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Tele pharmacy in the Digital Healthcare Era – A Systematic Evaluation of Its Benefits, Challenges and Transformative Potential

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Abstract

Tele pharmacy has emerged as a new system to address pharmaceutical challenges faced during the COVID-19 pandemic. The current review article outlines the benefits, limitations, and future outlook of Tele pharmacy in the pharmacy industry. With Tele pharmacy implementation, it is possible to provide remote medication assistance, video-based consultations, remote support for medication adherence, secure communication, and the use of mobile applications and devices. Studies from Jordan and Indonesia indicate positive responses to integrating Tele pharmacy, which could offer a convenient and cost-effective model for rural and inaccessible populations. Introducing tools like ChatGPT suggests improving Tele pharmacy outcomes by enabling pharmacists to manage medications more effectively. Although Tele pharmacy offers significant benefits, challenges remain in regulatory compliance, variations in implementation, and limited data from clinical trials evaluating long-term cost and performance effects. The need for data security and quick system access emphasizes the importance of strong and reliable implementation. As previously mentioned, Tele pharmacy provides notable advantages such as improved medication accessibility, patient safety, and process efficiency, even amid implementation inconsistencies. However, to sustain the tele pharmacy model, standards must be enforced, legal support secured, and training provided to overcome technological and demographic challenges. Future research should focus on empirical studies, AI adoption, and scalable models for effective tele pharmacy use. This review advocates for innovation in Tele pharmacy to deliver patient-centered and efficient technological solutions to the pharmaceutical community.

Keywords: Tele Pharmacy; Digital Health; Remote Pharmaceutical Care; Artificial Intelligence in Pharmacy; Medication Management; Healthcare Automation

1. Introduction

Pharmacy is in the middle of a major transformation. Over the past few years, especially during the COVID-19 pandemic, the profession has had to adapt quickly to new challenges. From how pharmacists deliver care to how students are trained, and even how new ideas are put into practice, everything is evolving [1]. This review highlights three key areas driving this change: tele pharmacy, artificial intelligence (AI) in pharmacy education, and implementation science [2]. The pandemic prevented people from going out to pharmacies in person. However, the dependency on pharmacy services did not diminish. tele pharmacy provided an alternative solution that patients could rely on [3]. With tele pharmacy, people could continue to access pharmacy services through video sessions, secure messaging, and digital solutions.

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The scoping review by Neta, G et al. [4] evaluates the use of tele pharmacy during COVID-19 across different countries and health care systems. This paper provides details about pharmacists managing medications, advising patients, and collaborating with healthcare providers remotely. This was not a temporary solution and led to new opportunities in remote and underserved areas [5]. The review indicates that the concept of tele pharmacy is still developing. The aspects of effectiveness, costs, and accessibility are still being assessed. Further research and data collection are needed to fully explore the benefits of tele pharmacy in pharmacy services [6].

While tele pharmacy is transforming healthcare delivery, artificial intelligence is beginning to change how future pharmacists are trained. Tools like ChatGPT and other AI models are now used to support learning in pharmacy schools [7]. Students help each other study, generate practice questions, simulate patient interactions, and even assist instructors in creating course materials. The article “Perception and Willingness to Use tele pharmacy Among the General Population in Jordan” evaluates tele pharmacy from the perspective of healthcare delivery [8]. Digital health care services are expanding worldwide, especially in areas with diverse socio-economic conditions. This analysis, conducted by Abu-Farha et al., is based on a survey of a cross-sectional population. The survey assesses the public’s awareness of the advantages and challenges of tele pharmacy [9]. Responses were collected from 800 participants across different cities. The research results identified factors related to approval, location, gender, and system usage processes. The conclusions highlight areas of unfamiliarity with tele pharmacy and emphasize its potential to reduce commuting and improve efficiency [10]. The analysis outlines the methodology, explains the data, and suggests pathways for future pharmacy implementations in Jordan.

The COVID-19 pandemic highlighted the need to use digital processes for healthcare systems worldwide. With the COVID-19 protocols, the concept of tele pharmacy gained significance [11]. Regarding remote services, Tjiptoatmadja and Alian indicate the preparedness of the Indonesian population through factors like awareness, understanding, and interest in using tele pharmacy services. The survey involved 203 cross-sectional participants. The study evaluates how demographic factors such as gender, age, educational background, and perceptions of tele pharmacy influence awareness [12-13]. The results show that only 50% of participants were aware of tele pharmacy concepts; however, many were optimistic about its potential positive outcomes in the future. The paper "tele pharmacy Services: Present Status and Future Perspectives: A Review" by Simone Baldoni, Francesco Amenta, and Giovanna Ricci provides an extensive review of the current state of tele pharmacy and future prospects. The study proposes tele pharmacy as an effective way to enhance pharmaceutical services in remote, underserved areas. It also addresses tele pharmacy as a solution to pharmacist shortages. The review categorizes tele pharmacy into three areas: clinical support, remote education and management of specialized pharmacies, and drug prescription and reconciliation. The paper suggests that tele pharmacy is an effective system to improve healthcare through online and digital technologies. It emphasizes the need for legal frameworks and standard protocols. The study highlights that further research, experiments, and studies are essential in this field. Overall, it strongly advocates for integrating tele pharmacy into healthcare systems.

2. Literature Review

Table 1 presents an extensive comparative review of 62 research studies highlighting advancements in artificial intelligence, tele pharmacy, robotics, automated dispensing systems, barcode technologies, and digital health solutions. It summarizes each study's objectives, findings, applications, and key remarks, offering valuable insights into the evolving landscape of pharmacy practice from 2010 to 2025.

Table 1 Comprehensive Review of AI, Automation, tele pharmacy, and Digital Innovations Transforming Modern Pharmacy Practice (2010–2025)

Ref#	Year	Name of the Paper	Authors	Observations	Application	Remarks
14	2025	The Evolution of Pharmacy Ecosystems. Acta Scientific Pharmaceutical Sciences	Andy, A., Keetha et all.	The study focuses on the impact of technology, particularly online platforms and digital services, on the way patients access medications and the role of pharmacists.	Digital pharmacy ecosystems use sophisticated software and hardware technologies, including telemedicine platforms, AI (Artificial Intelligence) driven analytics, automated dispensing systems, and IoT (Internet of things) devices, to improve operational efficiency, prescription management, and patient outcomes	This article examines the crucial significance of digital transformation in pharmacy practices, the essential technologies influencing the industry, and the obstacles to implementation
15	2025	Beyond the fill: Navigating pharmacy's technological future in 2050	Aungst, T. D.	The pharmacy profession stands at a pivotal juncture as it faces unprecedented technological advancements that will rapidly reshape the healthcare landscape by 2050.	Several potential scenarios may unfold by 2050, ranging from a diminished workforce overshadowed by technology to an evolved profession that leverages novel technologies to enhance clinical services and patient care.	This commentary explores the implications of technological advancements for pharmacy practice and how it may impact the workforce in the coming decades. The advent of digital health technologies (DHTs), artificial intelligence (AI), and automation is poised to transform patient engagement and care delivery.
16	2024	The Impact of Artificial Intelligence and Machine Learning on Pharmacy Practice The Impact of Artificial Intelligence and Machine Learning on Pharmacy Practice	Joseph Obiezu Chukwujekwu Ezeonwumelu et all	This paper discusses the application of AI and ML to pharmacy practice. The system examines the current system wherein it involves interpreting knowledge obtained from large health care data and develop algorithms or rules that are used to guide clinical decision-making, reduce system errors,	AI/ML applications in healthcare include clinical decision support, patient management, predictive analytics, population health management, precision medicine, image recognition, medical diagnoses, AI DIY (Do-It-Yourself), personalized health monitoring, drug discovery and development, robot-assisted surgery, virtual	Pharmacists have great potential to help patients with their drugs by acting as mediators between patients and their numerous medications.

				and ultimately optimize patient outcomes.	assistants, and automated external defibrillators.	
17	2024	Ethical considerations and concerns in the implementation of AI in pharmacy practice: a cross-sectional study	Hisham E. Hasan et all.	The study emphasized the benefits of using AI integration in pharmacy practice. The findings also underline the need for ethical standards and regulatory frameworks that help secure patient data privacy, cybersecurity and allow a fair access to AI system.	Innovative solutions should emerge safeguarding patient welfare and ethical principles in biomedical practice.	Ethical implications include the need for informed consent, beneficence, justice, and transparency in the use of AI.
18	2024	The Role and Impact of Telepharmacy and Digital Health Interventions on Modern Healthcare Systems	Joseph Obiezu Et all	This paper explores the benefits of telepharmacy and digital health interventions, examining their impact on healthcare professionals and patients. Key findings indicate that telepharmacy offers advantages such as improved medication adherence and reduced medication errors, it raises issues related to regulatory, legal, and ethical standards.	Telepharmacy can be implemented through a variety of interconnected platforms, a seated pharmacy management, robotic dispensing, and video consultation with a remote pharmacist.	By embracing these innovations, health care systems can provide quality health care and improved health care delivery.
19	2024	Utilizing ChatGPT in Telepharmacy	Firas H Bazzari et all.	This study evaluates the potential of using ChapGPT application in Telepharmacy, delivering of pharmaceutical care by telecommunications, through assessing its interactions, adherence to instructions and ability to play the role of pharmacist while handling a series of life like scenario questions.	The overall means of pooled scores were 3.425 (0.712) and 3.7(0.61) for ChatGPT 3.5 and 4.0 respectively.	The paper concludes by stating that ChatGPT holds strong promising potential for Telepharmacy.
20	2024	The promise and challenges of ChatGPT in community pharmacy: A	Ali H. Salama	The purpose of this study is to evaluate ChatGPT in addressing common inquiries in community pharmacies.	The assessment comprises of Drug-Drug Interactions, Adverse Drug Effects, Drug Dosage and Alternative Therapies, each comprising of 20	Researchers and healthcare professionals can improve AI modes to become extremely useful.

