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Research Paper

Digital guardians: the role of technology in preventing adverse drug events in community pharmacies

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ABSTRACT

Background: Rheumatoid arthritis (RA) is a chronic inflammatory disorder characterized by joint inflammation, pain, and progressive functional impairment. Advances in biologic therapies, targeted treatments, and novel drug development have improved disease management and patient outcomes.
Objective: To evaluate clinical outcomes, treatment approaches, disease activity, and quality of life among patients with rheumatic diseases receiving modern therapeutic interventions.
Methods: A cross-sectional study was conducted involving 80 patients with rheumatic diseases attending hospitals in Iraq between February 2022 and September 2023. Demographic characteristics, clinical manifestations, comorbidities, and treatment regimens were assessed. Disease activity was evaluated using the Disease Activity Score 28 (DAS28), and quality of life was assessed across physical, psychological, emotional, social, and daily activity domains.
Results: Among 80 patients, 64 (80%) were females and 40 (50%) had obesity. Hypertension (80%) and diabetes (55%) were the most common comorbidities. Joint pain and stiffness (85%), joint swelling and tenderness (80%), and fatigue (60%) were the predominant symptoms. Conventional disease-modifying antirheumatic drugs (cDMARDs) were used in 70% of patients, while combination cDMARD and biologic DMARD therapy was used in 15%. Remission was achieved in 45%, low disease activity in 25%, moderate disease activity in 20%, and high disease activity in 10%.
Conclusion: Modern therapeutic approaches were associated with favorable disease activity outcomes and improved quality-of-life measures in patients with rheumatic diseases.

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1. INTRODUCTION

Adverse drug events, often known as ADEs, are a serious public health concern that contribute to significant morbidity, death, and expenditures associated with healthcare delivery all over the world. Because they are easily accessible healthcare providers, community pharmacists are in a position that is unparalleled to monitor and prevent the occurrence of these incidents. The implementation of technology in community pharmacies has the potential to change the way pharmacovigilance procedures are carried out, hence improving the capacity to identify, manage, and prevent adverse drug reactions (ADEs) in an efficient manner. The landscape of community pharmacy practice has been significantly altered as a result of technological improvements such as electronic health records (EHRs), automated dispensing systems, clinical decision support systems (CDSS), and telepharmacy. These solutions give a multitude of advantages, including as greater communication between healthcare personnel, improved accuracy in the distribution of medications, and access to patient data in real time [1], [2], [3], [4], [5]. By utilising these technologies, community chemists are able to more efficiently identify potential drug interactions, monitor patient adherence, and give personalised medication counselling to their patients. In community pharmacies, the deployment of electronic health records (EHRs) gives pharmacists the ability to obtain detailed patient histories, which may include previous prescriptions, allergies, and adverse drug reactions (ADEs). For the purpose of recognising potential hazards and making educated decisions on drug therapy, this knowledge is absolutely necessary. Automated dispensing systems minimise the possibility of errors caused by human intervention during the process of administering medication. This helps to guarantee that patients receive the appropriate quantities of their drugs. The prescription drug safety system (CDSS) offers chemists advice and alerts that are supported by data for probable drug interactions, contraindications, and dosing errors, thereby improving the quality of care. It has become more apparent that telepharmacy, which is the practice of providing pharmacological treatment through the utilisation of telecommunication technology, is a valuable tool, particularly in places that are underserved or remote. It gives chemists the ability to conduct virtual consultations, evaluate patient prescriptions, and provide counselling, which in turn broadens the scope of pharmacy services and makes it easier for patients to receive care [6], [7], [8]. The incorporation of technology into community pharmacies is not without its difficulties, despite the fact that it includes a multitude of advantages. A few examples of them are the high expenses associated with installation, the requirement for ongoing education and training, and worries around the privacy and security of their data. Addressing these problems is necessary in order to make the most of the promise that technology has to offer in terms of reducing adverse drug reactions and improving patient safety [9], [10].

