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Advancements in ambulatory care pharmacy practice in Saudi Arabia: A comprehensive review of innovations and best practices at Johns Hopkins Aramco Healthcare

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ABSTRACT

Johns Hopkins Aramco Healthcare (JHAH) is a leading healthcare organization dedicated to revolutionizing healthcare practices in Saudi Arabia. This review article features the significant strides made by the JHAH ambulatory care pharmacy to symbolize Saudi Arabia's ambitious vision of healthcare transformation. This evolving journey includes details of JHAH's adoption of modern automation tools, several technological advancements, and establishing a pharmacist role far beyond dispensing medications. Moreover, it underscores the cultivation of patient-centered care initiatives like tele-pharmacy services through pharmacy call center, systematic patient satisfaction surveys, streamlined medication home delivery services, state-of-the-art medication drive-thru pick-up facility, the efficacious Q-Matic patient queue management architecture, and the establishment of discreet individual dispensing cubicles. Key focal points encompass technological enhancements, such as the incorporation of electronic health record Epic, cutting-edge pharmacy automation systems, and the patient-centric online portal MyChart®. The article also summarizes the multifaceted ambulatory care enhancements among clinical pharmacy services offered at JHAH. This includes a pharmacist-led medication management clinic, specialized anticoagulation clinic, psychiatric and hepatitis medication management, renal dose optimization, precision-driven thyroid and benign prostatic hyperplasia patients' treatment optimization, and clinical decision support system-backed clinical interventions. All these substantial enhancements at JHAH's ambulatory pharmacy have been made to improve the quality of pharmaceutical services. Besides automation and technological advancements, these also include the establishment of pharmacy competency and continuous education programs, the development of an internal pharmacy webpage on the JHAH website, the implementation of a mechanism for formulary management by the pharmacy and therapeutic committee, and very importantly the adoption of electronic incidence reporting system Datix. The review highlights JHAH's commitment to bringing ambulatory care pharmacy practice to new heights, thereby establishing a benchmark for patient-centric care and innovative excellence within the Saudi Arabian healthcare landscape.

1. Introduction

Ambulatory care pharmacy practice provides a unique setting that enables pharmacists to provide an integrated and accessible healthcare service to improve patients' health and overall quality of life. Ambulatory pharmacists work in a direct patient care environment to address patients' medication needs, enhance patients' compliances, improve medication adherence and management, offer individualized support, streamline medication delivery, educate patients about chronic conditions, and support them with lifestyle changes (Helling & Johnson,

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2014; "Standards of practice for clinical pharmacists," 2014).

As part of Saudi Vision 2030, the national healthcare strategic objectives aim to transform the traditional healthcare system massively. One of the goals of this transformation is to overcome the challenge of an inefficient preventive care system, which has created an opportunity to establish and improve ambulatory care services provided by pharmacists. As a part of this national healthcare transformation, ambulatory care pharmacist can use their clinical expertise to improve access to healthcare services, enhance disease prevention, and deliver medication therapy management services for various specialties. Some of these already established ambulatory pharmacist-led clinics kingdom-wide include anticoagulation, psychiatry, HIV, oncology, pain, solid organ transplant, and Medication-Management Clinics (MMCs)(Al-Jedai et al., 2016; Alshaya et al., 2022; Chowdhury et al., 2021).

Johns Hopkins Aramco Healthcare (JHAH) ambulatory pharmacy offers excellence in person-centered care using state-of-the-art medication dispensing systems, cutting-edge technology and automation. The JHAH ambulatory care pharmacy and pharmacist services practice model follows well-recognized guidelines like those from the American Society of Health-System Pharmacy (ASHP), as outlined in JHAH's medical services policies. The Electronic Health Record (EHR) system and the integrated clinical decision support system (CDSS) are used to deliver comprehensive pharmaceutical care. Various pharmacist-led clinics have been set up where ambulatory care pharmacists provide expert drug information services and medication guidance across areas like anticoagulation, internal medicine, infectious diseases, and psychiatry. Furthermore, by implementing telehealth solutions and the patient portal MyChart® system, JHAH ambulatory pharmacy has effectively established an advanced healthcare model that enhances convenience and improves access to care. These healthcare models cater to all groups of patients and are particularly focused on meeting the needs of vulnerable populations such as immunocompromised individuals and those with physical disabilities.

Pharmacists providing ambulatory care at JHAH play an important role in transforming patient-focused medication management. This article highlights the progress that JHAH's ambulatory pharmacy services achieved in improving technology, processes, clinical care, education, patient well-being, and safety, which were aligned with the Saudi vision of healthcare initiatives.

2. Methodology

This review provides a summary based on nine articles published by JHAH focusing on ambulatory care pharmacy services. It presents an analysis of the responsibilities of pharmacists in ambulatory care, emphasizing the implementation, outcomes, and impact of pharmacist-led programs within patient-centered frameworks. The discussion encompasses a range of nine articles outlined in Table 1, each highlighting the contributions and progress achieved by pharmacists in improving patient outcomes and care processes in ambulatory care settings.

3. Discussion

At JHAH's ambulatory pharmacy, the pharmacists are committed to helping patients achieve the best outcomes. They play a vital role in providing patient-centered care through well-established pharmacist-managed clinics, ensuring comprehensive medication management while collaborating with other healthcare providers. Their role at JHAH has drastically evolved with the incorporation of several technological advancements, extensive training, continuous education programs, physical transformation of the pharmacy design, and the integration of EHR.