		comparative analysis of response accuracy.			questions totaling 80 questions. Responses from ChatGPT were compared against standard answers, generating textual and chart scores. Textual Score was computed by relating correct answers multiplied by chart-type questions. ChatGPT exhibited 30% for Drug-Drug Interactions, 65% for Adverse Drug Effects, 35% for Drug Dosage, and 85% Alternative Therapies.	
21	2023	Artificial Intelligence in Pharmaceutical Technology and Drug Delivery Design	Lalitkumar K Vora et all	This paper aims at the benefits of using AI capabilities of data analysis, pattern recognition and optimization, pharmaceutical researchers and healthcare professionals can enhance drug efficacy, minimize side effects, and improve patient outcomes.	With AI, Drug Formulations, Personalized Therapies, Regulatory compliance and Risk Reductions lead to improved drug manufacturing processes and enhanced patient outcomes.	AI has the potential to transform pharmaceutical industry to greater levels.
22	2023	Overview of Chatbots with special emphasis on artificial intelligence enabled ChatGPT in medical science.	Chairanjib Chakraborty et all.	The paper studies chatbots, their application to the medical field, medicine, architecture and training and a comparison with other NLP.	The paper leads towards Deep Learning based, error free, responsible chatbots to improve the healthcare outcomes.	Chatbots can improve healthcare but may not replace the doctors and other medical professionals.
23	2023	Artificial intelligence in the field of pharmacy practice: A literature review	Sri Harsha Chalasani et all.	This paper examines the AI applications in the field of pharmacy practice. This paper brings in the benefit using AI algorithms and Machine Learning to analyze large volume of patient data, such as medical records, lab results, medication profiles in helping to identify potential drug to drug reactions, assessing the safety of medicines, and making	The paper proposes the concept of “Pharamacointelligence”, which is the integration of AI/ML into pharmacy practice with idea of improving patient care and safety.	For patients, AI may provide guidance for consuming the medications, guidance to obtain cost effective healthcare, guidance to provide the best channel to communicate with healthcare professionals, optimizing health care monitoring using wearable

				informed recommendations specific to patient needs.		devices and lifestyle changes.
24	2023	Innovative Robotic Technologies and Artificial Intelligence in Pharmacy and Medicine: Paving the Way for the Future of Health Care—A Review	Maryna Stasevych and Vicktor Zvarych	Analyzing the current state of affairs with robotics, the paper aims at possibilities for the future as Robotics and AI are playing a significant role in the advancements of healthcare and specifically in pharmacy management.	Using robots in healthcare reduces the contact, especially in cases COVID-19 pandemic.	These advancements can address some of the urgent challenges personalized medicine, targeted therapies, and reduction of human errors in clinical settings.
25	2023	Revolutionizing Drug Discovery: A Comprehensive Review of AI Applications	Rushikesh Dhudum et all.	This paper discusses the usage of AI in drug discovery processes. In this review the influence of AI on diverse aspects of drug discovery, drug target identification, molecular properties, compound analysis, drug development, quality assurance and drug toxicity assessment are considered.	The review is based on the concepts of AI and also explores the challenges of AI in drug discovery and development.	The strength of AI and drug discovery offers a path to overcome the challenges of pharmaceutical industry.
26	2023	The Role of Artificial Intelligence in Pharmacy Practice	Rayn Oswalt	This paper studies the benefits of introducing Artificial Intelligence into Pharmaceutical Industry.AI driven decision support systems help pharmacists choose the right drug, dosage, and identify possible drug reactions and Adverse Events.	AI driven resources can improve clinical judgement while reducing the likelihood of medication errors.	The role of AI in pharmaceutical practice is transformative. From improving patient safety and treatment outcomes.
27	2023	The future of pharmacy: How AI is revolutionizing the industry	Osama Khan et all.	This paper focuses on how AI can improve medication management, patient care, and health care efficiency in pharmacy.	The research objectives of this paper assess the feasibility of using AI in pharmacy on 24/7 support, to identify the potential and ethical implications such as data privacy, identify technical challenges such as data integration, system maintenance and develop solutions to overcome them, and to evaluate	Usage of AI in pharmacy can reduce health costs by improving efficiency and reducing errors.

					the cost benefits of AI pharmacy over a traditional pharmacy.	
28	2023	Artificial Intelligence in Pharmaceutical and Healthcare Research	Subrat Kumar Bhattamisra et all.	This article reviews the application of AI in disease diagnosis, digital therapy, personalized treatment, drug discovery and forecasting epidemics and pandemics.	Algorithm and Machine Learning was used by researchers in identification of cardiac arrhythmia by image processing the electrocardiogram signals.	Deep Learning and neural networks based on the ADMET predictor and ALGOPS program have been utilized for the prediction of lipophilicity and solubility of compounds.
29	2023	Improving Inpatient Medication Dispensing with an Automated System	Afaf Almalki et all.	This paper explores reduction of risk of medication errors by improving the efficiency and distributing medications and minimizing the waste. A Six-Sigma approach was applied to eliminate deficiencies through the medication management process.	ADCs provide efficient handling of medication distribution, quick access to the medication and minimize medication dispensing errors. BD Pyxis MedStation ES ADCs were integrated to the facility's Computerized Provider Order Entry (CPOE) system.	With ADCs there was 83% reduction for all transactions taking 30 minutes or less within 14 months of introducing ADC. There was a cost savings of 57% per annum from total expired medications.
30	2023	ChatGPT in pharmacy practice: a cross-sectional exploration of Jordanian pharmacists' perception, practice, and concerns.	Khawla Abu Hammour et all.	The purpose of this paper is to study to find out the usage of ChatGPT by pharmacists. The correlation of perceived benefits of using ChatGPT has been evaluated using Spearman's rho correlation due to the data's non-normal distribution.	Analysis showed a statistically positive link, between the perceived advantages of ChatGPT and its drawbacks ($r=0.255$, $p < 0.001$)	The target pharmacists were the licensed pharmacists from Jordanian Pharmacists association.
31	2023	Effectiveness of ChatGPT in clinical pharmacy and the role of artificial intelligence in medication therapy management	Don Roosan et all	The idea of this research paper is to use AI to optimize medication therapy management (MTM) in identifying drug interactions to potentially improve MTM efficiency. ChatGPT, an AI language model can be applied to identify medication interventions by integrating patient and drug databases.	ChatGPT was assessed based on three criteria, the ability to identify drug interactions, precision in recommending alternatives and providing matching management plans. ChatGPT 4.0 accurately solved 39 out 39 patient cases.	Future AI models can use ChatGPT to improve patient care.

32	2023	Prospective Role of ChatGPT in Pharmacy: According to ChatGPT	Som Biwas and Srirupa Biswas	The role of ChatGPT in the pharmacy can include, providing information on drug products, side effects, and dosage instructions, answering customer queries related to medication usage, drug interaction and contraindications.	ChatGPT is a valuable tool for the pharmacy, providing support in various as providing drug information, responding to customer queries, summarizing scientific articles, assisting in drug discovery and manage clinical trials	This paper provides an overview of the uses and disadvantages of using ChatGPT in pharmacy as stated by ChatGPT itself.
33	2023	RobotGPT: From ChatGPT to Robot Intelligence	Hongmei He	This paper reviews principles of ChatGPT and analyzes five types of robot perception related to human perception (visual, auditory, tactile, olfactory, and gustatory) and seven types of robot intelligence (logical, mathematical, linguistic, spatial, musical, bodily-kinesthetic, interpersonal, and naturalistic).	Key processes include image processing, object recognition, scene understanding, visual tracking, 3D perception.	ChatGPT provides a good methodology for implementing robot intelligence.
34	2023	Artificial intelligence (AI) in pharmacy: an overview of innovations	Anan S Jarab et all	This paper explores the strategies to overcome challenges to AI adoption in pharmacies. Pharmacies should employ privacy-enhancing technologies (PETs) such as data masking, differential privacy, homomorphic encryption, secure multi-party computation, and zero-knowledge proofs.	Analyzing models from countries with sophisticated AI integration yields strategies for proficient implementation, addressing prevalent challenges such as data privacy, regulatory constraints, and resource allocation.	It is crucial to take advantage of the huge opportunity that AI provides on pharmacies.
35	2023	Applications of AI in pharmacy practice: a look at hospital and community settings	Ahmad Z Al Meslamini	This paper reviews the usage of AI in community pharmacy practice. Using AI enhances supply chain management. AI can analyze vast amount of data, which helps pharmacies maintain an optimal inventory,	AI can improve Automated Dispensing Systems (ADSs). AI's capability can swiftly soft and label medications, anticipate maintenance needs and match needs of each patient. AI algorithms can predict medication demand.	AI plays a vital role in shaping future of pharmacy.

