Implementing a Medication Identification System in Retail Pharmacies to Reduce Medication Error Rates

by

Victoria Sutcliffe

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[Kathryn Summers, Thesis Advisor]

DocuSigned by: 7/20/2022

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[Bridget Blodgett, Committee Member]

Abstract

The prescription medication dispensing process in community and retail pharmacies has long been recognized as a process allowing for human error that can then lead to medication dispensing errors. One of the conditions that increase the risk of medication errors is the competing tasks faced by many pharmacy staff. In addition to filling and dispensing prescriptions, pharmacists and other pharmacy staff are tasked with counseling patients, administering vaccines, speaking to patients and providers over the phone, and even more, depending on the position. Recommended changes in the field of pharmacy include reducing staffing workload and implementing in community pharmacies some of the technological solutions used in hospitals. These solutions primarily face cost barriers, leading to resistance from major commercial pharmacies. This research study explores the potential to leverage technology that already exists in the community pharmacy setting to reduce dispensing errors. Specifically, the study focuses on testing the effectiveness of a medication identification system at the point of contact with users picking up prescriptions in community retail pharmacies. Ten total users took part in the study. All participants were currently prescribed a minimum of two prescription medications. Participants were given two scenarios during the user testing session, one in which the medication they were given matched the medication they were shown on the verification screen and one that did not match. User tests showed that a pill identification system could be a successful solution to medication dispensing errors, as all ten participants were able to successfully identify in the second scenario that the medication which they were given did not match the medication they were shown on the prototype. Qualitative results confirmed that the system was regarded as easy to use. Additionally, the System Usability Scale Questionnaire results confirmed that the medication identification system was helpful and easy to use. The implementation of this system in retail pharmacies is likely to assist in the identification of medication dispensing errors and help protect patients from potential harm.

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I would like to express my gratitude to the faculty, my family members, and my friends who have helped me reach this point in my academic career. Thank you to Dr. Kathryn Summers and Dr. Greg Walsh for their guidance throughout my entire time at University of Baltimore and for giving me the confidence for future career endeavors.

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Chapter One: Introduction

In 2003, a national observational study including 59 randomly selected community pharmacies in six metropolitan areas estimated that 51.5 million dispensing errors occur among the 3 billion prescriptions dispensed annually in the United States, or four errors per day in a typical pharmacy filling 250 prescriptions daily. A more recent meta-analysis of this study and eight others, completed in 2021, estimated a similar error rate of 1.5% in community pharmacies (Li and Marquez, 2021).

Unfortunately, even an error rate of 1.5% in community pharmacies is too high, because errors can cause harm to patients, and some errors are fatal. About 66% of American adults take a prescription drug (Health Policy Institute, 2019). Each year, in the United States alone, 7,000 to 9,000 people die because of a medication error (Tariq, et al., 2021). Additionally, hundreds of thousands of other patients experience adverse reactions or other medication complications that may go unreported. According to a 2019 report from the Drug Channels Institute, around 70 percent of prescriptions nationwide are dispensed by chain drugstores like CVS and Walgreens, supermarkets, or retailers like Walmart. CVS garners a quarter of the country's total prescription revenue and dispenses more than a billion prescriptions a year. Walgreens captures almost 20 percent. Walmart, Kroger, and Rite Aid fall next in line among brick-and-mortar stores (Gabler, E. 2020). Without interventions in place to reduce the occurrence of human error by retail pharmacy staff, medication dispensing errors will continue. Solutions to medication dispensing error and human error in the process of medication handling have been implemented within other healthcare settings, such as hospitals. These contexts have invested in various technological systems implemented to reinforce the work of healthcare staff and reduce human error, which then increases patient safety. For example, within inpatient patient care units and inpatient pharmacies, staff utilize technology that aids in the prescribing, dispensing and administration of medications. Technology such as barcode scanning, for both medication barcodes and patient identification barcodes, allows for positive patient identification and management of medications both for clinical staff and pharmacy staff. This technology ensures that the correct, appropriately prescribed medications are given to the correct patient. Other technology, such as Automatic Dispensing Cabinets that only allow access to appropriately prescribed medications also help to reduce dispensing errors in some settings.

Although some technological solutions exist within other healthcare settings, and other studies have found that pharmacies can reduce errors by shortening staff hours, or increasing staff numbers (Hayden and Parkin, 2020), there is an overlooked resource in this interaction: the patient. This study focuses on an intervention that makes it easier for patients to notice a dispensing error. There has been no previous research that focuses on a patient-facing solution as this study does. Such a medication identification system could be incorporated into an already existing process (signature) that patients interact with when picking up their medications.

This study will focus on the following research questions:

1. Are patients able to successfully identify the pills they are prescribed to take?
2. Will a patient-facing pill identification screen help patients become more familiar with their prescribed medications?
3. Will a patient-facing pill identification screen presented at the point of service help decrease medication dispensing errors?

This study answers these questions by first surveying participants prior to testing sessions to identify whether they are confident in their ability to identify their current prescribed medications. Then, through user testing sessions, I determine if participants can successfully identify a deliberate error in which the medication they were given does not match the description presented to them on the prototype. Finally, I collect satisfaction scores about the new system using the System Usability Scale (Lewis, J. R., 2018).