3.1. Technological improvements

Ambulatory care pharmacy is a diverse field within pharmacy

Table 1
Articles related to ambulatory care pharmacy services published by JHAH.

Author / Year of publication	Study Objective	Study outcomes
Mohiuddin SI et al. 2021	To detail the implementation process and assess the impact of a pharmacist-led tele-medication management clinic as a patient-centered care model in ambulatory care settings.	Person-centered, pharmacist-led tele-MMC provided personalized services, that proved invaluable for chronic disease patients, ensuring continuity of care. h These services included medication synchronization, maintenance of current lab tests, management of polypharmacy, patient counseling, and minimizing unnecessary medication use.
Arain S et al. 2022	To detail innovative measures implemented by JHAH pharmacy to improve access to quality mental health care and deliver comprehensive medication management for patients with mental health issues through a pharmacist-led telepsychiatry clinic.	The pharmacist-led telepsychiatry clinic provides comprehensive care for mental health patients. The service includes medication assessment, management of long-acting injectable antipsychotics, resolution of −drug related problems, clinical assessments, therapeutic drug monitoring, patient counseling, and polypharmacy management.
Parakkal SA et al. 2022	To evaluate the outcomes of pharmacist-driven renal dose optimization practice in the ambulatory care setting.	Ambulatory care pharmacists significantly reduce inappropriate drug use in renal failure patients and increase physician acceptance of renal dose recommendations.
Haneen K AL Abbasi et al. 2021	To detail the implementation steps and evaluate the effectiveness of drive-through medication pick-up and home delivery services in an ambulatory care setting.	A surge in drive-through and home delivery service usage during the COVID-19 pandemic was observed, significantly enhancing patient safety and minimizing infection risks.
Parakkal SA et al. 2022	To evaluate outcomes of pharmacist-mediated TSH test guideline monitoring in Levothyroxine patients.	Pharmacists bridged a significant gap in practice by creating new TSH lab requests through patient counseling. Pharmacist counseling and intervention improved THS test compliance and optimized thyroxine dosing, leading to a significant drop in non-compliance rates
Thorakkattil SA et al. 2021	To evaluate the effectiveness and utilization patterns of online patient portal-based management for medication renewal and refill pick-up in the ambulatory care setting.	Increased utilization of MyChart and higher customer acceptance rates were observed compared to the past. Medication refills requests for pick-up and renewal drastically increased in the second year compared to the first year of the study.
Thorakkattil SA et al. 2023	To propose a patient-centered ambulatory care pharmacy design on mitigating real-world patient counseling challenges.	An integrated, patient-centered pharmacy design and telehealth model were used to reduce the counseling barriers and enhance patient engagement. The study proposed a design for an ambulatory care pharmacy that focused on eliminating patient counseling barriers and outlined the components required for the successful

(*continued on next page*)

Table 1 (*continued*)

Author / Year of publication	Study Objective	Study outcomes
		implementation of this patient-centered pharmacy design.
Bashar et al. 2023	To evaluate the effectiveness of pharmacist-led management of Benign Prostatic Hyperplasia medications in achieving optimal treatment goals in the ambulatory care setting.	Pharmacist-led interventions have substantially impacted the quality-of-life (QoL) scores of individuals with lower urinary tract symptoms (LUTS). Patient counseling and medication interventions by ambulatory care pharmacists specifically contributed to this improvement in QoL scores for patients with LUTS.
S.A. Thorakkattil et al. 2021	To evaluate the impact of structural and operational redesigning on patient-centered ambulatory care pharmacy services during the COVID-19 pandemic.	Redesigning ambulatory care pharmacy services at structural and operational levels effectively ensured the continuity of care during the COVID-19 pandemic and beyond. The redesign led to a three-fold increase in pharmacy call center utilization and a significant reduction in physical visits to the pharmacy. Medication pick-up through home delivery, drive-through pharmacy, and remote pick-up locations proved to be highly effective and thrived during the COVID-19 pandemic.

practice with immense potential for patient care. Since the inception of ambulatory care, technology has played a transformative role in healthcare, leading to significant improvements in patient outcomes (Feldman et al., 2018). These technological interventions are equally crucial in ambulatory care pharmacy. Technological advancements have greatly influenced the role of ambulatory care pharmacists and significantly improved the quality of patient care (Sng et al., 2019). The healthcare field has been transformed by progress, as demonstrated at JHAH ambulatory pharmacy through the use of EHR Epic, sophisticated automation systems, and the user-friendly online patient portal, MyChart ®.

3.1.1. Electronic health record

The EHR is one of the most remarkable developments in healthcare information technology (Shahmoradi et al., 2017). Over the past decade, there has been an enhanced focus worldwide on transitioning to the utilization of EHRs. Most governmental and non-governmental hospitals and clinics in Saudi Arabia use EHRs (Abdullah Alharbi, 2023). However, the majority of these are not advanced EHR systems and are primarily limited to electronic prescribing and billing. JHAH is the first hospital in Saudi Arabia to implement the top-rated EHR system, Epic, aiming to place JHAH at the leading edge of healthcare information technology (First in Saudi - JHAH launches Epic, 2018). The organizationhas benefited greatly from this initiative in several ways. The EHR system benefits pharmacists by granting them access to up-to-date patient health data. Incorporating a CDSS aids in developing informed patient care strategies, offering healthcare professionals a secure online platform for real-time access to patient records, and facilitating more cohesive decision-making within the care team. This improved coordination leads to improved patient outcomes and increased patient satisfaction. (Evans, 2016; Huber et al., 2018).