				minimizing stockouts, overstock potentially unsold items.		
36	2023	Perception and Willingness to Use Telepharmacy Among the General Population in Jordan	Rana Abu-Farha et all.	The purpose of this research is aimed to explore how telepharmacy has been perceived and how the population of Jordan could receive the concept.	Regression analysis indicated that men are more likely to use this service compared to women.	In conclusion results received a positive attitude towards telepharmacy among Jordanian population.
37	2022	The Introduction of Robotics to an Outpatient Dispensing and Medication Management Process in Saudi Arabia: Retrospective Review of a Pharmacy-led Multidisciplinary Six Sigma Performance Improvement Project	Manal Al Nemari and James Waterson	The purpose of this paper is to measure the impact that integration of automation made to service, safety, efficiency, staff reallocation, workflow in outpatient pharmacy department. The Six Sigma definition was the current system of outpatient dispensing denies quality to patients in terms of waiting time and contact time with pharmacy professionals, incorporated risks to the patient in terms of mislabeling of medications and incomplete dispensing of prescriptions and is potentially wasteful in terms of time and resources.	The process of automation was carried out in the outpatient department of large hospital pharmacy. A review of activity in the outpatient department focused on non-value-added (NVA) pharmacist tasks, improving the patient experience and patient safety.	The Six Sigma methodology allowed for rapid transformation of the medication management process.
38	2022	Mobile Application: A Proposal for the Inventory Management of Pharmaceutical Industry Companies	Alfredo Leonidas Vasquez Ubaldo et all	This paper addresses the issue of poor inventory management in the Pharmacy. It provides a solution by applying mobile application prototype.	The mobile inventory management application for the pharmaceutical industry meets the requirements of user and the survey submitted resulted in expert judgement of 93%.	It has been recommended to use data mining and other latest software tools for Inventory Management.
39	2022	Evaluating the safety and efficiency of robotic dispensing systems	Tomoki Takase et all.	This paper explores the usage of automated dispensing robots on medication dispensing. A robotic dispensing system includes automated dispensing	Automated dispensing robot stores a maximum of 1200 single unit packages of oral medicines such as tables, capsules, powders, liquid, and topical medications. In the	The median dispensing time of pharmacists per prescription was significantly reduced (from 60 to 23 seconds)

				robot, automated dispensing robot for powdered medicine and barcoded medication dispensing support system with personal digital assistance.	hospital formulary, a total of 623 medicines were stored in the robot. 123 medicines could not be stored in robot due to temperature issues.	
40	2022	Robots in Healthcare: a Scoping Review	Ahmed Ashraf Morgan et all.	This paper reviews the usage of Robots in healthcare. The review found 10 different roles for robots on clinical environments out of which Pharmacy is one of them.	The paper concludes stating that the usage of robotics in healthcare has been expanding.	The APOTECA Chemo system can be used in Chemotherapeutic treatment.
41	2022	An Overview of the Current State and Perspectives of Pharmacy Robot and Medication Dispensing Technology	Asmaa R Alahmari et all.	The paper studies the Pharmacy Robots and Medication Dispensing Technology. The paper references studies in US, where it is estimated that 30 million pharmacy errors occur annually.	The most common pharmacy errors are incorrect dispensing of medications, incorrect dosage being administered, incorrect delivery and preparation of intravenous drugs.	Clinical decisions can be improved with AI.
42	2022	Knowledge, Perception, and Willingness to Use Telepharmacy Among the General Population in Indonesia	Nesqi N Tjiptoatmadja and Sofa D Alfian	The purpose of this study is to assess knowledge, perception, and willingness to use Telepharmacy among the general population of Indonesia. The paper defines Telemedicine as healthcare services that are performed from a distance using technology and include an exchange of information on diagnosis, treatment, and prevention.	The associations between demographic characteristics and knowledge, perception, and willingness to use telepharmacy services were tested with the Mann-Whitney U Test since all data were not normally distributed. Statistically analyses were carried out using SPSS software.	Of the 203 participants in the study, most of them had a fair knowledge and a positive perception about the telepharmacy service.
43	2022	Artificial Intelligence Applications in Education and Pharmacy Practice	Nikhil A. Sangave	This study involves the role of Artificial Intelligence in Digital Health. Pharmacists use AI to provide data driven interventions to Clinical Decision Support Systems (CDSS).	Arine, company has created a platform that provides pharmacists with necessary data to deliver comprehensive patient care services such as tailored medication management, lifestyle counseling and care coordination through telehealth. Cricket Health utilizes ML	Emphasis should be placed not only on digitally enabling the future generations of pharmacists through the curricular additions, but also on providing support to currently practicing

					support patient's chronic kidney disease.	pharmacists through CE and professional development training in emerging digital technologies.
44	2021	Barcode medication administration technology use in hospital practice: a mixed-methods observational study of policy deviations	Alma Mulac et all	Authors focused on the usage of Barcode Medication Administration in hospital/pharmacy and issues caused due to not using the technology.	Hospital staff indicated the accuracy of usage of the system.	The study's generalizability may be limited to the specific hospitals and healthcare professionals included in the sample. Further research across diverse settings is needed to validate the findings.
45	2021	Machine Learning (ML) in Medicine: Review, Applications, and Challenges	Amir Masoud Rahmani et all	This paper helps researchers to understand Machine Learning and its application in health care. The paper provides the classification of machine learning bases schemes in health care	The paper concludes by providing a futuristic view focusing on Deep Learning Techniques and Reinforcement Techniques to be applied to health care.	The paper also discusses the challenges and open issues in terms of Data availability, Data Quality, High Dimensions, Efficiency and Privacy.
46	2021	Artificial intelligence in advanced pharmacy	Tamanna Sharma et all.	This article examines the areas of Process Analytical Technology, Computational Fluid Dynamics and Pharmaceutical Automation Research using AI and Robotics. In the Pharmacy Automation area, the adoption of AI helps, Identifying the right Candidates for clinical trials, processing real time patient feedback, integrating data exchange with partners, distributors, and caregivers.	In the Pharmacy Automation area, the adoption of AI helps, Identifying the right Candidates for clinical trials, processing real time patient feedback, integrating data exchange with partners, distributors, and caregivers.	Robotics can be used in areas of robotics surgery. AI can be used within a cell to find out any DNA alterations.
47	2021	Robotic Pharmacy Implementation and Outcomes in Saudi Arabia: A 21-Month Usability Study	Hisham Momattin et all.	This paper evaluates the automation and integration of pharmacy in a private facility in Saudi Arabia. The intent of the project was to increase	The robotic pharmacy has been vital to ensure stock levels, specifically when automatic filling gets planed.	The data collected at the end of 10 months indicate there was 50% reduction in average patient wait time, 15% increase in patient

				throughput, reduce medication dispensing rates, improve patient satisfaction and free up pharmacists time to allow for increased face-to-face consultations with patients.		satisfaction regarding pharmacy wait time and pharmacy services, 25% increase in pharmacist productivity, and zero dispensing errors.
48	2021	Automated Drugs Dispensing Systems in Hospital Pharmacies and Wards: A Systematic Literature Review	Elisabetta Garagiola et all.	This study involved exploring the use of automated drug dispensing technologies in the pharmacy to minimize the medication errors, boost safety for patients.	The review was conducted using PRISMA methodology. Various stages of drug management Ordering, Dispensing and Administering Medications were automated.	Computerizations include Computerized Physician Order entry (CPOE), barcode medications administration (BCMA) systems, Pharmacy Dispensing Technologies, and Dispensing Cabinets.
49	2021	The Practice of Automated Drug Dispensing Technology on the Reduction of Medication Errors in the Medication Process	Harshita Gupta and Nandini Chaudhary	This review examines the improvement in pharmacy management in healthcare system by using Automated Dispensing Machines, Automated Dispensing Cabinets and Robotic Original pack dispensing systems. The implementation of Automated Dispensing Machine in the dispensing process involves the quality of the medication distribution process and effective utilization of human resources.	An automated drug dispensing system was estimated and indicated a 53% reduction in Medication Administration Error where all type of error was minimized in Unit Dose Dispensing Robot the WSS period ($p<0.001$). Hence a reduction of 79.1% in wrong dose and 93.7% in dispensing of incorrect medications.	The barcodes were implemented for dispensing the drug. The new emerging technologies such as Computerized Medication Administration Records (CMARs), Computerized Physician Order Entry (CPOE), automated dispensing machines (ADMs) and barcoding have impacts in minimizing medication errors.
50	2021	Telepharmacy during COVID-19: A Scoping Review	Elizabeth J. Unni et all.	This purpose of this study is the implementation of Telepharmacy during COVID-19. The study focuses on telepharmacy initiatives and innovative methods used by pharmacies to implement	An application called APOmondo was created as a free Telepharmacy portal to provide personal care for patients.	Use of Telepharmacy can lead to great return on investments, with improved productivity and efficiency.

				telepharmacy. Innovative medical application for use of Electronic Medical Records.		
51	2020	Study of Inventory Management in Pharmaceuticals: A Review of COVID-19 Situation	Mir Mohammed Junaid Basha et all	This study talks about enhancements of AI to supply chain management by usage of AI algorithms to analyze data pertaining to sales, seasonality, health trends, disease outbreaks etc.	AI can boost pharmacies profitability by using past sales, health trends and the algorithms can predict medication demand.	AI can boost pharmacies profitability by using past sales, health trends and the algorithms can predict medication demand.
52	2020	Automation of in-hospital pharmacy dispensing: a systematic review	Sarah Batson et all.	The purpose of the systematic review was to summarize the clinical and economic value of automated in-hospital pharmacy services with a primary focus on systems supporting dispensing of medicines.	ADS integration with other technologies were identified, including e-prescribing, BCMA systems or integrated with other technologies such as barcode scanning for dispensing and electronic medical record systems.	ADS integration with other technologies were identified, including e-prescribing, BCMA systems or integrated with other technologies such as barcode scanning for dispensing and electronic medical record systems.
53	2020	Customized 2D Barcode Sensing for Anti-Counterfeiting Application in Smart IoT with Fast Encoding and Information Hiding	Rongjun Chen et all.	Based on information hiding technology, the proposed approach can solve these challenging problems and provide a low-cost, difficult to forge, and easy to identify solution, while achieving the function of conventional 2D barcodes. a customized 2D barcode with fast encoding for smart IoT applications was proposed, based on information hiding technology, which obtained the ranking results of each image basic encoding module to define the corresponding image bit value.	The proposed customized 2D barcode and sensing recognition scheme showed an excellent performance in various authentic environments, compared to other state-of-the-art approaches, which could meet the practical requirements.	Intensive experiments illustrated that a customized 2D barcode has a strong practical value in visual anti-counterfeiting.