Chapter Two: Literature Review

There are more than 20,000 prescription drugs that are approved for marketing in the United States (FDA, 2020), and about 66% of American adults take a prescription drug (Health Policy Institute, 2019). According to Tariq, et al., (2021), in the United States alone, 7,000 to 9,000 people die each year because of a medication error. Additionally, hundreds of thousands of other patients experience an adverse reaction or other medication complications that may go unreported (Wittich et al., 2014). The cost of patient care for medication-associated errors exceeds $40 billion each year (Wittich et al., 2014). In addition to the cost, patients can also experience both psychological and physical pain resulting from medication errors (Wittich et al., 2014). The rise of medication errors can lead to a decrease in patient satisfaction, as well as a lack of trust in our healthcare system (Tariq et al., 2021).

According to a 2019 report from the Drug Channels Institute, around 70 percent of prescriptions nationwide are dispensed by chain drugstores like CVS and Walgreens, supermarkets, or retailers like Walmart. CVS garners a quarter of the country's total prescription revenue and dispenses more than a billion prescriptions a year (Gabler, 2019). Walgreens captures almost 20 percent. Walmart, Kroger, and Rite Aid fall next in line among brick-and-mortar stores (Gabler, E. 2020).

In 2018, there were around 67,000 retail and community pharmacies that dispensed 4.4 billion prescriptions (Chui, 2018). Many patients interact with community pharmacists every month when having to refill their prescriptions, which is noticeably more often than patients see their physicians or other primary health care providers. In addition to verifying the accuracy of written and dispensed prescriptions and ensuring patients' understanding of how to take their medication, community pharmacists serve an invaluable role to patients as the triage point when seeking over the counter (OTC) products (Chui, 2018).

Causes of Medication Errors During Dispensing

The most common medication dispensing error types are incorrect medication, incorrect doses, and incorrect directions. Although technology has allowed for prescribing to be done electronically, medication errors in the community pharmacy setting can still occur in any step of the prescription dispensing process.

Outpatient pharmacies face the pressure to provide convenient medication delivery options that have required changes in pharmacy workflow, personnel, and technical design (Szeinbach, 2007). Although these changes have facilitated prescription processing and improved patient accessibility to medications, additional risk is presented when sociotechnical (i.e. interaction of the social and technological systems) factors coexist with human factors in an environment where cognitive abilities are necessary to ensure accurate processing and delivery of prescribed medications. Community pharmacists perform tasks that are at times somewhat repetitive yet require high levels of professional training and optimal performance under considerable time constraints (Szeinbach, 2007).

Dispensing errors can be defined as any inconsistencies or deviations from a physician's prescription order such as dispensing the incorrect drug, dose, dosage form; wrong medication quantity; inappropriate, incorrect, or inadequate labeling; confusing or inadequate directions for medication use; and incorrect or inappropriate preparation, packaging, or storage or medication prior to dispensing (Szeinbach et al., 2007). Similarly named drugs and drug packaging is also a cause for confusion that leads to error by pharmacy staff.

A national observational study completed in 2003 at 59 randomly selected community pharmacies in six metropolitan areas estimated that 51.5 million dispensing errors occur among the 3 billion prescriptions dispensed annually in the United States, or four errors per day in a typical pharmacy filling 250 prescriptions daily (Li and Marquez, 2021). A more recent meta-analysis of this study and eight others, completed in 2021, estimated a similar error rate of 1.5% in community pharmacies (Li and Marquez, 2021).

How Medications are Filled

Filling a prescription is the process involved in translating a medication order, or prescription, into an individualized medication supply to a patient that is safe, appropriate, and legally accepted. The prescription filling process has five detailed steps: input and initial check, therapeutic check, preparation, technical check, and supply and educate (Chamberlain, 2020). These steps allow for an accurate and precise prescription filling process that is safe and legal for the customer and the pharmacist (Chamberlain, 2020). Prescriptions can either be handwritten by physicians, or electronically sent to the pharmacy. The first step is inputting the prescription.

When filling a prescription, pharmacists will ask for general information if it is a patient's first time at the pharmacy or if they have not already picked up medications before. If it is a patient's first visit, they are required to complete a consent form, filling out general demographic information along with a brief medical history and any known allergies. For established patients, their information will be in the pharmacy's database (Chamberlain, 2020).

Once the prescription has been inputted and double-checked, the pharmacist then does a therapeutic check, looking at the patient's medical history to confirm that the medication is appropriate for the patient. Then the pharmacist prepares the medication. The pharmacist or pharmacy technician will scan and pack the medication, check for expiration, label the medications, if needed, apply any cautionary labels, and write down the times to take, where and how to use, etc. The medication will then be handed over to another member who will take the medications through a technical check for completing the prescription filling process. For the technical check, another member within the pharmacy will check the accuracy of the information entered in the system and ask for further verifications if needed. This step allows a further check on the medication: brand, quantity, doses, and related labeling will be rechecked for accurate filling. Also, in this step, the pharmacists may print certain counseling documents if the medications provided need more detailed instructions or information. The final step of the process is to supply the medication and educate the patient. In this step, the pharmacist may provide certain elements of counseling for the customer regarding the medications and patients have an opportunity to ask questions, review potential side effects, confirm how many times a day to take the medication, discuss further refills, and so on (Chamberlain, 2020). For first-time patients, the therapeutic check, preparation, and technical check happen after the patient has provided profile information and some medical history.

When picking up a medication, patients are asked for an identifier, such as address or birthday, to help confirm identity and ensure patients are given the correct prescription. Patients may also be asked if they have used the medication before and for what treatment it was used for, to help the pharmacist update the medical profile when a new medication is filled. After receiving the medication patients routinely sign on a touchpad to acknowledge receipt. This final step is the focus of this study.