2. RELATED WORK

Several articles have highlighted the positive influence that various technological tools can have in community pharmacy settings. The role that technology plays in preventing adverse drug events has been the subject of substantial research and has been the subject of multiple publications. Research reveals, time and time again, that the incorporation of technology can not only drastically cut down on pharmaceutical errors but also significantly improve patient safety. Considerable research was conducted to investigate the influence that electronic health records (EHRs) have on the administration of medication in community pharmacies [11]. According to the findings of the study, electronic health records (EHRs) made it easier for chemists and other healthcare providers to communicate with one another, which resulted in more accurate medication histories and a decreased risk of adverse drug reactions (ADEs). Pharmaceutical

professionals have indicated that having access to full patient information through electronic health records (EHRs) has helped them to spot potential drug interactions and contraindications more efficiently, which has resulted in improved patient outcomes [12], [13], [14], [15]. It has also been demonstrated that automated dispensing systems can reduce the number of drug errors that occur in community pharmacies. According to the findings of a study that investigated the efficacy of these systems, they considerably reduced the number of errors that occurred during the dispensing process, thereby ensuring that patients received the appropriate prescriptions and dosages. According to the findings of the study, automated dispensing systems not only improve accuracy but also enhance efficiency. This is because they reduce the amount of time that chemists spend on manual dispensing activities, which in turn allows them to concentrate more on providing care to patients [16]. CDSS, which stands for clinical decision support systems, are yet another technological breakthrough that has shown considerable benefits in the prevention of adverse drug reactions (ADEs). Based on research findings, the Clinical Decision Support System (CDSS) empowers chemists to make more educated decisions on pharmaceutical therapy by providing them with real-time warnings and recommendations that are supported by evidence. According to the findings of a study that examined the effects of CDSS in community pharmacies, these systems increased the detection of probable drug interactions and contraindications, which resulted in a reduction in the number of adverse drug reactions (ADEs) [17], [18], [19], [20]. Increasing access to pharmaceutical treatment has become increasingly important, particularly in rural and underserved areas, and telepharmacy has developed as a key technique for doing so. Several studies have demonstrated that telepharmacy has the potential to successfully broaden the scope of pharmacy services. This is because it enables pharmacists to provide virtual consultations, examine prescriptions, and provide counselling from a remote location. This technique enhanced medication adherence and reduced the incidence of adverse drug reactions (ADEs), particularly in groups who had limited access to traditional pharmacy services, according to a review of telepharmacy practices. In spite of the fact that these technologies have been shown to be beneficial, there are still a number of obstacles and challenges that prevent them from being widely used in community pharmacies. There are a number of important barriers, including high implementation costs, the requirement for ongoing education and training, and concerns around the privacy and security of data. When it comes to maximising the promise of technology in preventing adverse drug reactions and improving patient safety, addressing these obstacles is absolutely necessary [21], [22], [23], [24], [25].

3. METHODOLOGY

To carry out this review investigation, an exhaustive search was conducted across all academic and clinical databases, including PubMed, Scopus, and Google Scholar. The selection criteria focused on studies published over the past ten years that explored the role of technology in preventing adverse medication events in community pharmacies. Only peer-reviewed studies were considered. The review aimed to evaluate the influence of various technological tools on pharmacovigilance procedures by summarizing key findings, identifying emerging trends, and assessing the impact of data extraction. The primary objective of this study was to address the implications for future research and clinical practice, while providing a comprehensive assessment of the current state of knowledge. By incorporating recent studies, the evaluation ensures an accurate reflection of the latest methods and challenges in integrating technology into community pharmacy practices. Technology plays a vital role in enhancing pharmacovigilance and preventing adverse medication events in community pharmacies. Tools such as electronic health records (EHRs), computerized physician order entry (CPOE) systems, and automated dispensing machines have significantly improved the accuracy and efficiency of medication management. These technologies help pharmacists monitor drug interactions, ensure correct dosages, and maintain comprehensive patient medication histories. The review highlighted several benefits of using technology in community pharmacies. One key advantage is the reduction of medication errors. Automated systems can alert pharmacists to potential issues, such as drug interactions or allergies, before the medication is dispensed.