54	2020	The Implementation of Barcode on Warehouse Management System for Warehouse Efficiency	Nadya Amanda Istiqomah et all.	The research uses Qualitative method to describe process of Warehouse management. The data collection was done by conducting semi-structural review. Authors contrast the difference between manual warehouse management versus barcode-based warehouse management.	The usage of barcode in every step of Warehouse management in the areas of Receiving, Put-away, Order Processing, Picking, Outbound Checking, Loading and Stock Take/Opname will get update in real time so that the data is accurate.	Usage of barcode make inventory activities faster.
55	2019	Telepharmacy Services: Present Status and Future Perspectives: A Review	Simone Baldoni et all	The purpose of this paper is to study the benefits of using a telepharmacy. The study reviewed into three categories of pharmacy practice, Support of Clinical Services, Remote Education and Handling of Special pharmacies and prescription and reconciliation of drug therapies, and prescription and reconciliation of drug therapies	Telepharmacy offers a large coverage of the pharmaceutical service in underserved areas due to geographical and economic issues.	The adoption of telepharmacy can represent a solution to the problem of physical storage and can contribute to guarantee proper pharmaceutical assistance in underserved areas.
56	2019	Using pharmacy technicians and telepharmacy to obtain medication histories in the emergency department	Brandy McGinnis et all	To determine if telepharmacy can be used to collect medication histories on patients admitted in the emergency department (ED) in a large health system.	Medication histories are conducted with the use of mobile carts enhanced with videoconferencing equipment allowing technicians to operate from a remote central location.	Based on the current performance and continued expansion of this novel strategy, use of telepharmacy to obtain medication histories in the ED has led to resource optimization for the remote delivery of a pharmacy service.
57	2018	Robotic dispensing improves patient safety, inventory management, and staff satisfaction in an	Carmen Guadalupe Rodriguez-Gonzalez et all.	The purpose of this paper is to study the Implementation of robotic systems in Outpatient pharmacies.	The impact of quality of stock management was also measured. Prior to the implementation drugs were dispensed manually using barcode-controlled system.	The frequency of medication dispensing errors before and after implementation of a robotic original pack dispensing system in an outpatient

		outpatient hospital pharmacy.				hospital pharmacy was measured.
58	2018	Safety, time, and cost evaluation of automated and semi-automated drug distribution systems in hospitals: a systematic review	Hanne Katriina Ahtianen et all	The idea of this paper is to systematically automated and semi-automated drug distribution systems (DDSs) in hospital and to evaluate their effectiveness on medication safety, time, and costs of medication care.	This study collected studies conducted on concerned technologies in drug distribution and administration in acute care hospitals and medication safety, time, and cost outcomes.	In conclusion, Automated Drug Dispense Systems improved quality of patient care by shifting pharmacists time from technical distributive activities.
59	2018	Smart Pharmacy System Based on IOT And Raspberry Pi	Zhang Yi et all	This paper proposes a system which makes less error and time taken to verify the for-stock availability and track its expiry date using IOT and raspberry pi with the help of barcodes.	Analyzing models from countries with sophisticated AI integration yields strategies for proficient implementation, addressing prevalent challenges such as data privacy, regulatory constraints, and resource allocation.	It is crucial to take advantage of the huge opportunity that AI provides on pharmacies.
60	2018	A centralized automated-dispensing system in a French teaching hospital: return on investment and quality improvement	Sarah Berdot et all.	The purpose of this study to evaluate the return on investment and quality improvement after implementation of a centralized automated dispensing system at a French dispensing hospital after 8 years of use.	The Return on Investment was calculated in 2008 and 2013. After 8 years of using robot (from 2008 to 2016), ROI was positive (+$294 498)	In 2008, each robot included refrigerated unit, loading unit to input drug boxes using bar-codes, and a dispensing system. In 2013, the system was upgraded to improve quality process. Almost 95% drugs were stored in the robot.
61	2016	Performance Improvement of Inventory Management System Processes by an Automated Warehouse Management System	Anas M. Atieh et all.	This paper talks about impact of automating the Warehouse Management System resulting in an efficient and reliable inventory management system for a warehouse for a telecommunication company in Jordan.	The software has been built to organize, handle, sort and store large amounts of organizing, handling, sorting, and storing large amounts of data efficiently.	Overall warehouse has become more reliable and efficient, after the automation by simplifying the process for the operators, the supplier and dealer.

62	2010	Automated drug dispensing system reduces medication errors in an intensive care setting.	Claire Chapuis et all.	The purpose of this paper to study the impact of automated dispensing system on medication errors related to picking, preparation, and administration of drugs in medical intensive care unit at a 2000 bed university hospital for a two-month period.	A total of 1,476 medications for 115 patients were observed. Before and after comparisons in the study unit showed a significantly reduced percentage of total opportunities for error (20.4% and 13.5%; p <.01)	Two automated dispensing systems were used one of them was chosen as Study unit and the other unit being the control.

3. Benefits of tele pharmacy

The paper "tele pharmacy Implementation to Support Pharmaceutical Care Services during the COVID-19 Pandemic: A Scoping Review" by Made Ary Sar Asmita and colleagues highlights several key advantages of tele pharmacy during the pandemic. It demonstrates that tele pharmacy effectively assisted pharmacists in providing remote pharmaceutical care, including medication review, adherence assessment, dispensing, patient education, disease prevention, and treatment monitoring. These services helped ensure continuity of care while reducing face-to-face interactions. The benefits were categorized using the Alberta Quality Matrix for Health: acceptability (high patient and pharmacist satisfaction), accessibility (ease of reaching care remotely), effectiveness (achieving desired health outcomes), efficiency (streamlined workflows), and safety (protecting both patients and healthcare providers). The study concluded that tele pharmacy played a crucial role in maintaining pharmaceutical services during COVID-19 and recommended further research to assess its long-term impact and cost-effectiveness. The increasing number of publications over the years (Figure 1) and the distribution of research topics (Figure 2) further underline the growing global interest and diversification in tele pharmacy research.

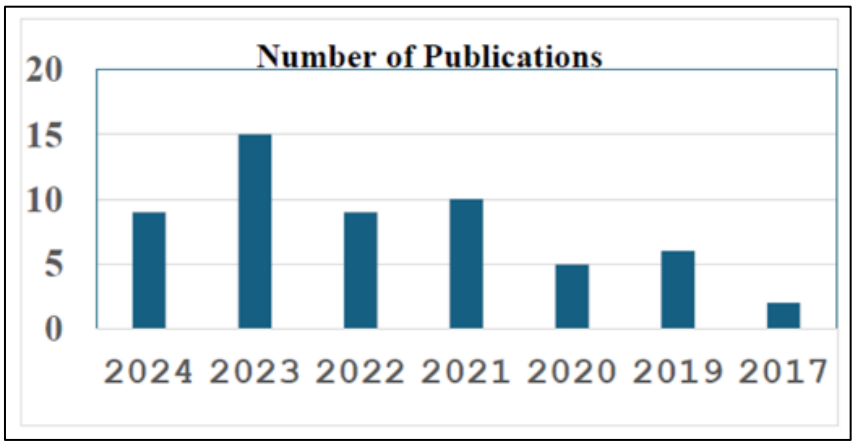

Figure 1 Graphic showing the Number of Publications reviewed year-wise

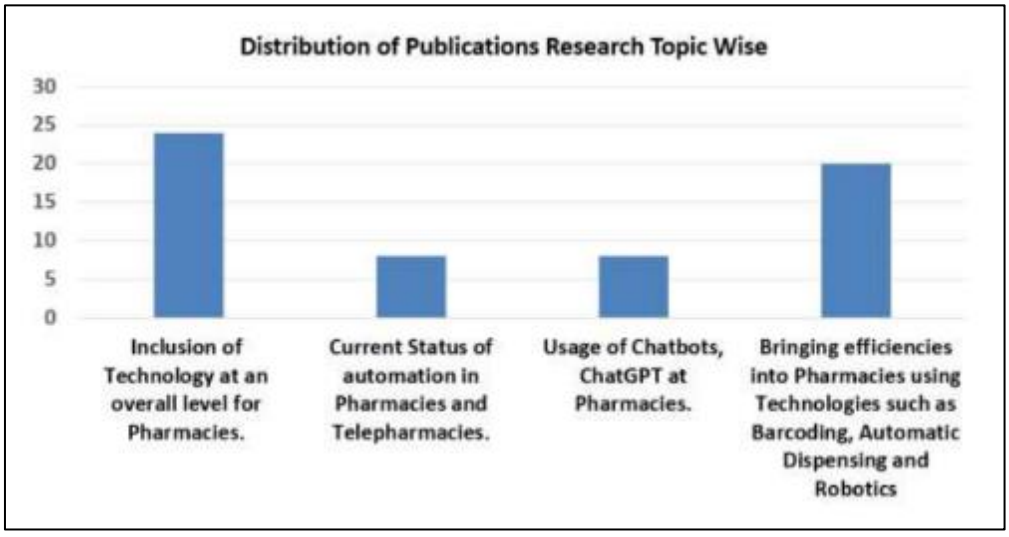

Figure 2 Graphic showing the Distribution of Publications Research Topic Wise

The study on Utilizing ChatGPT by Firas H Bazzari and Amjad H Bazzari highlights many benefits for patients and pharmacists. It emphasizes serving remote and underserved areas. The study shows the advantages of using the service for remote consultations without long wait times. It discusses the concept of Medication Adherence, which includes reminders to patients, patient counseling, and understanding treatment plans and medication risks. It also covers cost savings for patients using Telepharmacy. Patient safety improves with fewer medication errors. It offers 24/7 access to