3.1.2. Pharmacy automation

Pharmacy automation has had a significant impact on drug control, increasing its effectiveness and safety wherever it has been implemented, including in Saudi Arabia. Automated dispensing systems in Saudi Arabia have improved workflows, reduced medication errors, and enhancing patient outcomes (*Pharmaceutical Care Services*). JHAH's ambulatory care pharmacies use the Box/Pack dispenser, a state-of-the-art technology, to manage medications for ambulatory care patients. This system has the capacity to dispense up to 85 % of medication packages and can store and dispense around 15,000 medication packages (Thorakkattil et al., 2023). Pharmacists in non-robotic pharmacies primarily focus on checking orders, filling prescriptions, and dispensing medications. The automated Box/Pack system delivers the requested medication to dispensing booths, enabling pharmacists to spend more time interacting with patients. This helps them use their knowledge for care, thereby enhancing patient counseling and education. As a result, this can improve compliance, leading to better treatment outcomes. (*CONSIS Pharmacy Robot Dispensing*). A study in Saudi Arabia reported that ambulatory care pharmacy automation resulted in a significant drop in patient time in pharmacy with an increase in pharmacist-patient interaction time. Dispensing errors and wastage costs decreased significantly (Al Nemari & Waterson, 2022). Another study in Saudi Arabia also found a 53 % reduction in waiting time, a 20 % increase in patient satisfaction related to pharmacy wait times, and a 33 % increase in pharmacist productivity with zero dispensing errors following pharmacy automation (Momattin et al., 2021). With robotic medicine dispensation systems in place, all these aspects can be optimized to make pharmaceutical inventory management more effective. Furthermore, it is abundantly evident from domestic and global statistics that this introduction is essential for enhancing the pharmaceutical care delivery system.

3.1.3. Online patient portal MyChart

Online patient portals play a significant role in medication management and optimization. At JHAH, MyChart®, a portal integrated into the Epic EHR system, allows patients to view their records and communicate securely with healthcare providers. With MyChart®, patients can easily access healthcare services and request prescription renewals and refills, eliminating the need to physically visit the physician or pharmacy. MyChart® offers many benefits, such as booking appointments, checking lab results, requesting medication refills, securely communicating with healthcare providers, reviewing health summaries, viewing immunization records, and receiving reminders for screenings and vaccinations. By using MyChart®, JHAH patients can take control of their healthcare, leading to better treatment outcomes and improved patient services (Mohiuddin et al., 2021; Thorakkattil et al., 2023). At JHAH, MyChart® has proven to be very useful and effective in managing medication renewal and refill pick-up. In the first year of the study, 92,997, and the second year, 156,020, refills were requested and received through MyChart® without directly visiting the pharmacy. The number of refill renewal requests sent to physicians through MyChart® was 363159, with a 95.6 % approval rate (Thorakkattil et al., 2022). Similarly, a study from the Netherlands shows that communication between pharmacists and patients through the eConsult tool helped reduce medication errors and improved patient empowerment and access to care (Weinberg et al., 2023).

The Middle East, particularly Saudi Arabia, has a lot of potential when it comes to improving patient-provider interactions through the use of online patient portals. For instance, a study on diabetes showed that using a portal enhanced the treatment of chronic illnesses, such as diabetes, leading to better glycemic control (Belcher et al., 2019). A cross-sectional study conducted in Riyadh, Saudi Arabia, found that 82 % of patients believed a patient portal could assist in self-care management and 51 % of patients had a positive attitude toward it (AlOthman et al., 2017). A systematic review on the impact of digital patient portals on health outcomes, which included 47 studies, found that patient portals can improve health status awareness, strengthen the patient-doctor relationship, and boost therapy adherence (Carini et al.,

2021).

3.2. Person-centered pharmacy services

JHAH's ambulatory pharmacy has revamped its services by focusing on patients' needs by through the incorporation of tele-pharmacy services, the establishment of a medication management clinic, offering patient feedback surveys, medication home delivery, a drive-through medication collection service, a Q-Matic queuing system, and private dispensing areas that ensure patient privacy.

3.2.1. Tele-pharmacy services

JHAH's pharmacy call center provides tele pharmacy services through a toll-free number, allowing patients to connect with pharmacists. By utilizing the Epic EHR system, pharmacists efficiently address medication-related problems, offer counseling, and manage medication refills and pick-ups. These remote services focus on the needs of a range of patients, including the elderly, immunocompromised, and patients who are homebound or have physical disabilities. This setup enables patients to contact pharmacists, enhancing accessibility and ensuring continuity of care (Thorakkattil et al., 2023). Tele pharmacy has gained attention and importance in Saudi Arabia, especially during the COVID-19 pandemic. Various regional studies have shown the effectiveness and improved patient access following tele-pharmacy implementation. A study conducted in an academic medical center reported improved patient satisfaction scores due to tele-pharmacy services (Asseri et al., 2020). Another study highlighted that tele-pharmacy services helped reduce waiting times and increase medication adherence (Al-Dossari et al., 2024). As healthcare needs evolve, the integration of tele pharmacy in Saudi Arabia has generally shown encouraging outcomes, opening the door for further developments in the provision of pharmaceutical care (Asseri et al., 2020).