E-Prescribing

Dispensing errors have experienced declines before. The introduction of electronic prescribing, or e-prescribing, in the early 2000s, introduced a convenient and safer way of prescribing for providers, pharmacies, and patients. Through electronic health records (EHR's), physicians can electronically send a new prescription or refill request directly to pharmacies through the process of electronic prescribing (e-prescribing). Before the introduction of e-prescribing, patient prescriptions were handwritten by physicians and taken to a pharmacy to be filled. The e-prescribing process has decreased prescribing and medication errors and has resulted in a decrease in the need for pharmacies to contact physicians for clarification of written prescriptions (Porterfield et al., 2014). The prevalence of e-prescribing increased between 2008 and 2014, with the introduction of two important policies that promoted the use of e-prescribing. The Medicare Improvements for Patients and Providers Act (MIPPA), or the "eRx incentive" program, began in 2008 and offered financial incentives for providers to e-prescribe. The Medicare and Medicaid Electronic Health Record (EHR) Incentive Programs, or the "meaningful use" program, began in 2011. To demonstrate meaningful use, providers must use their EHRs to meet several program objectives, including e-prescribing (Gabriel, Swain, 2014). These federal policies and programs accelerated the uptake of this technological improvement.

Although there are many benefits provided by the capabilities of e-prescribing, there are negatives to it, as well. One example of an issue with the use of e-prescribing has occurred at CVS Pharmacy. The American Psychiatric Association found that that the CVS retail chain was giving patients larger supplies of medication than doctors had directed in their electronic prescriptions (Gabler, 2020). Essentially, CVS was pre-filling e-prescribed refills for its own convenience (Gabler, 2020).

Although it is common for pharmacies to dispense 90 days (about 3 months) worth of medications classified as maintenance, which treat chronic conditions like high blood pressure or diabetes, doctors state that the 90-day period inappropriate for other types of drugs (Liberman, Girdish, 2011). For example, patients with bipolar disorder can be prescribed lithium, a drug that if taken in excess can be potentially lethal. Psychiatrists commonly start a patient on a low dose or will limit the number of pills dispensed at once, especially if the person is at risk of suicide (Barnett et al., 2022). The psychiatric association has found that smaller quantities specified on prescriptions are being ignored, particularly by CVS. E-prescribing is becoming a primary method of prescribing among providers, and potential patient harm could arise when pharmacies ignore medication directions with quantity limitations for certain conditions (Gabler, 2020). CVS has recently created a system where doctors can register and request that 90-day supplies not be dispensed to their patients, but doctors report that this registry has not solved the problem (Gabler, 2020). In a statement, CVS said it continued to “refine and enhance” the program (Gabler, 2020). This example demonstrates that clarity alone is insufficient to guarantee prescribing accuracy.

Electronic Health Records

Although the implementation of e-prescribing has decreased prescribing and medication errors, community pharmacists still lack access to patients’ electronic health records. This lack of access is another source of medication errors. In settings like hospitals, long-term care facilities and clinics, pharmacists analyze and double-check prescription information within electronic health records (EHRs) and promote the safe use of medications. Pharmacists then use the patient information to ensure each prescription is accurate and appropriate. Yet community pharmacists nationwide are without access to patients' electronic health records and can only access the partial medication profiles that are maintained by the dispensing pharmacy (Gerhards, 2020). Up to 93% of patient medical records contain allergy information that is different from the information recorded at the community pharmacy (Collins, 2016). As a result, pharmacists are not always able to know when their patients are admitted to the hospital or see what medications were given during their hospital stay, what medications are newly prescribed, as well as what medications may have been discontinued. Pharmacists also do not have universal access to patient's labs, and if patients use multiple pharmacies, community pharmacists may not even have a complete list of their medications. A pharmacist's review of each medication order is important to assess potential duplication in therapy, contraindications, unsafe dosing, allergies, and other medication-related concerns before a drug is given to a patient (Institute for Safe Medication Practices, 2019).

These pieces of medical history, however, are crucial to patient safety and positive outcomes for prescribing and dispensing medications. Pharmacists can play a crucial role in improving patient outcomes when armed with complete information about their patients. The level of access—if any at all—granted by state, local, and regional health information exchanges (HIEs) to pharmacists vary widely from state to state (Collins, 2016). If pharmacists knew why a patient had been prescribed a medication and had the clinical context for those prescriptions, then they would be able to make better decisions about whether they need to follow up with the prescribing provider about certain issues (Gerhards, 2020).

Pharmacy Staff Workload

Although there are more pharmacies in the United States than ever before, the number of pharmacists and pharmacy staff has not kept pace with the growth in prescriptions (Hayden, Parkin, 2022). Nearly two years into the Covid-19 pandemic, pharmacists and technicians across the nation are under intense strain as their daily responsibilities shift from filling prescriptions and counseling patients, to administering Covid-19 vaccines and tests, handing out masks and dealing with increasingly angry customers (Ngo, 2020). Large retail pharmacy chains have tried to respond to the pandemic labor shortage, with some pharmacies reducing store hours, increasing starting wages, offering more breaks, and giving out bonuses to retain employees (Ngo, 2022). Pharmacies have been struggling to deal with a lack of both pharmacists and technicians, though shortages are higher for technicians, who serve as support staff and help dispense medication. There were 166,337 pharmacy technician job postings through the fourth quarter of 2021, an increase of about 21,100 from the year prior, according to a Pharmacy Workforce Center report (Pharmacy Workforce Center, Inc., 2021). A 2022 survey conducted by The American Pharmacists Association found that 74 percent of respondents said they did not think they had sufficient time to safely perform patient care and clinical duties (Negatu, 2022).