pharmacy services, helps better manage chronic diseases, allows patients to receive specific treatments, and reduces wait times for refills and consultations. Additionally, it ensures compliance with legal standards such as HIPAA. From a pharmacist's perspective, remote pharmacists help manage workload by balancing peak and off-peak hours. Telepharmacy enables pharmacies to reach out to patients for their needs, rather than patients having to contact the pharmacy first. Overall, setting up Telepharmacy can improve business and pharmacy management. These benefits contribute to better healthcare access, increased efficiency, and improved health outcomes.

4. Key Findings

The paper "Telepharmacy Implementation to Support Pharmaceutical Care Services during the COVID-19 Pandemic: A Scoping Review" by Made Ary Sarasmita and colleagues presents several key findings. The paper shows various benefits of Telepharmacy during COVID-19 pandemic. The study indicates the benefits in the areas of remote medication administration, keeping patients informed, medication delivery and dispenses, checking treatment progress and disease prevention. The review analyzed 19 original research articles and found that telepharmacy enabled the effective functioning of pharmacists as per the International Pharmaceutical Federation's COVID-19 guidelines. The study highlights the features of Telepharmacy of better accessibility, medication safety and minimized in person interactions. The study indicates the need to evaluate long term impacts and cost effectiveness of the services.

The paper "Utilizing ChatGPT in Telepharmacy" by Firas H. Bazzari and Amjad H. Bazzari highlights several benefits of integrating ChatGPT into telepharmacy services. It introduces the concept of ChatGPT simulating pharmacists, thereby making patient interactions more efficient by noting side effects and instructions for use. The study indicates improved results with ChatGPT 4.0 compared to version 3.5. It also shows that ChatGPT 4.0 provides consistent information with source attribution. The inclusion of AI-based technology could help serve remote areas and address pharmacist shortages with lower financial costs. The paper advocates for using ChatGPT in telepharmacy services. The comparison of performance between the two ChatGPT versions (Table 2) and the mean score comparison (Figure 3) are summarized below.

Table 2 Comparative Performance and Functional Features of ChatGPT 3.5 vs ChatGPT 4.0 in Telepharmacy Applications

Criteria	**ChatGPT 3.5**	**ChatGPT 4.0**
Mean Score (± SD)	3.425 (± 0.712)	3.7 (± 0.61)
Accuracy	High	Higher
Clarity	Good	Very Good
Precision	Consistent	More Consistent
Harmful Responses	None	None
Source Citation Ability	No	Yes
Input Limitations	Unlimited	40 questions per 3 hours
Feedback Capability	No	Yes

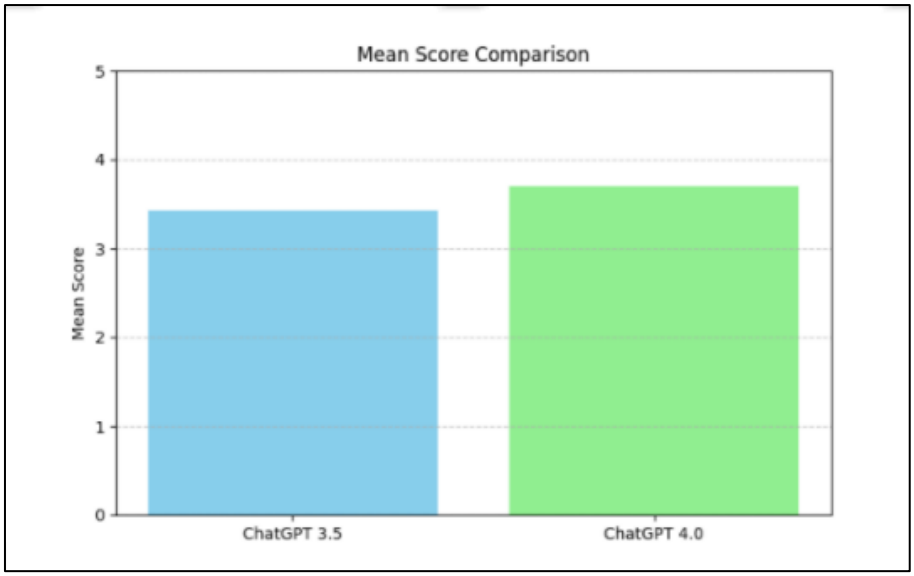

Figure 3 Graphic showing comparison of Mean Score Comparison of ChatGPT 3.5 and ChatGPT 4.0

The paper "Perception and Willingness to Use tele pharmacy Among the General Population in Jordan" by Rana Abu-Farha and colleagues evaluates the concept in Jordan. The study found that many participants view tele pharmacy as a convenient service. It indicates that tele pharmacy reduces unnecessary trips to pharmacies (83.5%), saves travel time and costs (79.0%), and protects patients during pandemics (78.9%). It also addresses medication adherence and decreases waiting times in pharmacies. Additionally, 61.3% of respondents liked the idea of tele pharmacy services for the future, showing interest in remote counseling and home medication reviews. These findings suggest that tele pharmacy can improve access to pharmaceutical care, especially for rural populations, and support more efficient healthcare delivery in Jordan. This information, backed by data on public perception (Table 3) and agreement indicators (Figure 4), highlights the importance of tele pharmacy in enhancing medication access and patient satisfaction.

Table 3 Public Perception of tele pharmacy: Key Benefits Reported by Participants

Participants' Perceived Benefits of Tele pharmacy (N = 800)			
Statement	Agree (%)	Neutral (%)	Disagree (%)
Reduces unnecessary visits to pharmacies	83.5	13.1	3.4
Improves medication adherence	66	27	7
Saves money to reach pharmacies	77	17.3	5.6
Saves travel time	79	14.4	6.6
IT knowledge is important for conducting tele pharmacy	74.8	19.8	5.6
Solves waiting time problems	77.6	16	6.4
Protect patients during pandemics	78.9	16.5	4.6
Effective for health education and counseling	69.4	24.3	6.4
More convenient for rural patients	73.5	19.9	6.6
Allows prompt patient interventions	63.5	27.8	8.8
Enhance communication with healthcare providers	71.9	22.9	5.3

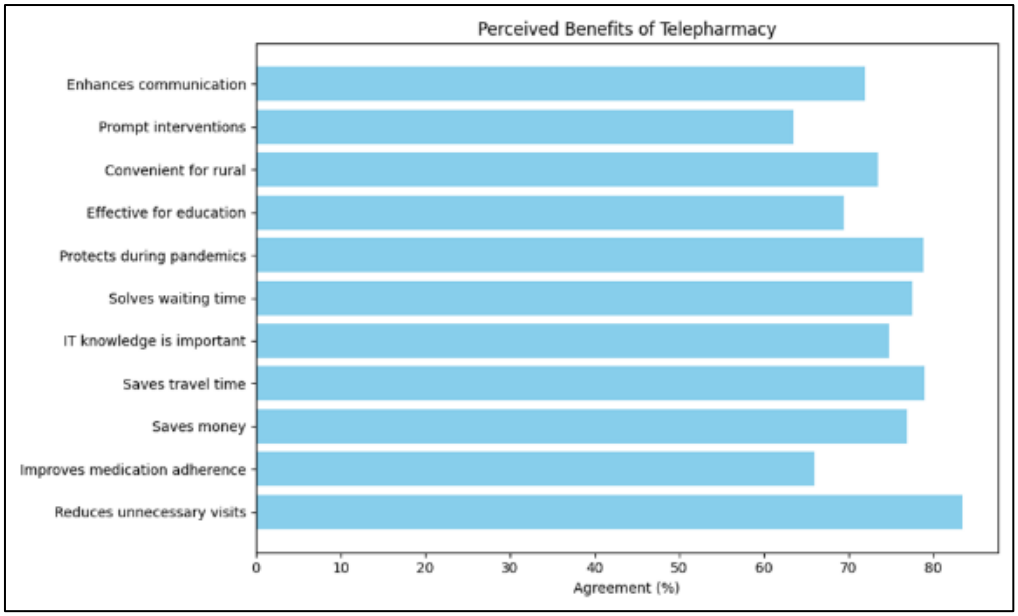

Figure 4 Agreement Levels on Key Benefits of tele pharmacy Among Participants

A large proportion of participants agreed that tele pharmacy could reduce unnecessary pharmacy visits, save time and money, and protect patients during pandemics, as discussed in Table 4. Significant respondents believed that tele pharmacy could improve medication adherence, enhance interactions with healthcare providers, and assist rural populations. The paper "Knowledge, Perception, and Willingness to Use tele pharmacy Among the General Population in Indonesia" by Nesi N. Tjiptoatmadja and Sofa D. Alian highlights several key benefits of tele pharmacy adoption. The study found that only 50% of the population surveyed was aware of the concept of tele pharmacy. However, 98% liked the idea of tele pharmacy, and 90% of those unfamiliar with it expressed interest in trying it. Participants appreciated tele pharmacy as convenient, cost-effective, and capable of saving time and effort. The findings indicated that younger and educated individuals were more knowledgeable about the concept, highlighting the need to familiarize older populations. In conclusion, the study emphasizes the benefits of implementing tele pharmacy in Indonesia, especially its remote utility feature.