3.2.2. Patient satisfaction surveys

A survey link is sent to the patients to provide feedback on their pharmacy experience after each visit. The pharmacy administration at JHAH uses the feedback from these survey to identify and improve areas of patient satisfaction and enhance service quality. Patient satisfaction scores are key performance indicators that drive continuous improvement in pharmacies. A study at JHAH found that patient satisfaction remained above 90 % for four years, increasing to over 95 % in 2020 during reaccreditation preparation ($p < 0.001$, 95 % CI: 90.8–95.4). Additionally, the mean change in satisfaction per International Patient Safety Goals (IPSG) performance of 0.946 indicated a positive impact on patient safety and experience, which aligns with JCI requirements. However, these findings correlate with our current study, as it is not limited to ambulatory care pharmacy (Al-Sayedahmed et al., 2021).

3.2.3. Medication home delivery services

To reduce the need for patients to visit pharmacies within the hospital, JHAH introduced a medication home delivery service. In the beginning, this initiative was available only to certain patient groups, and it mainly benefits vulnerable, immunocompromised, and elderly patients by providing a convenient way to receive their medications.. The expansion of services to all eligible patients without age or disease class restrictions resulted from the effective implementation and favorable patient feedback. Since the start of implementation, the study found that the utilization of home delivery services has gradually increased. This patient-centered service may enhance patient experience, boost satisfaction, improve healthcare outcomes, and potentially reduce healthcare expenses… Another study in Qatar also reported a successful implementation and high utilization of home delivery services (Al-Zaidan et al., 2021).

3.2.4. Medication Drive-Thru pick-up

The drive-through pharmacy is a widely used model for dispensing medications. In Malaysia, the drive-through Pharmacy was first implemented at Queen Elizabeth Hospital in 2015 as a value-added service provided by the pharmacy. Compliance with medication collection was acceptable, and patients were satisfied with the services (Liew et al., 2020). The implementation of the drive-thru model by the JHAH pharmacy department aims to increase patient access. With this model, patients can easily pick up their required medication refills while remaining in the car without entering the hospital premises. The establishment of the drive-throughpharmacy has greatly enhanced the patient experience, as evidenced by higher patient satisfaction scores. Consistency in utilization, in terms of the number of prescriptions and patients, was observed in the study (AlAbbasi et al., 2021).

3.2.5. Efficient patient queue management system

The ambulatory care pharmacies at JHAH use Q-Matic® queue management solutions to handle patient queues efficiently. These solutions are designed to improve customer service quality and create a better work environment for staff members. They provide pharmacy management with tools to oversee pharmacy services in a well-organized manner. This system reduces wait times and alleviates congestion in waiting areas, ensuring smooth patient flow during operations. It ensures patients stay informed about wait times during their visit and allows for the collection of insights into the customer experience. This, in turn, aids in data-driven decision-making and offers measurement tools for assessing pharmacy and pharmacist performance (*Q-matic queue management system*).

3.2.6. Individualized dispensing counters with adequate privacy

JHAH is dedicated to offering patient-centered care and has revamped the pharmacy setup, to address the lack of visual and auditory privacy at the pharmacy windows. JHAH redesigned the medication dispensing area, creating counters that ensure confidentiality, providing comfortable seating for pharmacists and patients, promote face-to-face interaction and strengthen relationships between patients and pharmacists. Moreover, a specially designed area has been allocated to accomodate patients with disabilities, improving their ease of access and convenience. Each medication dispensing counter is connected to an automated medication dispenser, which ensures swift delivery of medication packages directly to the counter,minimizes the need for pharmacists to move around, and allows them more time to engage with patients. Furthermore, each counter is equipped with an Epic EHR system, seamlessly incorporating technology into the patient care process to improve efficiency (Thorakkattil et al., 2023).

3.3. Clinical pharmacy services in ambulatory care

Within the JHAH framework, pharmacist lead various clinical services, including the medication management clinic, anticoagulation clinic, psychiatric medication management clinic, renal dosing optimization, thyroid treatment optimization, hepatitis medication management, and benign prostatic hyperplasia (BPH) medication management and optimization.

3.3.1. Pharmacist-led medication management clinic

The MMC is a pharamcist-run clinic that provides services to manage and optimize medications. These services include renewing medication refills, synchronizing refills, monitoring laboratory tests, counseling patients, managing polypharmacy, and deprescribing medications according to established guidelines. JHAH provides both in-person and tele-MMC services. Patients may utilize the in-person MMC to renew medications for which refills are no longer available. This will help the patient to avoid the protracted process of renewing their chronic medications through a physician's appointment. Tele-MMC services are available for vulnerable patients, offering both telephonic and video call options (Mohiuddin et al., 2021).