On top of such a high volume of patients to manage, community pharmacists have many other responsibilities to tend to in their position that take both their time and attention from prescription management and dispensing. These tasks can leave room for human error throughout the process of medication dispensing. Human error is defined as inevitable, unpredictable, and unintentional failure in the way we perceive, think, or behave (Institute for Safe Medication Practices, 2020). Human error may occur under conditions involving emotional stress, lack of motivation, high workload, poor communication, insufficient staff, distraction related to noise or interruption, and missed patient information (Li and Marquez, 2021).

Effects of Distraction

Individuals that work within a healthcare setting face constant distraction or interruption, even when performing critical tasks. For instance, nurses administering medications and pharmacists and technicians dispensing medications are distracted and interrupted as often as once every 2 minutes (Relihan et al., 2010). Multi-tasking is expected from those being interrupted, and constant distractions and interruptions are accepted as the norm in healthcare settings. Constant distractions and interruptions can then contribute to medication errors. To cite one study, the risk of any medication error increases 12.7% with each interruption, and the risk of a harmful medication error is doubled when nurses are interrupted 4 times during a single drug administration and tripled when interrupted 6 times (Westbrook et al., 2010). Thus, these constant distractions and interruptions in the community pharmacy setting have major consequences in healthcare.

Distractions and interruptions include anything that draws away, disturbs, or diverts attention from the current desired task, forcing attention on a new task at least temporarily (Westbrook, 2010). Attending to the new task increases the risk of an error with one or both tasks because the stress of the distraction or interruption causes cognitive fatigue, which leads to omissions, mental slips or lapses, and mistakes (Westbrook, 2010).

Distractions and interruptions have a strong impact on prospective memory, or the ability to remember to do something that must be deferred (Relihan et al., 2010). When a person forms an intention, their memory establishes a specific cue to remind them to act. If the task is interrupted and the cue is encountered later, a spontaneous process is supposed to bring the intention to mind. However, individuals are less likely to remember the intention if they are outside the context in which the cue was established (Grundgeiger and Sanderson, 2009). For example, in a hospital setting, an interruption that causes a nurse to leave the patient’s room decreases the likelihood that the nurse will remember to finish the interrupted task. A study on multi-tasking with computers found that 40% of the time, individuals wandered off in a new direction after the interruption ended, forgetting what they were doing prior to the interruption (Daley, 2006). While distractions and interruptions in healthcare cannot be fully eliminated, there are steps that can be taken to create a less chaotic environment for clinicians.

Explored Policy Solutions to Prescribing Errors

Some methods for reducing prescribing errors would require mandates. For example, due to the Covid-19 pandemic and widespread staff shortages, the need for mandating both pharmacy staffing levels and staff working hours are at an all-time high (Hayden, Parkin, 2021). And the standardization of pharmacist access to Electronic Health Records (EHR's) would provide the pharmacists with the patient health information and past medical history they need to ensure medications are appropriately prescribed for each patient.

The Need for Higher Staff to Patient Ratios

The practice of pharmacy in community settings has changed dramatically in the past two decades in the U.S. and internationally, with pharmacists now providing services such as administering vaccines that go beyond just filling prescriptions and providing patient counseling for both prescription and over-the-counter medications (Owens, Baergen, 2021). Working in high-volume retail settings, community pharmacists are having to find ways to balance their responsibilities to corporate managers, as well as to their patients. The result is that many pharmacists and pharmacy staff work in incredibly stressful conditions (Owens, Baergen, 2021). Community pharmacies often do not have adequate staffing, making it even harder to meet demand. These obligations can stretch pharmacists to their limits to meet corporate demands and a variety of productivity metrics, while at the same time performing their professional roles, such as giving due diligence to confirming the appropriateness of prescriptions, identifying, and solving potential drug-related problems, educating patients about their medications, and providing a growing number of clinical services such as administering vaccines (Owens and Baergen, 2021). Both pharmacists and other pharmacy staff, like technicians, have a list of duties in addition to medication dispensing and counseling, such as vaccine administration, speaking to patients and/or physicians on the phone, stocking inventory, running registers, and in some locations even managing drive-throughs. However, because increasing staffing levels will reduce profits, any such increase is likely to require legal mandates (Owens, Baergen, 2021).

Current Technology to Reduce Dispensing Errors

There are currently many technical solutions in place in clinical settings that assist with the detection and prevention of medication prescribing and dispensing errors. These solutions exist primarily in hospital settings, including inpatient hospital pharmacies. One of these is routine access to patient electronic health records. Working within a hospital provides inpatient pharmacists with the ability to see the entire patient history, including why patients are prescribed medications. Community pharmacists in retail pharmacies lack access to whole patient records and can only see prescription history. Just as the transition to e-prescribing was accelerated by legislation, broad access to electronic health records by pharmacies would require changes in public policy.