Table 4 Participants' Perceptions and Common Responses Regarding tele pharmacy Services

Statement	**Most Common Response (%)**
Availability of tele pharmacy services	Neutral: 76 (37.4%)
Liking tele pharmacy (among users)	Neutral: 68 (46.6%)
Importance for communication	Agree: 92 (45.3%)
Saves time and energy	Strongly Agree
Cuts service costs	Strongly Agree: 86 (42.4%)
Willing to pay for service	Strongly Agree: 82 (40.4%)
Recommendation to family/friends	Strongly Agree: 79 (38.9%)

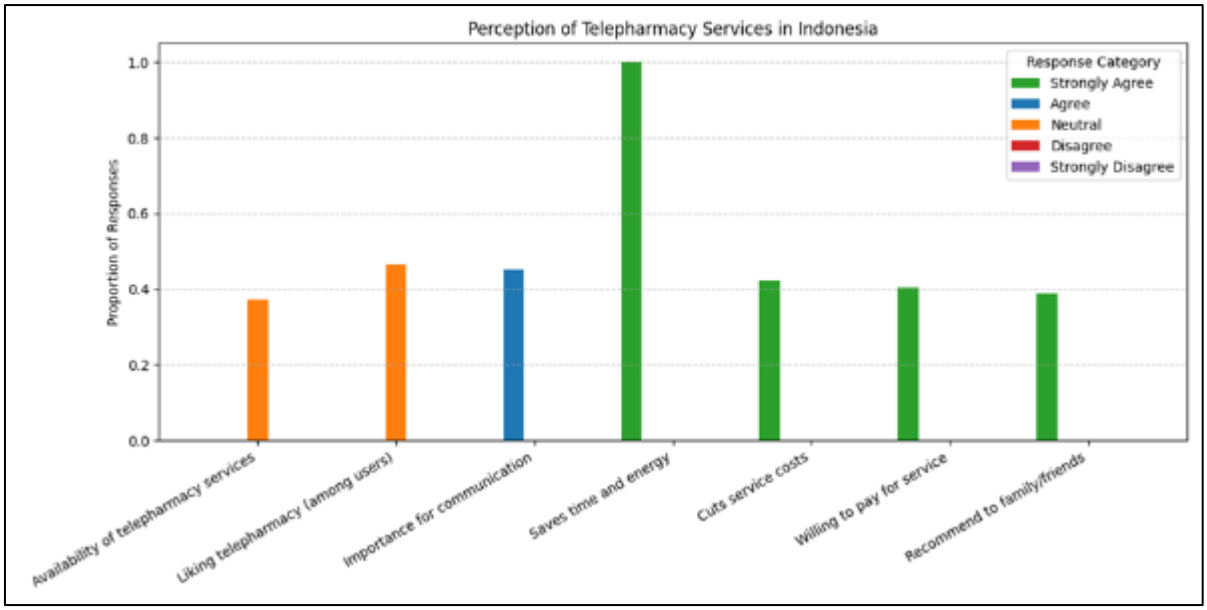

Figure 5 Distribution of Public Responses on tele pharmacy Perceptions in Indonesia

The above Figure 5 from the paper "Knowledge, Perception, and Willingness to Use tele pharmacy Among the G The general population in Indonesia presents participants' perceptions of tele pharmacy services. The study showed that many participants did not have a specific opinion. However, participants agreed and, in some cases, strongly agreed with the concept of tele pharmacy and its benefits. The benefits observed included improved communication, cost-effectiveness, time savings, and willingness to pay for the service. In conclusion, the data indicate a positive attitude toward tele pharmacy, even though the concept was unfamiliar to many. The paper "tele pharmacy Services: Present Status and Future Perspectives: A Review" by Simone Baldoni, Francesco Amenta, and Giovanna Ricci outlines the significant benefits of tele pharmacy in modern healthcare. It states that tele pharmacy is an alternative solution to address pharmacist shortages and provide pharmaceutical care to remote areas. The review examines tele pharmacy applications under three categories: support for clinical services, remote education and management of specialized pharmacies, and prescription and reconciliation of drug therapies. Users agreed that tele pharmacy is a good solution within these categories. The paper notes that technology use in tele pharmacy can enable better patient care, remote patient support, medication monitoring, and clinical support. Although the study emphasizes tele pharmacy, it recommends evaluating long-term adoption and conducting thorough investigations to assess its impacts on healthcare.

Table 5 Support to Clinical Services: Objectives, Delivery Methods, and Reported Outcomes

Program/Location	Purpose	Method	Outcome/Impact
PILL Program (USA)	Improve medication adherence post-discharge	Phone calls by pharmacists	Better adherence, reduced interactions
Mount Isa Hospital (Australia)	Address clinical pharmacist shortage	Remote pharmacist intervention	Safe treatment support
Nebraska Medical Center (USA)	Same as above	Remote pharmacist intervention	Enhanced inpatient care
Spain (HIV patients)	Home drug delivery	Hospital pharmacist management	Time/money saving, patient satisfaction
Denmark	Remote counselling for online/home delivery	Phone/video calls by pharmacists	Adequate treatment, satisfaction

The above Table 5 from the paper "tele pharmacy Services: Present Status and Future Perspectives: A Review" summarizes the data about the benefits of tele pharmacies from countries supporting clinical and pharmaceutical services are significant. The idea here is to improve medication adherence, address pharmacist shortages, and enhance patient care through remote interventions. The methods include phone calls, video consultations, and home drug

delivery. The results indicate better treatment safety, increased patient satisfaction, and a reduction or elimination of barriers to accessing healthcare—highlighting tele pharmacy's importance in the future of pharmacy systems.

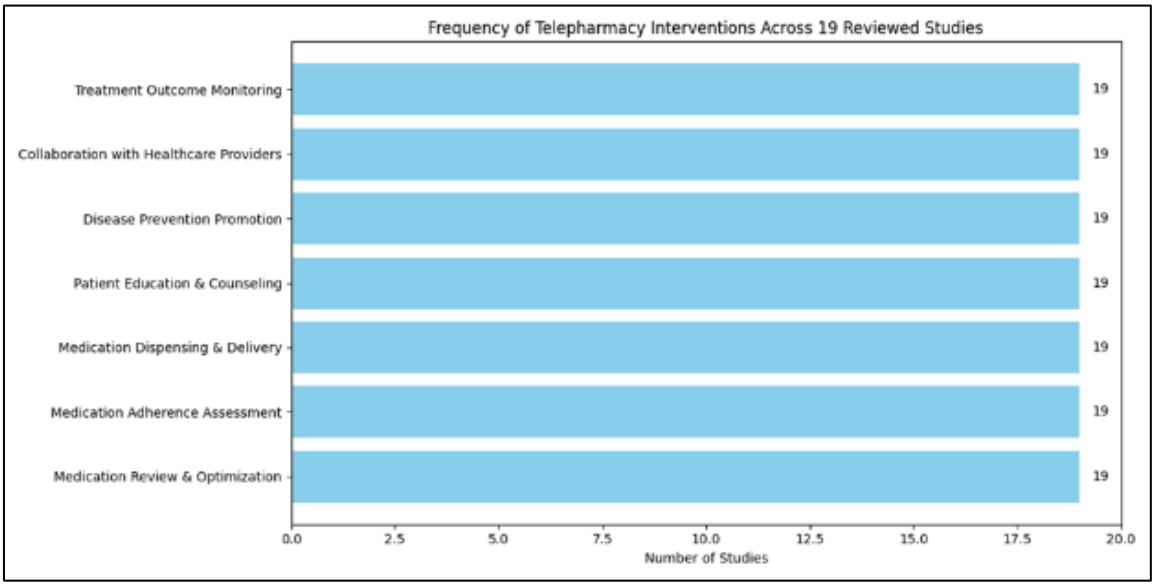

Figure 6 Core tele pharmacy Services and Their Prevalence Across Reviewed Studies

The infographic in Figure 6 shows that all nineteen studies reviewed used tele pharmacy for key services like medication review, adherence checks, dispensing, education, prevention, collaboration, and monitoring. Video calls were the most common technology, followed by mobile apps and messaging. Most studies came from Asia, with others from Europe, North America, and Africa. The significant benefit indicated was access to better care, reducing COVID-19 vulnerability, and extended treatment.

