. Marketing.* 2000;15:416–437. [Google Scholar]
43. Jalkala A.M., Keränen J. Brand positioning strategies for industrial firms providing customer solutions. *J. Bus. Ind. Marketing.* 2014;29:253–264. [Google Scholar]

44. Dou W. Brand positioning strategy using search engine marketing. *Mis Quarterly.* 2010:261–279. [Google Scholar]

45. Chiu C.-Y. An intelligent market segmentation system using k-means and particle swarm optimization. *Expert Syst. Appl.* 2009;36:4558–4565. [Google Scholar]

46. Toker D. A decision model for pharmaceutical marketing and a case study in Turkey. *Ekonomska Istraživanja.* 2013;26:101–114. [Google Scholar]

47. Singh J. Sales profession and professionals in the age of digitization and artificial intelligence technologies: concepts, priorities, and questions. *J. Pers. Selling Sales Manage.* 2019;39:2–22. [Google Scholar]

48. Milgrom P.R., Tadelis S. National Bureau of Economic Research; 2018. How Artificial Intelligence and Machine Learning Can Impact Market Design. [Google Scholar]

49. Davenport T. How artificial intelligence will change the future of marketing. *J. Acad. Marketing Sci.* 2020;48:24–42. [Google Scholar]

50. Syam N., Sharma A. Waiting for a sales renaissance in the fourth industrial revolution: machine learning and artificial intelligence in sales research and practice. *Ind. Marketing Manage.* 2018;69:135–146. [Google Scholar]

51. International Pharmaceutical Federation. FIP Digital Health in Pharmacy Education: Developing a Digitally Enabled Pharmaceutical Workforce. Published 2021. https://www.fip.org/file/4958. Accessed August 17, 2021.

52. Golinelli D, Boetto E, Carullo G, Nuzzolese AG, Landini MP, Fantini MP. Adoption of digital technologies in health care during the COVID-19 pandemic: systematic review of early scientific literature. *J Med Internet Res.* 2020;22(11):e22280. [PMC free article] [PubMed] [Google Scholar]

53. Guo M. A prototype intelligent hybrid system for hard gelatin capsule formulation development. *Pharm. Technol.* 2002;6:44–52. [Google Scholar]

i. Mehta C.H. Computational modeling for formulation design. *Drug Discovery Today.* 2019;24:781–788. [PubMed] [Google Scholar]

54. Zhao C. Toward intelligent decision support for pharmaceutical product development. *J. Pharm. Innovation.* 2006;1:23–35. [Google Scholar]

55. Wootton R. *Telemedicine BMJ.* 2001;323(7312):557–560. [PMC free article] [PubMed] [Google Scholar]
56. Angaran DM. Telemedicine and telepharmacy: Current status and future implications. *Am J Health Syst Pharm.* 1999;**56**(14):1405–1426.
doi: 10.1093/ajhp/56.14.1405. [PubMed] [CrossRef] [Google Scholar]

57. Petropoulou S, Bekakos M, Gravvanis G, editors. E-prescribing-Telepharmacy. 7th Hellenic European Conference on Computers; 2005: Citeseer.

58. Elnaem MH, Akkawi ME, Al-Shami AK, Elkalmi R. Telepharmacy knowledge, perceptions, and readiness among future Malaysian pharmacists amid the COVID-19 pandemic. *Ind J Pharm Educ Res.* 2022;56(1):09–16.
doi: 10.5530/ijper.56.1.2. [CrossRef] [Google Scholar]

59. Belay TS. *Utilization of Telemedicine in Tikur Anbessa Specialized Hospital, Addis Ababa.* Ethiopia: Addis Ababa University; 2013. [Google Scholar]

60. Baldoni S, Amenta F, Ricci G. Telepharmacy services: present status and future perspectives: a review. *Medicina.* 2019;55(7):327. doi: 10.3390/medicina55070327. [PMC free article] [PubMed] [CrossRef] [Google Scholar]

61. Keeys C, Kalejaiye B, Skinner M, Eimen M, Neufer J, Sidbury G, et al. Pharmacist-managed inpatient discharge medication reconciliation: a combined onsite and telepharmacy model. *Am J Health Syst Pharm.* 2014;71(24):2159–2166.
doi: 10.2146/ajhp130650. [PubMed] [CrossRef] [Google Scholar]