There are technological tools for reducing prescribing errors, but some of these are very expensive. For example, another medication-specific technology that exists in the hospital setting is Automated Dispensing Cabinets (ACDs), which are computerized medicine cabinets that are prevalent across the United States and Canada. ADCs are locked medication cabinets. When data are entered on digital screens (like user identification, medication requested), only selected drawer(s) open giving staff access to only those items, and each transaction is recorded electronically. ADCs were first introduced in hospitals in the 1980s to transition to a more dispersed medication distribution system while maintaining safety. Originally designed as an automated unit stock system with the ability to assist with capturing charges and automated medication replenishment, many medications were placed in open matrix drawers to which practitioners were allowed access without prescriptions first being reviewed by a

pharmacist. Over time, however, changes to ADC hardware and software, as well as improvements in associated workflows, have given many organizations the ability to utilize ADCs in locations outside of hospital pharmacies (Institute for Safe Medication Practices, 2019). In most care areas, a pharmacist will review and approve the appropriateness of each medication order for a patient prior to allowing a nurse access to the ordered drug. As previously stated, pharmaceutical review of each medication order is important to assess potential duplication in therapy, contraindications, unsafe dosing, allergies, and other medication-related concerns before a drug is removed from stock and administered (Institute for Safe Medication Practices, 2019). Although computerized dispensing cabinets make fewer errors, there is still an element of human error that can occur. For example, error can occur when pharmacy staff are stocking medications in the cabinets, as this is one of their responsibilities. In some cases, nurses can restock unused doses of certain medications, and this is also subject to human error (Institute for Safe Medication Practices, 2019). Another element of these ADC's that can threaten patient safety is the ability of staff to override warnings from the cabinets when dispensing medications. Institute for Safe Medication Practices defines "override" as a process of bypassing a pharmacist's review of a medication order to obtain a medication from an ADC when a nurse's assessment of the patient indicates that a delay in administration of the medication would harm the patient (Institute for Safe Medication Practices, 2019). This definition assumes that an order for the medication exists; that assessment of the patient indicates that a delay in therapy may be harmful; and that the drug must therefore be removed from the ADC before the order has been reviewed by a
pharmacist. Unfortunately, one of the biggest challenges to the safe use of ADCs is the ease with which medications can be removed from the cabinets by using the override function. Too often this function is used unnecessarily and without considering its associated risk. It has been found that clinical staff often view the override process as routine in their practice, rather than a risky step that can put a patient at risk of harm (Institute for Safe Medication Practices, 2019). Staff may fail to recognize that use of

ADC overrides should be situation dependent and individually justifiable, and not based merely on an approved list of medications available on override. While hospitals and other healthcare organizations do indeed need to identify the drugs with the potential to be obtained on an emergency basis, along with examples of situations that might require these drugs to be removed before a pharmacist has reviewed them, there will be many circumstances when there is enough time for the pharmacist to review even emergent medication orders without the override function needed (Institute for Safe Medication Practices, 2019). Another safety concern involves the process that should be in place for pharmacists and nurse managers to review medications removed from an ADC via override. Too often, this review process is inadequate or absent; when it does happen, little can be learned from the recorded reason for the override, or else important findings never reach nursing leadership with oversight of the Automatic Dispensing Cabinets (Institute for Safe Medication Practices, 2019).

Another form of technology focused on medication safety is the practice of Barcode Medication Administration (BCMA). BCMA is generally combined with Automated Dispensing Cabinets to reduce the risk of errors, both when drugs are removed from an ADC and when they are being placed in the cabinet as inventory. BCMA systems reduce medication errors by electronically verifying the '5 rights' of medication administration—right patient, right dose, right drug, right time, right route—at the patient's bedside. For example, a nurse would scan a bar code on his or her identification badge, on a patient's hospital wristband, and on the medication to be administered. This data is delivered to a computer software system where algorithms check various databases and generate real-time warnings or approvals. Most systems then automatically document, in real-time, the administration of the medication in an electronic medication administration record (eMAR) so that the time when medications were given can be easily viewed in the patient's electronic health record (Shah et al., 2016).

Another technology on the rise is robotic dispensing systems. For example, robotic dispensing systems were implemented in Saudi Arabia. The project was undertaken to increase throughput, reduce medication dispensing error rates, improve patient satisfaction, and provide pharmacists' more time for face-to-face interaction with patients (Momattin et al., 2021).

These technologies have the potential to reduce dispensing errors, but they involve significant cost. Aside from technological assistance in the pharmacy setting, there are other potential solutions that can be put in place to improve patient safety in the retail pharmacy setting. Other potential systemwide changes in pharmacies that can enhance patient safety include mandatory counseling of patients about their drugs at the point of service, and utilization of a national medication error reporting system for both staff and patients, as well as transparency in error reporting. These changes would likely require regulation, as would increasing pharmacy staffing to help with workload and to prevent employee burnout. In recent years, some states like California, Illinois and Virginia have created new rules like capping shift lengths, mandating safe staffing levels, and prohibiting excessive performance metrics, but most states do not regulate these things (Gabler, 2020).

Conclusion

Current research related to medication error solutions is limited. It would be an advantageous expansion for researchers to investigate how existing hardware/technology in pharmacies can be leveraged to target medication dispensing errors or introducing new technology that can do the same. This research is focused on a customer facing solution, but research into a pharmacist and pharmacy staff facing solution would be advantageous, as well.

As discussed in this chapter, most previous efforts to reduce dispensing errors have focused on technological solutions, process changes, or staffing changes. The goal of this project is to leverage the technology already in use in community pharmacies to engage patients in a final check of their medicine. This solution does not dispense with the need for the other improvements discussed in this chapter; however, this solution has the advantage of being both easy and inexpensive to implement. The purpose of this project is to demonstrate its viability and potential value.