5. Limitations and Gaps

The paper "tele pharmacy Implementation to Support Pharmaceutical Care Services during the COVID-19 Pandemic: A Scoping Review" by Made Ary Sar Asmita and colleagues highlights limitations in current tele pharmacy implementation and research. The study points out the lack of randomized clinical trials, which means there is no strong evidence for the long-term benefits and cost-effectiveness of tele pharmacy. The review analyzed 19 original research articles. The small number of articles prevents the ability to establish general guidelines based on the findings. The implementation of Tele pharmacies varied across different locations and healthcare settings. Due to these differences, it was difficult to establish uniform guidelines. Although the paper discusses the benefits of tele pharmacy, it also notes the lack of legal and regulatory support, which is still developing. These gaps underscore the need for more comprehensive studies and an integrated approach to legal and compliance issues. The paper "Utilizing ChatGPT in tele pharmacy" by Firas H. Bizzarri and Amjad H. Bizzarri identifies several limitations and gaps in the current use of ChatGPT for tele pharmacy. The study highlights one drawback of ChatGPT, which allows only 40 questions every 3 hours, limiting operations during high-demand situations. ChatGPT 3.5 offers unlimited interactions but produces lower-quality output. The study observed that sometimes the tools did not provide definitive answers or excluded results. Although this limitation did not lead to serious issues, the outputs were considered erroneous at times. The study suggests that significant improvements are needed to ensure reliable outputs. Overall, these results show that ChatGPT has potential for the future but requires major adjustments for use in tele pharmacy environments.

The paper "Perception and Willingness to Use Telepharmacy Among the General Population in Jordan" by Rana Abu-Farha and colleagues highlights several limitations and gaps in the study. One issue reported was that about 42.9% were unfamiliar with the concept of Telepharmacy. A small group, around 16.4%, indicated they had used Telepharmacy, suggesting that most participants lacked prior experience. The elderly population, unfamiliar with digital systems, faced mental stress when considering Telepharmacy. The study also revealed gender disparities and regional differences. Men were more inclined to use Telepharmacy than women, and people from North and South Jordan showed greater interest than others. These findings underscore the need to raise awareness about Telepharmacy services across different population groups. Similarly, the paper "Knowledge, Perception, and Willingness to Use Telepharmacy Among the General Population in Indonesia" by Nesi N. Tjiptoatmadja and Sofa D. Albian points out several limitations. The findings

show limited awareness, with only 51% of the population familiar with the term Telepharmacy. The study found correlations with age and education, noting that older adults and those with lower education levels were less aware of the concept. While responses indicated strong interest in using Telepharmacy, the study did not address the challenges of integrating technology into Telepharmacy. The results may be biased since only 203 participants were surveyed online, excluding those without internet access. These gaps suggest that a more detailed and comprehensive study is necessary to fully understand the benefits of Telepharmacy. The paper "Telepharmacy Services: Present Status and Future Perspectives: A Review" by Simone Baldoni, Francesco Amenta, and Giovanna Ricci outlines several limitations in the current landscape of tele pharmacy. A major gap is the lack of coverage on legal and compliance standards, which could pose significant challenges for implementation. The review emphasizes the need for empirical data to evaluate Telepharmacy practices. Although the study generally reports positive outcomes, the evidence is insufficient for large-scale or long-term deployment. It also highlights challenges related to Patient Privacy and Staff training needs. While Telepharmacy has promising prospects, issues related to regulation, training, infrastructure, and sustainable growth need to be addressed.

6. Conclusion

Telepharmacy marks a significant advancement in pharmaceutical care by improving medication accessibility and patient safety. During COVID-19, its adoption increased greatly due to its ability to serve remote locations. Studies from various sources highlight the benefits of Telepharmacy, including better medication adherence, reduced travel to pharmacies, enhanced care and monitoring, and remote counseling. The integration of Artificial Intelligence tools makes Telepharmacy more interactive and helps pharmacists expand their skills to address staff shortages. Despite these benefits, Telepharmacy faces many challenges. Regulatory inconsistencies, technological barriers, and ethical concerns about data privacy and equitable access need to be addressed to ensure safe and effective implementation. Standard practices, clinical trials, policies, and procedures must be established. Public awareness efforts are essential so people can understand the system's benefits. In conclusion, Telepharmacy is a game-changer in healthcare, with many benefits still to be realized. Collaboration among technologists, healthcare professionals, lawmakers, and legal experts is necessary to develop solutions that can be adopted globally.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Steere, P. L. (2004). Pharmacy Systems: An Emerging Role in Drug Treatment Management. Healthcare Information Management Systems: Cases, Strategies, and Solutions, 332-353.

[2] Koshechkin, K., Klimenko, G., and Polikarpov, A. (2019, June). Implementation of Digital Technologies in Pharmaceutical Products Lifecycle. In Intelligent Decision Technologies 2019: Proceedings of the 11th KES International Conference on Intelligent Decision Technologies (KES-IDT 2019), Volume 2 (pp. 295-305). Singapore: Springer Singapore.

[3] Abraham, O., Brothers, A., Alexander, D. S., and Carpenter, D. M. (2017). Pediatric medication use experiences and patient counseling in community pharmacies: perspectives of children and parents. Journal of the American Pharmacists Association, 57(1), 38-46.

[4] Neta, G., Chambers, D. A., and Simpson, L. (2024). Conference on the Science of Dissemination and Implementation in Health. Implementation Science, 19(2), 42.

[5] Abu Zwaida, T., Pham, C., and Beauregard, Y. (2021). Optimization of inventory management to prevent drug shortages in the hospital supply chain. Applied Sciences, 11(6), 2726.

[6] Kefale, A. T., and Shebo, H. H. (2019). Availability of essential medicines and pharmaceutical inventory management practice at health centers of Adama town, Ethiopia. BMC health services research, 19, 1-7.

[7] Elarbi, M., Ayadi, O., Masmoudi, M., and Masmoudi, F. (2021, January). Druginventory- management-model for a multi-echelon pharmaceutical supply-chain: case study of the Tunisian pharmaceutical supply-chain. In Supply Chain Forum: An International Journal (Vol. 22, No. 1, pp. 44-56). Taylor and Francis.

[8] Ogbuagu, O. O., Mbata, A. O., Balogun, O. D., Oladapo, O., Ojo, O. O., and Muonde, M. (2022). Enhancing biopharmaceutical supply chains: Strategies for efficient drug formulary development in emerging markets. International Journal of Medical and All Body Health Research, 3(1), 73-82.

[9] Ojeleye, O., Avery, A., Gupta, V., and Boyd, M. (2013). The evidence for the effectiveness of safety alerts in electronic patient medication record systems at the point of pharmacy order entry: a systematic review. BMC medical informatics and decision making, 13, 1-10.

[10] Pinna, R., Carrus, P. P., and Marras, F. (2015). The drug logistics process: innovative experience. The TQM Journal, 27(2), 214-230.

[11] Tsolakis, N., and Srai, J. S. (2017). Inventory planning and control in 'green'pharmacies supply chains–A System Dynamics modelling perspective. In Computer Aided Chemical Engineering (Vol. 40, pp. 1285-1290). Elsevier.

[12] Edoh, T. O., and Teege, G. (2011). Using information technology for an improved pharmaceutical care delivery in developing countries. Study case: Benin. Journal of medical systems, 35, 1123-1134.

[13] Abideen, A., and Mohamad, F. B. (2021). Improving the performance of a Malaysian pharmaceutical warehouse supply chain by integrating value stream mapping and discrete event simulation. Journal of Modelling in Management, 16(1), 70-102.

[14] Andy, A., Keetha, N. R., Andy, D., and Suresh, A. (2025). From Brick-and-Mortar to Digital: The Evolution of Pharmacy Ecosystems. Acta Scientific Pharmaceutical Sciences (ISSN: 2581-5423), 9(1).

[15] Aungst, T. D. (2025). Beyond the fill: Navigating pharmacy's technological future in 2050. Journal of the American Pharmacists Association, 65(1), 102285.

[16] Paul-Chima, O., Ugo, E., and Chukwudi, A. (2024).The Impact of Artificial Intelligence and Machine Learning on Pharmacy Practice.

[17] Hasan, H. E., Jaber, D., Khabour, O. F., and Alzoubi, K. H. (2024). Ethical considerations and concerns in the implementation of AI in pharmacy practice: a crosssectional study. BMC Medical Ethics, 25(1), 55.

[18] Paul-Chima, O., Ugo, E., and Chukwudi, A (2024). The Role and Impact of Telepharmacy and Digital Health Interventions on Modern Healthcare Systems.

[19] Bazzari, F. H., and Bazzari, A. H. (2024). Utilizing ChatGPT in telepharmacy. Cureus, 16(1).

[20] Salama, A. H. (2024). The promise and challenges of ChatGPT in community pharmacy: A comparative analysis of response accuracy. Pharmacia, 71, 1-5.

[21] Vora, L. K., Gholap, A. D., Jetha, K., Thakur, R. R. S., Solanki, H. K., and Chavda, V. P. (2023). Artificial intelligence in pharmaceutical technology and drug delivery design. Pharmaceutics, 15(7), 1916.

[22] Chakraborty, C., Pal, S., Bhattacharya, M., Dash, S., and Lee, S. S. (2023). Overview of Chatbots with special emphasis on artificial intelligence-enabled ChatGPT in medical science. Frontiers in artificial intelligence, 6, 1237704.

[23] Chalasani, S. H., Syed, J., Ramesh, M., Patil, V., and Kumar, T. P. (2023). Artificial intelligence in the field of pharmacy practice: A literature review. Exploratory research in clinical and social pharmacy, 12, 100346.