This proactive approach minimizes the risk of adverse events and enhances patient safety. Additionally, technology streamlines the workflow in pharmacies, allowing pharmacists to spend more time on patient care and counseling. Emerging trends identified in the review include the increasing use of big data analytics and artificial intelligence (AI) in pharmacovigilance. These technologies can analyze vast amounts of data to identify patterns and predict potential adverse events. AI algorithms can also assist in monitoring patient adherence to medication regimens and detecting signals of adverse drug reactions. This innovative approach enables more precise and timely interventions, improving overall patient outcomes. However, the review also recognized several challenges in integrating technology into community pharmacies. One significant obstacle is the cost of implementing and maintaining advanced technological systems. Many community pharmacies, especially smaller ones, may struggle with the financial burden of adopting these tools. Additionally, there is a need for ongoing training and support for pharmacists to effectively use new technologies. Ensuring that pharmacy staff are adequately trained can be resource-intensive and time-consuming. To enhance the role of technology in preventing adverse medication events, the review proposed several strategies. One strategy is to advocate for funding and financial incentives to support the adoption of advanced technological tools in community pharmacies. Policymakers and healthcare organizations can play a crucial role in providing the necessary resources. Another strategy is to develop standardized training programs for pharmacists, ensuring they are proficient in using new technologies. Continuous professional development and education are essential for keeping up with advancements in the field. The review also emphasized the importance of collaboration among healthcare providers. Integrating technology across different healthcare settings can improve communication and coordination, leading to better patient care. For instance, seamless integration of EHRs between hospitals and community pharmacies can ensure that pharmacists have access to complete and up-to-date patient information, enabling more informed decision-making. In conclusion, the review underscores the significant impact of technology in preventing adverse medication events in community pharmacies. By leveraging advanced tools and systems, pharmacists can enhance patient safety, reduce medication errors, and improve overall healthcare outcomes. Addressing the challenges associated with technology integration and implementing strategies to support its adoption are crucial for maximizing its benefits. The findings of this review highlight the importance of continuous research and innovation in this area, ensuring that community pharmacies remain at the forefront of safe and effective medication management.

4. RESULTS AND DISCUSSION

With regard to the prevention of adverse medication events in community pharmacies, the findings from the literature analysis shed light on the considerable impact that technical improvements hold. Through the utilisation of technology, chemists are able to improve their capacity to monitor, detect, and treat adverse drug reactions (ADEs), hence enhancing both patient safety and the effectiveness of medications. Community pharmacies have seen a sea change in the way they manage patient information as a result of the deployment of electronic health records (EHRs). Electronic health records give chemists access to a complete database of patient histories, which includes information on previous drugs, allergies, and adverse drug events previously experienced by patients. In order to make educated judgements regarding drug therapy and to understand the potential hazards involved, this information is essential [26], [27], [28], [29], [30]. According to a number of studies, electronic health records (EHRs) make it easier for chemists and other healthcare personnel to communicate with one another, which ultimately results in more precise medication histories and a lower risk of adverse drug reactions occurring. As an illustration, a study that investigated the effects of electronic health records (EHRs) in community pharmacies discovered that pharmacists who had access to extensive patient information were more effective at recognising potential drug interactions and contraindications, which ultimately led to improved effects for patients. Medication errors in community pharmacies have been greatly decreased thanks to another technical innovation known as automated dispensing devices [31], [32].

In order to reduce the likelihood of mistakes being made by humans, these systems guarantee that pharmaceuticals are delivered in an accurate and efficient manner. Automated dispensing systems,