Chapter Three: Methods

Research Goal

The goal of this user testing is to find out if a pill identification/verification screen, presented to patients at the time they receive their prescribed medications, will help identify medication dispensing errors and potentially decrease the occurrence of these errors. The intent of the pill identification screen is to prompt patients to confirm that the medication they are taking home with them is correct and matches what they see on the screen. If the medication is not correct, or if the patient is unsure of what they were prescribed, this can be reported to the pharmacist and be remediated.

Research Questions

4. Are patients able to successfully identify the pills they are prescribed to take?
5. Might a patient-facing pill identification screen help patients become more familiar with their prescribed medications?
6. Might a patient-facing pill identification screen presented at the point of service help decrease medication dispensing errors?

User Testing Participants

I recruited adults, ages 18+, who are currently prescribed more than one prescription medication, and who get their prescriptions filled at retail pharmacies (Rite Aid, CVS, Walgreens, Walmart, etc.). Participants were asked screening questions prior to the usability testing to ensure they fit the criteria for the study.

Procedure

During research sessions, participants performed tasks using a paper prototype. Paper prototyping is a technique that consists of creating hand drawings of user interfaces to enable them to be rapidly designed, simulated, and tested. During user testing sessions, I acted as the facilitator and the human computer.

- **Users:** Users interacted with a paper version of the user interface that is being tested.
- **Facilitator:** Recorded the issues raised during testing and probed into the issues raised so that they are well documented.
- **Human Computer:** Manipulated the paper prototype in order to collect feedback based on the user's interaction. The human computer does not explain or give hints to the users about how the interface is supposed to behave so that the users are left entirely on their own to perform the tasks that they have been assigned.

Research/Testing Procedure

Before user testing began, I interviewed participants to determine user background information (how many medications they are prescribed, what pharmacies they utilize for prescriptions). After the interview, users completed a brief questionnaire to determine whether patients could identify or describe their current prescribed medications.

When testing began, users were first asked if they were familiar with the touch screen pads presented to them at the pharmacy counter when picking up their medications. This question helped identify patients that are familiar with the existing pharmacy process. This was beneficial for the testing sessions, as participants that were already familiar with the process could identify if they felt that the integration of the pill identification steps would flow easily into the existing process. Had participants not been familiar with the process, they would not have an opinion on the ease of integration of the additional steps. Participants were then informed that they would be presented with paper prototypes of screens that they might see on these touch screen pads before leaving the pharmacy with their medications.

As the moderator, I used the Concurrent Think Aloud (CTA) protocol, a widely used usability evaluation method. The CTA method was originally based on the theoretical framework developed by cognitive psychologists Ericsson and Simon in 1980 and was introduced to the field of usability testing by Lewis and Rieman in 1982 (Lewis and Rieman, 1993). Typically, the testing method has test participants work on a set of tasks, and asks them to verbalize their experiences, thoughts, actions, and feelings while interacting with a system. This technique provides direct insight into the cognitive processes of a user, which can then inform strategies to improve usability (Alhadreti et al., 2017).

After the prototype testing sessions, participants were asked to fill out the questions of the System Usability Scale. The System Usability Scale is a standardized questionnaire designed to assess perceived usability. The standard version of the SUS has 10 items, each with a response scale ranging from "Strongly Disagree" to "Strongly Agree." It is a mixed-tone questionnaire in which the odd-numbered items have a positive tone, and the even-numbered items have a negative tone. The industry goal has become to achieve a SUS score of 80 or higher as evidence of an above-average user experience (Lewis, J. R., 2018). I completed a pilot test prior to the usability testing sessions. This pilot session allowed me to ensure that I had all the materials, consents and documentation prepared and checked. The pilot test also helped me identify any scenarios or other materials that needed to be changed prior to the usability testing. Pilot testing (a session or two before the real test) helps fine-tune usability studies, leading to more reliable results. It provides an opportunity to validate the wording of the tasks, understand the time necessary for the session, and, if all goes well, may even supply an additional data point for your study (Schade, 2015).

Usability Testing Participants

Table 1 - *Demographics of survey participants and number of current prescriptions*

Participant	Age	Gender	Number of Prescriptions
1	61	Female	4
2	63	Male	6
3	49	Female	3
4	47	Male	2
5	34	Female	3
6	36	Male	2
7	53	Male	4
8	28	Female	2
9	29	Female	2
10	32	Female	2

The users that participated in my study were a convenience sample that I recruited by approaching friends and family in person to provide a summary of the research and its purpose and obtain their consent to participate. I used screening questions to confirm the recruited participants were a proper fit for the study.

Table 2 - *Survey Questions*

#	Question
1	What is your age?
2	What is your gender?
3	How many prescription medications are you currently taking?
4	Without first looking at your current prescription medications, are you able to describe what they look like? Are you confident that you would be able to correctly identify a medication by seeing a picture of it?

Question number four was included to determine if participants were familiar with their prescribed medications prior to being introduced to the proposed medication verification process, and to see if they would benefit from becoming more familiar with the medications they are taking/using.

Chapter Four: Results

A total of 10 user testing sessions were conducted for this study. Participants ranged from 28 to 63 years of age. All 10 participants were currently prescribed a minimum of 2 medications, with 6 prescribed medications being the highest. Six out of the ten participants were female, and four were male.