[24] Stasevych, M., and Zvarych, V. (2023). Innovative robotic technologies and artificial intelligence in pharmacy and medicine: paving the way for the future of health care— a review. Big data and cognitive computing, 7(3), 147.

[25] Dhudum, R., Ganeshpurkar, A., and Pawar, A. (2024). Revolutionizing drug discovery: A comprehensive review of AI applications. Drugs and Drug Candidates, 3(1), 148- 171.

[26] Oswalt, R., and Candidate, P. (2023). The Role of Artificial Intelligence in Pharmacy Practice. Pharmacy Times. September 5, 2023.

[27] Khan, O., Parvez, M., Kumari, P., Parvez, S., and Ahmad, S. (2023). The future of pharmacy: how AI is revolutionizing the industry. Intelligent Pharmacy, 1(1), 32-40.

[28] Bhattamisra, S. K., Banerjee, P., Gupta, P., Mayuren, J., Patra, S., and Candasamy, M. (2023). Artificial intelligence in pharmaceutical and healthcare research. Big Data and Cognitive Computing, 7(1), 10.

[29] Pandel, N., Tiwari, A., Bansal, P., and Amrousse, R. (2025). Unlocking the Potential of AI in Healthcare: A Critical Review of Innovations Barriers and the Path Forward. Integrating AI With Haptic Systems for Smarter Healthcare Solutions, 467-492.

[30] Abu Hammour, K., Alhamad, H., Al-Ashwal, F. Y., Halboup, A., Abu Farha, R., and Abu Hammour, A. (2023). ChatGPT in pharmacy practice: a cross-sectional exploration of Jordanian pharmacists' perception, practice, and concerns. Journal of Pharmaceutical Policy and Practice, 16(1), 115.

[31] Roosan, D., Padua, P., Khan, R., Khan, H., Verzosa, C., and Wu, Y. (2024). Effectiveness of ChatGPT in clinical pharmacy and the role of artificial intelligence in medication therapy management. Journal of the American Pharmacists Association, 64(2), 422-428.

[32] Biswas, S. (2023). Prospective role of chatgpt in pharmacy: According to chatgpt.

[33] Available at SSRN 4405384.

[34] He, H. M. RobotGPT (2023). From chatGPT to robot intelligence.

[35] Jarab, A. S., Abu Heshmeh, S. R., and Al Meslamani, A. Z. (2023). Artificial intelligence (AI) in pharmacy: an overview of innovations. Journal of Medical Economics, 26(1), 1261-1265.

[36] Al Meslamani, A. Z. (2023). Applications of AI in pharmacy practice: a look at hospital and community settings. Journal of Medical Economics, 26(1), 1081-1084.

[37] Abu-Farha, R., Alzoubi, K. H., Abu Assab, M., Awwad, O., Gharaibeh, L., Mukattash, T. L., and Halboup, A. M. (2023). Perception and willingness to use telepharmacy among the general population in Jordan. Patient preference and adherence, 2131-2140.

[38] Al Nemari, M., and Waterson, J. (2022). The introduction of robotics to an outpatient dispensing and medication management process in Saudi Arabia: retrospective review of a pharmacy-led multidisciplinary Six Sigma performance improvement project. JMIR Human Factors, 9(4), e37905.

[39] Ubaldo, A. L. V., Albines, J. A. B., Salazar, J. L. H., Andrade-Arenas, L., and Cabanillas- Carbonell, M. (2022). Mobile application: A proposal for the inventory management of pharmaceutical industry companies. International Journal of Advanced Computer Science and Applications, 13(8).

[40] Takase, T., Masumoto, N., Shibatani, N., Matsuoka, Y., Tanaka, F., Hirabatake, M., ... and Muroi, N. (2022). Evaluating the safety and efficiency of robotic dispensing systems. Journal of Pharmaceutical Health Care and Sciences, 8(1), 24.

[41] Morgan, A. A., Abdi, J., Syed, M. A., Kohen, G. E., Barlow, P., and Vizcaychipi, M. P. (2022). Robots in healthcare: a scoping review. Current robotics reports, 3(4), 271-280.

[42] Alahmari, A. R., Alrabghi, K. K., and Dighriri, I. M. (2022). An overview of the current state and perspectives of pharmacy robot and medication dispensing technology. Cureus, 14(8).

[43] Tjiptoatmadja, N. N., and Alfian, S. D. (2022). Knowledge, perception, and willingness to use telepharmacy among the general population in Indonesia. Frontiers in Public Health, 10, 825554.

[44] Sangave, N. A., Cheung, C., and Berkley, E. (2022). Artificial intelligence applications in education and pharmacy practice.

[45] Mulac, A., Mathiesen, L., Taxis, K., and Granås, A. G. (2021). Barcode medication administration technology use in hospital practice: a mixed-methods observational study of policy deviations. BMJ quality and safety, 30(12), 1021-1030.

[46] Rahmani, A. M., Yousefpoor, E., Yousefpoor, M. S., Mehmood, Z., Haider, A., Hosseinzadeh, M., and Ali Naqvi, R. (2021). Machine learning (ML) in medicine: review, applications, and challenges. Mathematics, 9(22), 2970.

[47] Sharma, T., Mankoo, A., and Sood, V. (2021). Artificial intelligence in advanced pharmacy. International Journal of Science and Research Archive, 2(1), 047-054.

[48] Momattin, H., Arafa, S., Momattin, S., Rahal, R., and Waterson, J. (2021). Robotic pharmacy implementation and outcomes in Saudi Arabia: a 21-month usability study. JMIR Human Factors, 8(3), e28381.

[49] Garagiola, E. (2023). Automated Drugs Dispensing Systems in Hospital Pharmacies and Wards-A Systematic Literature Review. Biomedical journal of scientific and technical research, 53(5), 45094-45103.

[50] Gupta, H., and Chaudhary, N. (2021). The practice of automated drug dispensing technology on the reduction of medication errors in the medication process. Int J Pharm Sci Rev Res, 70(2).

[51] Unni, E. J., Patel, K., Beazer, I. R., and Hung, M. (2021). Telepharmacy during COVID- 19: a scoping review. Pharmacy, 9(4), 183.

[52] Basha, M. M. J., VS, N., Wani, S., and Gogi, V. (2020). Study of inventory management in pharmaceuticals: A review of COVID-19 situation. Int. J. Innov. Sci. Res. Technol, 5, 366-371.

[53] Batson, S., Herranz, A., Rohrbach, N., Canobbio, M., Mitchell, S. A., and Bonnabry, P. (2021). Automation of in-hospital pharmacy dispensing: a systematic review. European Journal of Hospital Pharmacy, 28(2), 58-64.

[54] Chen, R., Yu, Y., Chen, J., Zhong, Y., Zhao, H., Hussain, A., and Tan, H. Z. (2020). Customized 2D barcode sensing for anti-counterfeiting application in smart IoT with fast encoding and information hiding. Sensors, 20(17), 4926.

[55] Istiqomah, N. A., Sansabilla, P. F., Himawan, D., and Rifni, M. (2020, July). The implementation of barcode on warehouse management system for warehouse efficiency. In Journal of Physics: Conference Series (Vol. 1573, No. 1, p. 012038). IOP Publishing.

[56] Baldoni, S., Amenta, F., and Ricci, G. (2019). Telepharmacy services: present status and future perspectives: a review. Medicina, 55(7), 327.

[57] McGinnis, B., Padilla, E., Garret, P., and Aziz, S. (2019). Using pharmacy technicians and telepharmacy to obtain medication histories in the emergency department. Journal of the American Pharmacists Association, 59(3), 390-397.

[58] Rodriguez-Gonzalez, C. G., Herranz-Alonso, A., Escudero-Vilaplana, V., Ais- Larisgoitia, M. A., Iglesias-Peinado, I., and Sanjurjo-Saez, M. (2019). Robotic dispensing improves patient safety, inventory management, and staff satisfaction in an outpatient hospital pharmacy. Journal of evaluation in clinical practice, 25(1), 28-35.

[59] Ahtiainen, H. K., Kallio, M. M., Airaksinen, M., and Holmström, A. R. (2020). Safety, time and cost evaluation of automated and semi-automated drug distribution systems in hospitals: a systematic review. European Journal of Hospital Pharmacy, 27(5), 253-262.

[60] Abdulkadhim, F. G., Zhang, Y., and Khalid, M. (2020). Smart pharmacy monitoring system based on Mqtt protocol using Rfid and Raspberry PI. EUREKA: Physics and Engineering, (2), 98.

[61] Berdot, S., Korb-Savoldelli, V., Jaccoulet, E., Zaugg, V., Prognon, P., Lê, L. M. M., and Sabatier, B. (2019). A centralized automated-dispensing system in a French teaching hospital: return on investment and quality improvement. International Journal for Quality in Health Care, 31(3), 219-224.

[62] Atieh, A. M., Kaylani, H., Al-Abdallat, Y., Qaderi, A., Ghoul, L., Jaradat, L., and Hdairis, I. (2016). Performance improvement of inventory management system processes by an automated warehouse management system. Procedia Cirp, 41, 568-572.

[63] Chapuis, C., Roustit, M., Bal, G., Schwebel, C., Pansu, P., David-Tchouda, S., and Bedouch, P. (2010). Automated drug dispensing system reduces medication errors in an intensive care setting. Critical care medicine, 38(12), 2275-2281.