

# Pharma Guard: Smart Medication Management System

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## Abstract

*Pharma Guard Smart Medication Management System presenting a comprehensive overview of an innovative technology designed to revolutionize medication management in healthcare settings. In an era of advancing digital solutions, the Pharma Guard system offers a sophisticated approach to ensuring medication safety and adherence. Through the integration of smart technology, including internet of things (IoT) devices and machine learning algorithms, Pharma Guard enables real-time monitoring, tracking, and management of medication consumption by patients. This paper outlines the key features and functionalities of Pharma Guard, highlighting its potential to mitigate medication errors, improve patient outcomes, and streamline healthcare workflows. Additionally, the paper discusses the implementation challenges and considerations associated with deploying Pharma Guard in diverse healthcare environments. While canceling traditional prescriptions and converting them to electronic format can facilitate communication between the patient and the health facility and enhance smooth communication between prescriptions and pharmacy staff about discontinued medications, there is little work that can be explored to meet the needs of pharmacy staff users. The purpose of this research: This study makes use of qualitative interviews with pharmacy staff to address the following question: When a physician makes changes to a medication, using what information do pharmacy staff need to make correct and effective decisions in their medication management roles? We performed an inductive thematic analysis of interviews with numerous pharmacy staff members, comprising pharmacists and pharmacy technicians, at diverse outpatient community pharmacy locations within an academic health district. Both pharmacists and pharmacy technicians consistently identified three themes of information needs: understanding the prescriber's intention when initiating treatment, clinical justification for medication change, and the intended medication regimen. It was observed that traditional electronic health record (EHR) systems often fail to fully address these multiple information needs, hindering the common goals of accurately dispensing medications and supporting patient self-management. Our qualitative analysis indicates that outpatient community pharmacy staff within an academic health system frequently require additional information from the EHR following medication changes to meet their information needs effectively. Ideally, prescribers should have access to enough information to automatically recognize all discontinued prescriptions. These limitations highlight the significance of developing functionalities that enable the regular exchange of essential information during medication changes, such as structured data elements.*

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## INTRODUCTION

In the evolving landscape of healthcare, the transition from traditional paper prescriptions to electronic formats has significantly impacted communication channels between patients, healthcare facilities, and pharmacy staff. While this shift has undoubtedly improved efficiency and accuracy in medication management, there remains a notable gap in addressing the specific information

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needs of pharmacy staff users [1]. Despite the widespread adoption of electronic health records (EHRs), current systems often fail to adequately support the nuanced requirements of pharmacy professionals in their medication management roles [2]. This paper aims to address this gap by conducting a comprehensive investigation into the information needs of pharmacy staff when physicians make changes to medication regimens [3]. By conducting qualitative interviews with a diverse group of pharmacy staff, including both pharmacists and pharmacy technicians, at various outpatient community pharmacy locations within an academic health district, our aim is to address the following inquiry [4]: What information do pharmacy staff require to make correct and effective decisions in medication management? Our research employs an inductive thematic analysis approach to identify and explore key themes of information needs consistently reported by pharmacy professionals. Specifically, we focus on understanding the prescriber's intention when initiating treatment, the clinical justification for medication changes, and the intended medication regimen [5]. By delving into these themes, we aim to shed light on the complexities of pharmacy staff's decision-making processes and highlight the inadequacies of current EHR systems in meeting their information requirements. Through our qualitative analysis, we uncover significant challenges faced by outpatient community pharmacy staff in accessing essential information from EHR systems to support medication dispensing and patient self-management [6]. Furthermore, our findings underscore the critical need for tailored features and functionalities within EHR systems to facilitate routine communication of vital information during medication changes, such as structured data elements. Ultimately, this paper seeks to contribute valuable insights to the ongoing discourse surrounding medication management in healthcare settings. By bridging the gap between traditional prescriptions and electronic formats, we aim to enhance communication channels between healthcare providers and pharmacy staff, ultimately improving patient outcomes and safety in medication administration [7].

## RESEARCH QUESTIONS

### **This Work Will Try to Seek and Address the Following Question**

How can bridging the gap between traditional paper prescriptions and electronic formats enhance communication channels between healthcare providers and pharmacy staff, ultimately improving patient outcomes and safety in medication administration?