When asked the questions "Without first looking at your current prescription medications, are you able to describe what they look like? Are you confident that you would be able to correctly identify a medication by seeing a picture of it?", six out of 10 participants said yes, and 4 out of 10 participants said that they could not visually identify their medication, or that they only knew the color of the pills they are prescribed but are not confident in their ability to successfully identify them by looking at a picture or seeing a comparison to similar looking pills, creams, etc. Table 3 contains a complete list of the participant responses to these questions.

Table 3 - *Participant Responses*

Responses of each survey participant to the question: "Without first looking at your current prescription medications, are you able to describe what they look like? Are you confident that you would be able to correctly identify a medication by seeing a picture of it?"

Participant	Response
1	"Yes, I've been taking the same 3 pills daily for years and could easily identify or describe all of them."
2	"The pills I take, probably. But I'm prescribed some creams for my skin that have complicated names that I usually forget and can't spell. When I see a new doctor, I usually take a copy of my medications from my other doctors with me."
3	"Honestly, no. I can tell you what shape and color they are (like 'small white round pill'), but I only ever take them out of the pill bottle to take them in the morning and don't look closely at them."

4	"I probably could, but I put my pills in a container for each day of the week, so I usually just take them all at once and don't really pay attention to them."
5	"I know what color they are, but I usually forget the name."
6	"Probably not if they were being compared to other medications and I had to choose which one I take, I don't think I could choose correctly. My medications are daily, and they come in a designated container (like birth control) that I never take them out of."
7	"I think I could, most of my pills I just remember by color and shape."
8	"Yes, I could identify what I take if I saw a picture of them."
9	"Yes, I could."
10	"Yes, I only take two and one of them I take multiple times a day, so I could identify them easily."

User Testing Sessions

For the user testing sessions, I designed a paper prototype of pill identification screens for existing hardware in pharmacies. In many pharmacies, patients are presented with a touch screen pad in which they indicate whether they would like to receive medication counseling from a pharmacist and to also provide a digital signature. The touch screen pads are the existing hardware through which pill identification screens can be presented (Figure 1). During the user testing sessions, users were presented the paper prototype screens as though they were picking up a prescription from a pharmacy.

Scenarios/Prototype Screens Presented to Users

I decided to approach the testing scenarios as though the prototype was being trialed in a pharmacy. Users were presented with an initial screen letting them know that a new law was under consideration that would change the prescription pick up process, and that they would be asked to provide their opinion of the process after completing the medication identification.

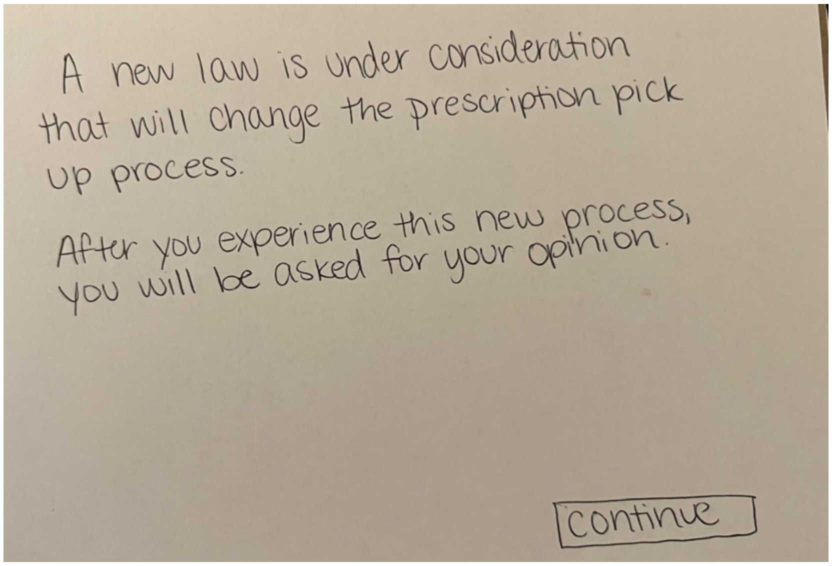
During the user testing, users were presented with two scenarios. Participants were given one bottle of pills that matched the description they were presented in the paper prototype, and one bottle of pills that did not match the description they were presented. In both scenarios, they were told to respond to the prototype as realistically as possible. Users were first given the pill bottle, then began the verification process. When presented with the medication image and description screen, users needed to confirm or deny that the medication presented matched the pills they were given.

During one of the testing scenarios, participants were deliberately given a pill that did not match the description and image that was presented to them on the paper prototype screen. The screen stated “Description: Round tablet, pink”, followed by an image of the pill. The image of the pill presented to the participants was black and white, with the color of the pill only being called out to them within the description. The pill that participants were given was a round blue pill. Ten out of the ten total participants were able to successfully identify that the pill they were given did not match the picture and description that was presented to them on the paper prototype screen, confirming that a pill identification system could potentially help to catch medication prescribing errors if implemented in pharmacies.