3.3.2. Pharmacist-led anticoagulation clinic

JHAH has a stand-alone, person-centered, outcome-oriented, pharmacist-managed interdependent anticoagulation ambulatory clinics, where specially trained pharmacists in the field of anticoagulation review the patient medication profile and parameters, provide international normalized ratio (INR) testing and appropriate counseling to ensure optimal therapy, primarily for Warfarin patients. This clinic is instrumental in optimizing the safe management of patients on anticoagulation therapy. The pharmacist acts as a liaison for the physician, ordering lab tests for anticoagulation goals, reviews interactions, documents interventions, and electronically prescribes patient-specific doses. The patients are scheduled to test their INR every two weeks, and necessary dosage adjustments are made to achieve the targeted INR. Pharmacists also provide thorough counseling sessions covering the reasons for anticoagulation, potential side effects, and the importance of treatment adherence. (Dib et al., 2014).

Pharmacist-managed anticoagulation clinic services in Saudi Arabia have demonstrated significant clinical benefits, particularly in improving patient outcomes and enhancing the management of anticoagulation therapy. A study comparing pharmacist-led and physician-led clinics in an ambulatory care setting found that patients in the pharmacist-led clinics had higher Time in Therapeutic Range (TTR) levels than those in the physician-led clinic (Alghadeeer et al., 2020). Another study comparing the safety and efficacy of a pharmacist-run anticoagulation clinic with one run by a hematologist found that the pharmacist-led clinic had a significantly longer time in the therapeutic range (Noor et al., 2021). Overall, these studies represent a significant advancement in the management of anticoagulation therapy by pharmacists in Saudi Arabia.

3.3.3. Pharmacist- led psychiatric medication management clinic

As part of the healthcare team, pharmacists play an integral role in managing medications and supporting patients with mental health issues. Specialized psychiatric pharmacists play a role in bridging significant healthcare system gaps and enhancing the patient journey for individuals with psychiatric conditions. Recently, there has been a shift towards providing care for mental health patients in outpatient settings, rather than traditional institutional environments. This shift has enabled specialized psychiatric pharmacists to offer services such as medication reviews, promoting medication compliance, extending support, making referrals, conducting follow-ups, and monitoring multiple antipsychotic medications(El-Den et al., 2021; Stuhec & Gorenc, 2019). The pharmacy services division at JHAH has set up a clinic for outpatient care led by psychiatric pharmacists that offers various pharmaceutical services. Fig. 1 provides a list of these services. In addition to providing face-to-face consultations, the JHAH ambulatory psychiatric clinic has also established a telemedicine health model. By leveraging telephonic or virtual consultations, MyChart text messages, and email communication, pharmacists enhance their availability and patients' access to mental health care (Arain et al., 2022).

3.3.4. Pharmacist-led renal dosing and treatment optimization

The impaired renal function in individuals can lead to altered drug pharmacokinetics, potentially resulting in drug toxicity or reduced therapeutic efficacy. Several studies show highly inappropriate drug use in kidney disease patients. Manley et al. found that 60 % of CKD patients on medications require dose adjustments due to renal impairment (Manley et al., 2016). Although CDSS can prevent drug-related problems (DRPs) in patients with renal disease, they remain underutilized in ambulatory care (Naughton, 2008). Another widely adopted strategy to