### **The Hypothesis of This Research Is Formulated to Address the Question**

If the specific information needs of pharmacy staff users when physicians make changes to medication regimens are adequately identified and addressed, then the effectiveness and efficiency of medication management processes in healthcare settings will be significantly improved. Additionally, if tailored features and functionalities within EHR systems are developed to meet the identified information needs of pharmacy professionals, then communication channels between healthcare providers and pharmacy staff will be enhanced, leading to improved patient outcomes and safety in medication administration [8].

## METHODS

For the Pharma Guard: Smart Medication Management System, this study delves into the literature concerning the current state of electronic commerce within the healthcare sector, particularly focusing on its implementation within the Gulf Cooperation Council (GCC) countries and specifically in the Sultanate of Oman [9]. The landscape of electronic commerce is continuously evolving, driven by the demands imposed by modern electronic systems. As pharmaceutical companies hold a moral responsibility to ensure the sustainability and advancement of electronic commerce frameworks, this paper aims to explore how modern healthcare enterprises fulfill this obligation within the context of medication management [10].

To validate the hypothesis and present the findings, this paper is structured as follows:

- An overview of the best practices in information management relevant to medication management and electronic commerce is provided.

- The paper outlines the approaches utilized in e-commerce platforms within the healthcare industry and highlights the significant challenges they encounter.

### **The Status of Smart Medication Management System in the Arab Gulf Countries**

The status of Smart Medication Management Systems (SMMS) in the Arab Gulf countries reflects a dynamic landscape characterized by ongoing technological advancements and evolving healthcare infrastructure. As these nations strive to enhance healthcare delivery and patient outcomes, the adoption of SMMS has garnered significant attention as a pivotal component of modern healthcare ecosystems [11]. In recent years, Arab Gulf countries have demonstrated a growing interest in leveraging SMMS to optimize medication administration processes, enhance patient safety, and improve medication adherence. These systems incorporate a range of innovative technologies, including electronic prescribing, medication dispensing automation, medication reconciliation, and real-time monitoring solutions [12]. The implementation of SMMS in the Arab Gulf countries is driven by several factors, including the increasing prevalence of chronic diseases, rising healthcare costs, and the need to mitigate medication errors. By integrating advanced digital solutions into medication management practices, healthcare providers aim to streamline workflows, minimize medication-related adverse events, and ultimately enhance the quality of patient care [13].

Despite the progress made in adopting SMMS, challenges persist, such as interoperability issues, data security concerns, and limited access to technological infrastructure in certain regions. Additionally, cultural, and regulatory factors may influence the pace of adoption and implementation strategies across different Arab Gulf countries [14]. Moving forward, concerted efforts are needed to overcome these challenges and further advance the adoption of SMMS across the Arab Gulf countries. Collaborative initiatives involving healthcare stakeholders, government agencies, and technology providers can help facilitate the seamless integration of SMMS into existing healthcare systems, ultimately leading to improved medication management practices and better health outcomes for individuals across the region [15].

### **Study Design, Setting, and Data Collection**

In September 2023, an implementation was investigated at various pharmacies within a prominent academic healthcare institution, which serves as the focal point of this Pharma Guard investigation. The organization's EHR system operates independently of the pharmacy management software, necessitating the use of an electronic system to facilitate seamless communication between clinics and pharmacies [16]. During the implementation phase, the health care organization chose to suppress messages regarding medication reorders to mitigate potential confusion. This decision is intended to prevent scenarios in which pharmacies receive a cancellation and a new prescription simultaneously, especially in cases where outpatient community pharmacies have not submitted an order electronically to and may receive cancellation letters via fax [17]. It works by notifying pharmacies of canceled prescriptions through an exact "one-to-one" match between canceled prescriptions in the clinic software and corresponding messages in the pharmacy software.