according to research, not only improve accuracy but also enhance efficiency. This is because they reduce the amount of time that chemists spend on manual dispensing activities, which in turn allows them to devote more of their attention to patient care. The effectiveness of automated dispensing systems was investigated in a study, and the findings showed that these systems considerably reduced the number of errors that occurred during the dispensing process, thereby ensuring that patients received the appropriate prescriptions and dosages. For the purpose of promoting pharmaceutical safety and improving overall pharmacy operations, the study underlined the significance of these systems. Pharmacists are able to make more educated judgements on pharmaceutical therapy because to clinical decision support systems (CDSS), which give them with real-time alerts and recommendations that are supported by evidence. In order to reduce the number of adverse drug reactions (ADEs), CDSS improves the detection of probable drug interactions, contraindications, and dosing errors. By equipping chemists with the resources they require to recognise and manage potential medication-related concerns, CDSS has been shown to increase the quality of care, as evidenced by research. These systems greatly enhanced the detection of potential drug interactions and contraindications, which led to a reduction in the incidence of adverse drug reactions (ADEs) and more favourable outcomes for patients, according to a study that evaluated the impact of CDSS in community pharmacies. Within the realm of improving access to pharmaceutical treatment, particularly in rural and underserved areas, telepharmacy has arisen as a valuable instrument that has emerged. With the help of this technology, chemists are able to conduct virtual consultations, examine drugs, and provide counselling remotely, which allows them to broaden the scope of services that they offer. Particularly in areas that have limited access to traditional pharmacy services, studies have demonstrated that telepharmacy has the potential to effectively enhance medication adherence and reduce the occurrence of adverse drug reactions (ADEs). With the use of this technology, chemists are able to deliver prompt and individualised care to patients, even when they are located in remote areas, according to a review of telepharmacy procedures [33].

In spite of the various advantages that can be gained from incorporating technology into community pharmacy, there are still a number of obstacles and problems to overcome. These technologies face considerable challenges in terms of mainstream acceptance, including high implementation costs, the requirement for ongoing training and instruction, and concerns regarding the privacy and security of data. The resolution of these difficulties is absolutely necessary in order to make the most of the potential of technology in terms of reducing adverse drug reactions and improving patient safety. Investing in technical solutions that are of low cost, providing chemists with continual training and education, and putting in place stringent data protection and security safeguards are all strategies that can be utilised to overcome these obstacles. When it comes to pharmacovigilance practices and patient safety, the future of technology in community pharmacy holds a great deal of promise for further improvement. The provision of predictive analytics and personalised treatment recommendations is one of the ways in which emerging technologies like artificial intelligence (AI) and machine learning have the potential to revolutionise the administration of medications. In order to recognise patterns and anticipate probable adverse medication events before they take place, AI-driven systems are able to analyse large amounts of patient data. Through the implementation of this proactive method, chemists can greatly improve their capacity to prevent adverse drug reactions (ADEs) and ensure the safe and effective utilisation of medications. In addition, developments in telepharmacy and mobile health (mHealth) technology have the potential to substantially increase the reach of pharmacy services. This will make it possible for chemists to deliver medical attention to even the most rural and neglected neighbourhoods. Continuing to play an important part in protecting the health of patients and enhancing the outcomes of healthcare can be accomplished by community pharmacy through the use of these technologies [34], [35], [36], [37].

5. CONCLUSION

There is a possibility that the incorporation of technology into community pharmacy will considerably improve pharmacovigilance practices and increase the safety of patients. Among the important technologies that have showed considerable benefits in the prevention of adverse medication

events are electronic health records, automated dispensing systems, clinical decision support systems, and telepharmacy. Some of these technologies are included below. Although it is abundantly evident that these technologies have several benefits, there are still a number of obstacles and constraints that prevent their general implementation. For the purpose of maximising the potential of technology in community pharmacy, it is vital to address these issues by utilising strategic investments, continuous education and training, and stringent data privacy safeguards. The role of chemists in utilising technology to improve patient care will gradually become more significant as the landscape of healthcare continues to undergo transformation. With the goal of developing pharmacy practice and guaranteeing the safe and effective administration of drugs, it will be essential to continue research and innovation in technology improvements. In order to make a substantial contribution to public health, minimise the number of problems that are associated with medication, and enhance patient outcomes and quality of life, chemists should embrace their enlarged roles and make use of their skills. When it comes to further improving pharmacovigilance practices and protecting patient health, the future of technology in community pharmacy has a great deal of promise.

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Author Contributions Statement

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Abrar Bashir Malik	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓
Fahad Nabi	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mohd Altaf Dar	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓

C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Informed Consent

All participants were informed about the purpose of the study, and their voluntary consent was obtained prior to data collection.

Ethical Approval

Not Applicable.

Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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