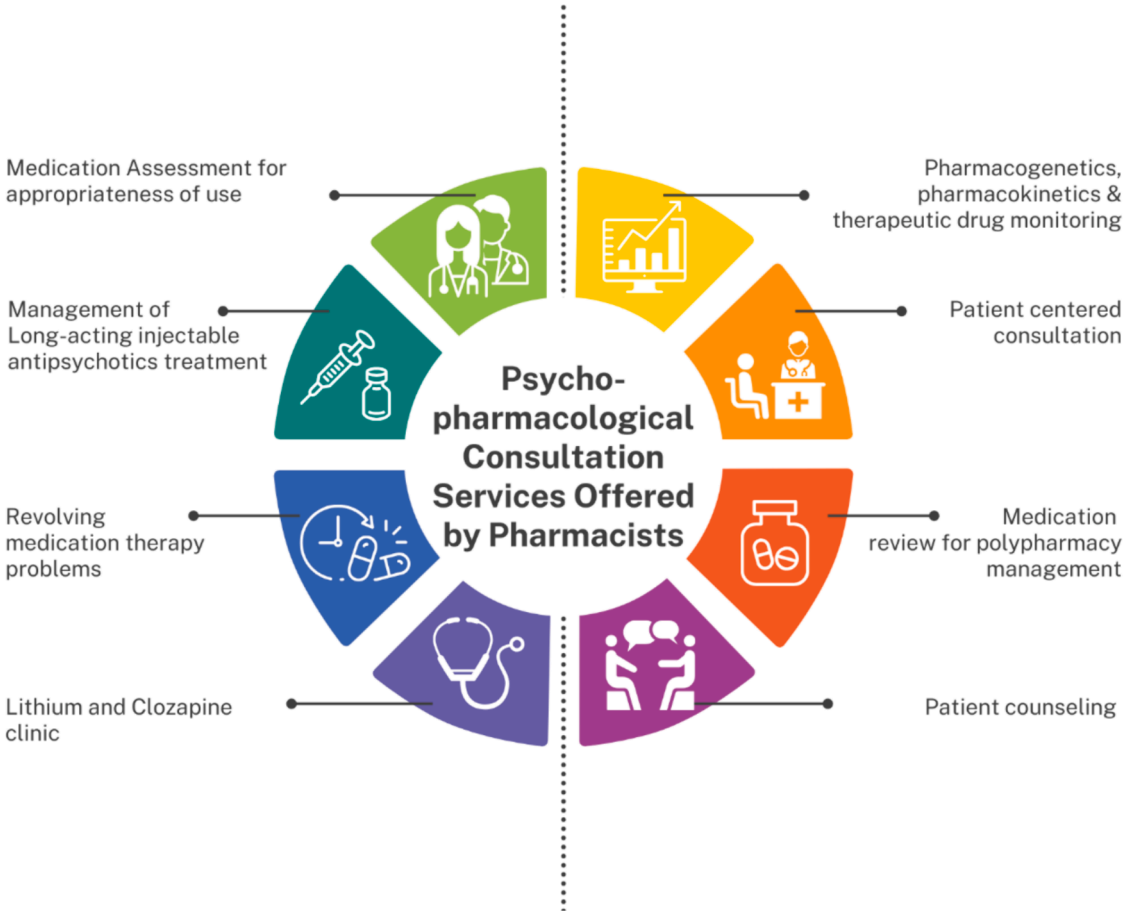

Fig. 1. Pharmacist-led psychiatric services at JHAH ambulatory care psychiatric clinic.

prevent DRPs in patients with renal disease in ambulatory care settings involves adhering to dosing guidelines. Despite this, there is a notable discrepancy in following renal dose guidelines across various settings, with non-compliance rates ranging from 19 % to 70 %, and an exceptionally high rate of 69 % non-adherence observed in ambulatory care settings. (Dörks et al., 2017; Long et al., 2004).

To address these issues, JHAH introduced a team-based approach led by ambulatory care pharmacists to oversee medication use in patients with renal-impairment. In this role, pharmacists adjust renal dosesand the modifications made are recorded as part of medication management interventions in the EHR. JHAH pharmacists made 302 renal dose recommendations for 269 patients, achieving a 72.52 % acceptance rate by doctors. This underscores the crucial role of pharmacists in preventing inappropriate medication practices and averting adverse drug reactions in patients with kidney disease. (Parakkal et al., 2022).

3.3.5. *Pharmacist-led thyroid patients' treatment optimization*

Achieving and maintaining optimal thyroid hormone levels is critical to thyroid patients' overall well-being and health. Regularly monitoring thyroid-stimulating hormone (TSH) levels and appropriate adjustments to levothyroxine dosage are essentialfor effective treatment. Through TSH monitoring, clinicians can assess whether the dosage of levothyroxine is appropriate or requires modification (*Thyroid Function Tests | American Thyroid Association*). In outpatient settings, non-compliance with laboratory monitoring for long-term medications varies between 44 % and 73 %. Approximately 30 % to 60 % of individuals taking levothyroxine do not achieve the desired balance in their thyroid hormone levels, indicating that they may be receiving excessive treatment. (Canaris et al., 2000). Pharmacists play a crucial role in facilitating lab requests to ensure that drug therapy goals are met and medications are properly monitored. (Rosenthal, 2000). By utilizing an EHR system and collaborating closely with doctors, pharmacists can improve patient adherence to lab tests and help achieve ideal initial lab results for patients receiving care outside the hospital(Raebel et al., 2006).

Through telephonic consultation, pharmacists at JHAH-MMC have enhanced adherence to TSH testing and assisted in modifying doses for levothyroxine patients who were not following recommendations. This intervention has led to a reduction in non-adherence and has facilitated more accurate dose adjustments by doctors (Parakkal et al., 2023).

3.3.6. *Pharmacists-mediated hepatitis medication management*

Epclusa is an oral drug authorized to treat hepatitis C virus (HCV) infection across all genotypes. It is effective against all varieties of HCV and provides patients with a range of therapy options(Feld et al., 2015). Before initiating treatment, physicians assess the patient's liver function, viral load, HCV genotype, and any additional medical issues. Lab tests, such as liver function tests, complete blood count, and renal function tests, are crucial for monitoring the effectiveness of the treatment and ensuring patient safety. (Ghany et al., 2009). The duration of Epclusa treatment can vary based on the patient's HCV genotype and previous treatments. Typically, Epclusa is administered for 12 weeks, regardless of genotype or treatment history. However, individuals with conditions like compensated cirrhosis may require an extended treatment duration of up to 24 weeks for optimal results (Curry et al., 2015).

Before dispensing Epclusa, the JHAH ambulatory care pharmacists provide a comprehensive pretreatment evaluation. Fig. 2 depicts the major steps involved in the comprehensive pretreatment evaluation provided by the pharmacist at JHAH before dispensing Epclusa.

3.3.7. *Pharmacist-led benign prostatic hyperplasia (BPH) medication management*

In the pharmacy setting at JHAH, interventions led by pharmacists have shown success in improving the quality of life of patients with lower urinary tract symptoms(LUTS) linked to BPH. These initiatives entail pharmacists collaborating with physicians to enhance and tailor treatment outcomes for BPH patients, underscoring the importance of teamwork in addressing this condition(Al Makahleh et al., 2023). The results suggested that older adults, especially those over 60, are more prone to LUTS. The study observed that there is an increase in prevalence with age. The highest percentage of individuals with LUTS was in the age group of 71 and above (46.08 %), followed by the 61 to 70 years age group (38.24 %) and then the 50 to 60 age group (15.68 %) (Al Makahleh et al., 2023).