After receiving a notification, the pharmacy software attempts to associate the cancellation with a prescription linked to a particular patient [18]. While workflow within pharmacy settings has been thoroughly documented elsewhere, it is important to note that pharmacy technicians often identify identical and institutionalized cancellations. However, organization policy requires pharmacists to handle cancellations that do not automatically match the pharmacy program. The details of this study adhere to the standards outlined in the Qualitative Research Reporting (SRQR) guidelines. The analysis forms part of a broader human-centered design study focused on examining safety and usability issues associated with Pharma Guard implementation [19].

### **Recruitment and Interview Process**

In this research, we conducted an analysis of interviews involving pharmacy staff, comprising both pharmacy technicians and pharmacists, sourced from numerous outpatient community pharmacies

operating within a major academic healthcare institution catering to patients from diverse outpatient practices [20]. Pharmacy personnel eligible for participation were those employed at community pharmacies involved in the study, recruited via email communications sent through organizational channels and utilizing lists supplied by site managers. A total of 25 pharmacy staff, comprising 20 pharmacists and 5 pharmacy technicians, consented to participate in the study. Among these participants, 15 identified as female and 10 as male. Their length of service in their respective roles, whether pharmacist or technician, varied from 1 to 20 years, with approximately half indicating tenure between 2 and 4 years [21]. The study's design was orchestrated by a multidisciplinary team of researchers, encompassing backgrounds in general internal medicine, pharmacy, human factors, healthcare quality improvement, and patient safety. As a component of a larger qualitative investigation, the team developed a semi-structured interview guide designed for healthcare professionals, which was employed for interviews with both prescribers and outpatient pharmacy personnel. Participants were queried on topics such as the user-friendliness of the medication discontinuation workflow, its clarity, and its impact on communication among pharmacy staff, physicians, and patients. Conducted virtually via Zoom, the interviews spanned from August 2023 to December 2023, forming a vital component of the research's data collection process [22].

## RESULTS

All participants emphasized the importance of specific information requirements regarding the use of Pharma Guard during medication adjustments [23]. Through the interviews, three dominant themes relating to information needs consistently emerged:

1. Understand the prescriber's intent when initiating a medication change (e.g., stopping medication without substituting, adjusting dose, substituting with alternative therapy).
2. The medical reasoning behind altering the medication (e.g., adjusting dosage to enhance blood pressure control, addressing adverse drug reactions).
3. Clarification regarding the intended medication regimen after the cancellation letter.

These topics are consistently emphasized by both pharmacists and pharmacy technicians and are often mentioned in conjunction with each other [24].

For instance, a pharmacist emphasized the significance of comprehending both the clinical reasoning and the intent of the prescriber when they receive a cancellation notice, as cancellations typically lack accompanying information. So, when a cancellation comes from the EHR, it does not tell you why it was canceled or what's going on. We first consider the clinical rationale, and then proceed with our role as inpatients by simply updating the medical list [25].

## DATABASE DESIGN

In the context of our research on Pharma Guard: Smart Medication Management System, all participants underscored the significance of specific information needs concerning the utilization of Pharma Guard during medication adjustments [26]. Through the interviews, three predominant themes regarding information requirements consistently emerged:

1. Understanding the prescriber's intention when initiating a medication change (e.g., discontinuing medication without substitution, adjusting dosage, substituting with alternative therapy).
2. The clinical rationale behind the medication change (e.g., dosage adjustment to enhance blood pressure management, adverse drug reactions).
3. Clarification regarding the intended medication regimen after receiving the cancellation notification.

Both pharmacists and pharmacy technicians consistently underscored these themes, frequently discussing them in conjunction [27]. For instance, a pharmacist emphasized the importance of comprehending both the clinical rationale and the prescriber's intention upon receiving a cancellation notice: "When a cancellation is made, there is no information attached to it. When an EHR sends a

cancellation notification, it does not provide any explanation or context for the cancellation. Clinical Rationale: "Then we address that we are inpatients and we just clear the medical list."

In designing the structure of the Pharma Guard system, MySQL, a popular open-source relational database management system, was chosen for its well-established reliability and efficient performance. MySQL Workbench, a comprehensive tool for database design, allowed for seamless integration of SQL development, database creation, design, and maintenance within a unified development environment for the Pharma Guard system.