3.3.8. *Cds-aided and non-aided clinical interventions by pharmacists*

Ambulatory care pharmacy encounters obstacles in managing patient care that demand precise clinical decision-making. Thankfully, the introduction of EHRs integrated with CDSS has revolutionized pharmacists' approach to care. The EHR-linked CDSS equips pharmacists with a wealth of data, such as medical history, lab results, and medication details, enabling them to make well-informed decisions based on the patient's complete health records. Research by Bates et al. revealed that integrating EHR-based CDSS enhanced adherence to recommended care processes by 50 %, underscoring the significance of comprehensive information in clinical decision-making (Bates et al., 2003). EHR-based CDSS generates real-time alerts and reminders for clinical pharmacists, ensuring timely interventions and reducing medication errors. These alerts can include drug-drug interactions, allergies, contraindications, and dosage adjustments. By highlighting potential issues such as drug interactions, allergies, contraindications, and dosage adjustments EHR-

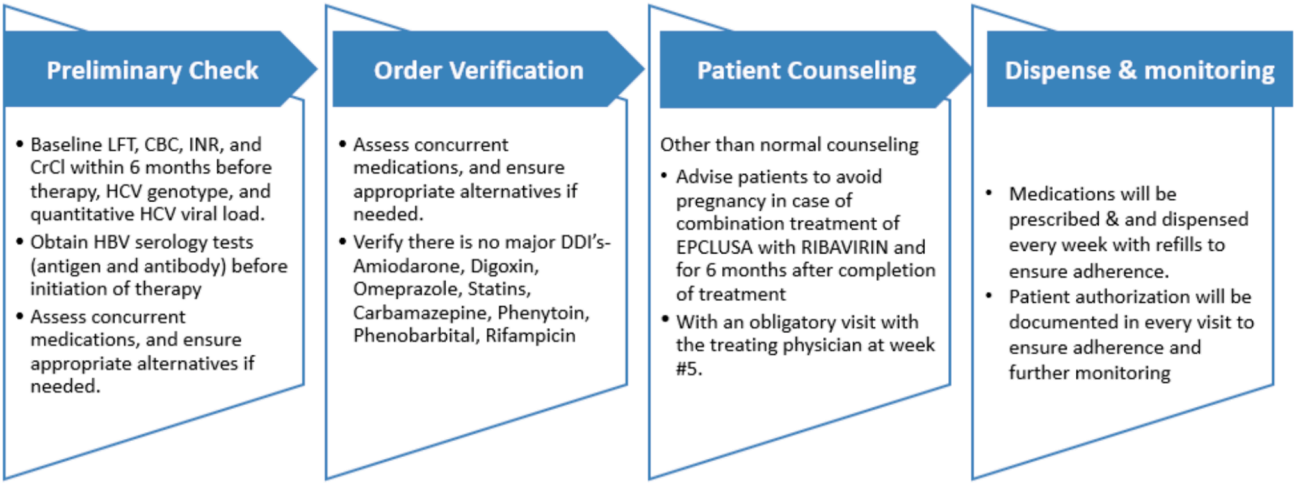

Fig. 2. Comprehensive pharmacists-mediated hepatitis medication management services at JHAH ambulatory care pharmacy setting.

integrated CDSS empowers pharmacists to take action and prevent medication errors. Incorporating CDSS alerts into EHRs significantly bolsters medication safety; onestudy even indicated that this integration reduced prescribing errors by 66 %. (Kesselheim et al., 2011). The JHAH's Epic EHR system, embedded with an up-to-date clinical decision system, further enhances the quality of pharmacy services provided. Epic uses data to offer personalized medication suggestions tailored to age, gender, medical history, and lab results. The EHR-driven CDSS plays a significant role in helping pharmacists deliver exceptional care at JHAH's outpatient pharmacies (Thorakkattil et al., 2023).

3.4. Continuing education programs and learning opportunities

The customized pharmacy website at JHAH provides tailored information and improves access to resources, including drug and therapeutic committee alerts, supporting pharmacists in delivering person-centered care. Additionally, continuing education lectures and competency-based programs further empower pharmacists to enhance their knowledge and skills, thus elevating the quality of service they deliver in ambulatory care settings.

3.4.1. Competency-based pharmacy education program

Pharmacists play a critical role in patient-centered outpatient care, necessitating ongoing professional development to ensure safe medication practices. Clinical pharmacists engage in continuous learning through board certifications and self-assessment initiatives to enhance their skills. Competency-based education (CBE) programs have become increasingly popular among healthcare providers, offering advanced opportunities that address evolving healthcare needs and lead to improved patientoutcomes. (Katoue & Schwinghammer, 2020; Saseen et al., 2017).

The pharmacy services department at JHAH has developed a program focused on enhancing clinical skills through self-paced learning. This initiative aims to foster a culture of continuous improvement and skill development among pharmacists, facilitating their growth and ensuring the emergence of well-trained professionals. Following ASHP guidelines, the program offers pharmacy practitioners the opportunity to stay current with advancements and therapeutic approaches by offering a review of therapeutics and a competency assessment using FlexiQuiz software.

3.4.2. Drug and therapeutic committee alerts

JHAH holds meetings with the D&T Committee to review medication use and to look at safety and regulatory updates. This includes monitoring medication batches recalled by SFDA and safety alerts like LASA (look alike, sound alike) near misses. Safety measures such as keeping medications separate using Tall Man letters, scanning barcodes, and automated dispensing systems are implemented to avoid mistakes (Bryan et al., 2021). Any preventable medication issues, such as errors or near misses, are shared through emails and unit-level meetings to inform staff and prevent them from happening.

3.4.3. Continuing education program lectures

The pharmacy continuing education program provides tailored learning opportunities, lectures for staff, and weekly updates on clinical and regulatory topics, ensuring compliance with best practices, such as those recommended by ASHP.

3.4.4. Pharmacy website at JHAH

The JHAH pharmacy department's internal website includes key components enhancing services in ambulatory care. These include:

1) *Medication Information& Evidence-Based Guidelines:* This section offers pharmacist resources such as a "therapeutic alternatives" medication list, a guidelines summary for geriatric medication management, erythropoiesis-stimulating agents, and educational materials for preventing errors with high-alert and LASA medications.
2) *Infectious disease guidelines:* A dedicated section to help pharmacists maintain appropriate antibiotic utilization, consult local and international infectious disease guidelines easily, and make renal dose adjustments for antibiotics.
3) *Patient Counseling Materials:* This section equips pharmacists with educational materials to inform patients about their medications, including resources for chemotherapy and hazardous medications, anticoagulant usage, and epinephrine pen administration.

3.5. Medication safety and monitoring

JHAH has implemented Datix, a leading patient software company, to show its commitment to safety and quality standards while making the incident reporting process easier. Datix allows pharmacists to use a combination of technology and data to reduce adverse healthcare events. Pharmacists and other healthcare professionals can report and document incidents, near misses, and possible risks (Cousins et al., 2005). It allows for efficient tracking of incidents while capturing accurate information. (Tabar & Allinson, 2022) As highlighted by several studies and witnessed at JHAH, implementing an electronic incidence reporting system (E-IRS) fosters a culture of continuous improvement and promotes a proactive safety culture. Runciman et al., in their study, showed an increase in incident reporting for medication errors, near misses, and adverse events (Runciman et al., 1993). At JHAH, the adoption of (E-IRS) has proven to increase the number of reported incidents, improve tracking, and decrease the number of medication errors (Mushcab et al., 2020). Additionally, a "Good Catch" recognition award program has been implemented in JHAH to initiate a positive reporting experience and highlight JHAH's safety culture and commitment to healthcare quality.

4. Navigating challenges and overcoming limitations

Although the adoption of EHR and other technological advancements significantly improved patient services at JHAH, it also posed some challenges. The implementation of pharmacist-led tele-medication management clinics and online patient portal-based systems faced challenges in identifying and implementing technology requirements for video and telephone visits, including software, hardware, and EHR integration. Additionally, patient reluctance toward new technology necessitated information technology support personnel assistance. This was overcome by providing patients with education and training to use new technological advancements effectively.

Moreover, the introduction of drive-thru medication pick-ups and home delivery services required the reshaping of the current pharmacy workflows, impacting face-to-face consultations. Despite offering additional avenues for patient services, these services struggled to overcome patient preferences for in-person interactions. Furthermore, they could not manage facility-administered medications, mandating patients' physical presence at the hospital. This was overcome by reassuring the patients about the safety and efficacy of these person-centered services.

While EHR-integrated CDSS improved pharmacy services by providing comprehensive patient information and real-time alerts, pharmacists initially encountered alert fatigue due to overwhelming number of alerts,which diminished their response tocritical clinical notifications.. To address this challenge, a review and fine-tuning of the alert algorithms in the EHR system were conducted, reducing irrelevant alerts and enabling pharmacists to effectively prioritize and respond to the most pertinent alerts. Therefore, the challenges presented by the implementation of technological advancements were effectively tackled through thorough comprehensive training for pharmacy staff, patient education and reassurance, and the establishment of robust informatics support teams These measures ensured the seamless and successful adoption of new workflows and technology.

5. Conclusion

The ambulatory care pharmacy at JHAH integrates advanced technologies, streamlined processes, and specialized clinical services to deliver patient-centered care, setting a recognizable standard not only locally but also across global healthcare landscape These innovations follow the worldwide trend of healthcare institutions adopting digital solutions such as EHRs, MyChart® portal, pharmacy automation, and telehealth which improve access and convenience while optimizing medication management. To further solidify its position as a leader in ambulatory care, both within Saudi Arabia and globally, it has adopted advancements in pharmacy services such as medication home delivery and drive-through pick-up, which have significantly prioritized patient safety and satisfaction. In addition, JHAH's pharmacy emphasizes continuous learning and safety through competency-based programs and a comprehensive website. At JHAH, the adoption of (E-IRS), in line with the global demand and international standards, has successfully enhanced incident tracking and analysis. It has successfully increased the number of reporting incidents, improved incident management, and reduced medication errors, fostering a culture of safety and improvement. With an increased focus on enhancing healthcare quality in Saudi Arabia and numerous studies highlighting the role of pharmacists in medication management clinics, JHAH has established several pharmacist-led clinics in specialties like anticoagulation, endocrinology, nephrology, urology, and psychiatry. These clinics have successfully optimized treatment methods and improved patient outcomes. The initiatives undertaken by JHAH highlight the importance of ambulatory care pharmacy in revolutionizing healthcare services and enhancing patient safety and well-being. This review recommends that future research focus on the significance of examining advancement of ambulatory care pharmacy services in Saudi Arabia in order to emphasize their outcome and advantages.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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