The initial phase of developing the Pharma Guard database involved designing the structure of the database using MySQL Workbench. This entailed creating tables to organize data efficiently, such as tables for medications, patient information, prescriber details, and medication change history. MySQL Workbench provided valuable tools for modeling the database structure, allowing for seamless integration and management of complex datasets [28].

Furthermore, the design process included the categorization of medications and diseases, as well as the establishment of relationships between different data entities. Tables were created to store information on drug properties, treatment regimens, and author details, facilitating comprehensive data organization and retrieval.

The enhanced entity-relationship (EER) model, created with MySQL Workbench's EER Diagram editor, effectively depicted the attributes and restrictions present in the Pharma Guard database. This model provided a visual representation of the database structure, enabling the research team to refine and optimize the system architecture for enhanced performance and usability [29].

Overall, the meticulous design and implementation of the Pharma Guard system, supported by MySQL and MySQL Workbench, ensures robust data management capabilities and seamless communication between healthcare professionals, thereby enhancing medication management processes and improving patient outcomes.

## DISCUSSION

In our study of Pharma Guard: Intelligent Medication Management System, our qualitative analysis highlighted three primary themes of information needs observed among pharmacy staff during medication changes:

- Understand the prescriber's intent when initiating the transaction.
- Understand the clinical rationale behind the medication change.
- Clarifying the intended therapeutic regimen after treatment.

Pharmacy professionals emphasized the significance of receiving all three pieces of information together, particularly through functionalities like the "Notes to Pharmacy" section within the message. However, they often noticed inconsistencies in using these features to communicate important information effectively. When these information needs were not adequately met, pharmacy staff faced challenges in counseling patients or ensuring clarity in medication regimens [30].

Pharmacists and pharmacy technicians frequently seek information from the EHR as an alternative solution for details not readily accessible within the message. This underscores the unmet information need within the pharmacy information program after a transaction is received.

Our study highlights the vital information cascade that pharmacy staff seek across the system, which includes understanding the intended change from the prescriber leading to an intended drug regimen, justified by a clinical rationale. Pharmacists and pharmacy technicians emphasized the benefit of

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incorporating this information, especially when presented through features such as the “Notes to Pharmacy” feature within the system as a way to share context.

However, previous research has identified limitations in using the Notes to Pharmacy feature, including its association with a new prescription rather than prescription cancellation, continued refills of prescriptions, and inconsistent use by physicians. These limitations underscore the need for design features that facilitate routine communication of essential information during medication changes, such as mandatory structured data elements that define the clinical rationale for changing or canceling a medication within the system.

Pharmacists and pharmacy technicians also emphasized the common goal of supporting patient self-management. They play critical roles in providing medication counseling to patients, answering questions, and ensuring adherence to medication regimens, all of which are vital to patient safety [31].

When the Pharma Guard system was implemented, no messages were sent to reorder medications, which may contribute to some of the information-seeking behaviors observed among pharmacy staff. Addressing these gaps in information sharing is critical to support effective medication management and ensure patient safety.

## CONCLUSION

In conclusion, our study sheds light on the critical information needs of pharmacy staff during medication changes within the Pharma Guard: Smart Medication Management System. Through qualitative analysis, we identified three primary themes: understanding the prescriber's intent, grasping the clinical rationale, and clarifying the intended medication regimen. These themes underscore the importance of clear and comprehensive communication to support effective medication management and patient safety. However, our findings also reveal notable gaps in current information exchange practices, particularly regarding the inconsistent utilization of features like the "Notes to Pharmacy" section within the system.

These constraints underscore the necessity for improved design elements that facilitate regular communication of vital information during medication alterations, such as structured data elements detailing the clinical reasons for medication adjustments or cancellations. Furthermore, our study underscores the shared goal of pharmacy staff in supporting patient self-management and ensuring medication adherence, emphasizing the pivotal role they play in patient care.

Moving forward, it is imperative to address these information gaps and design deficiencies to optimize the functionality and usability of medication management systems like Pharma Guard. By fostering clearer communication channels and providing pharmacy staff with the necessary information to make informed decisions, we can enhance medication safety and improve patient outcomes in healthcare settings.

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