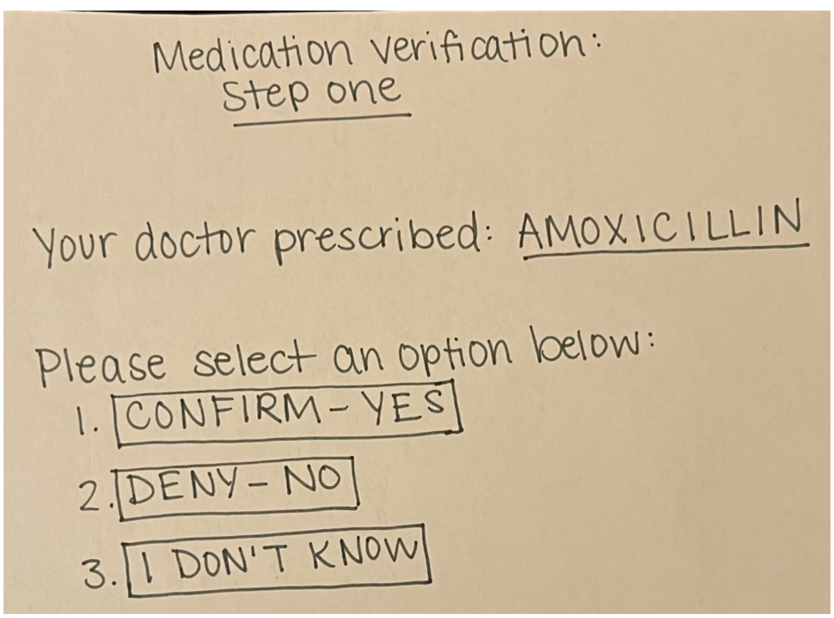
The paper prototype screens used in the testing are presented below.

Scenario: Medication given to the user matched what was presented on the prototype.

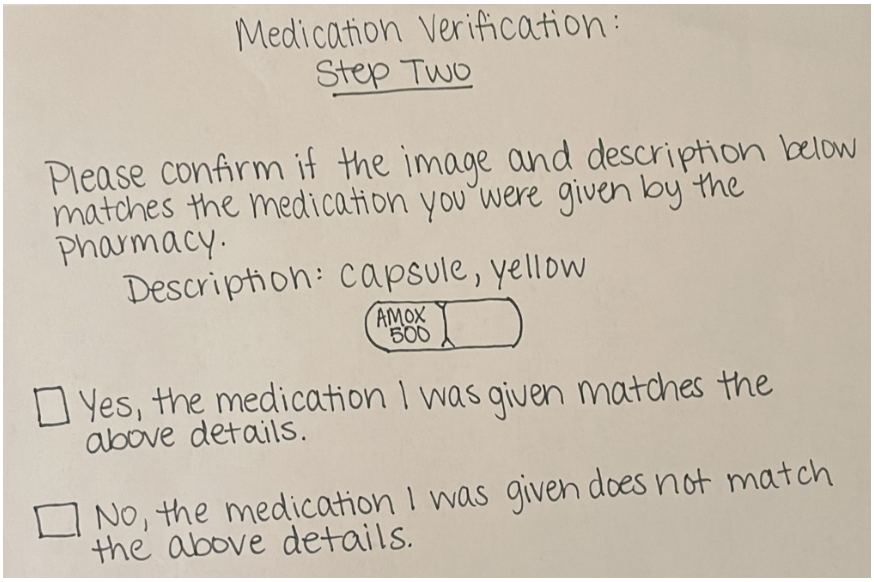
1. Screen 1: User selects "Continue":



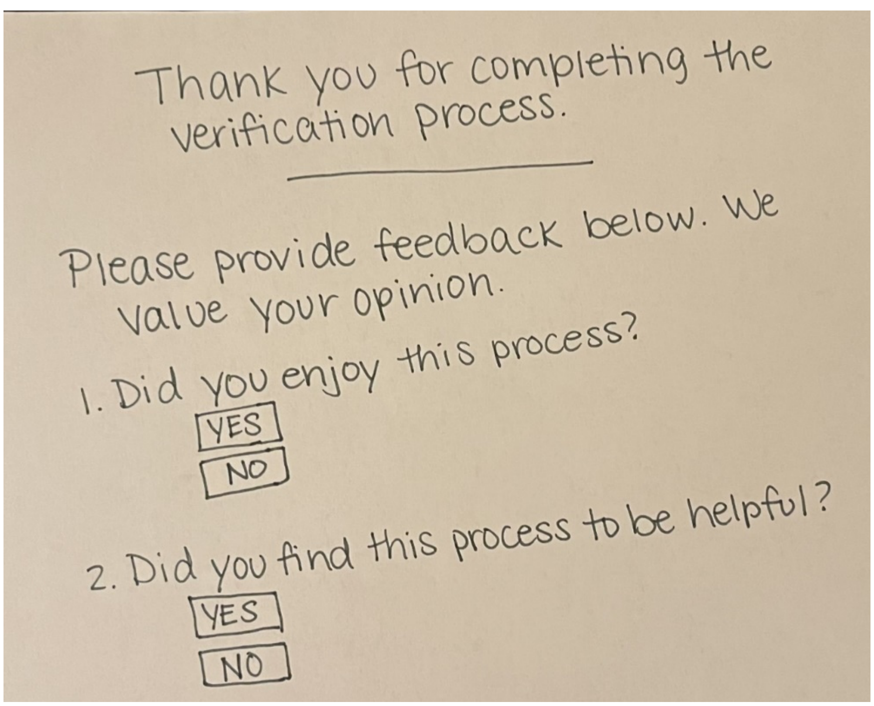
2. Screen 2: User selects "Confirm - Yes":



3. Screen 3: User selects "Yes, the medication I was given matches the above details":

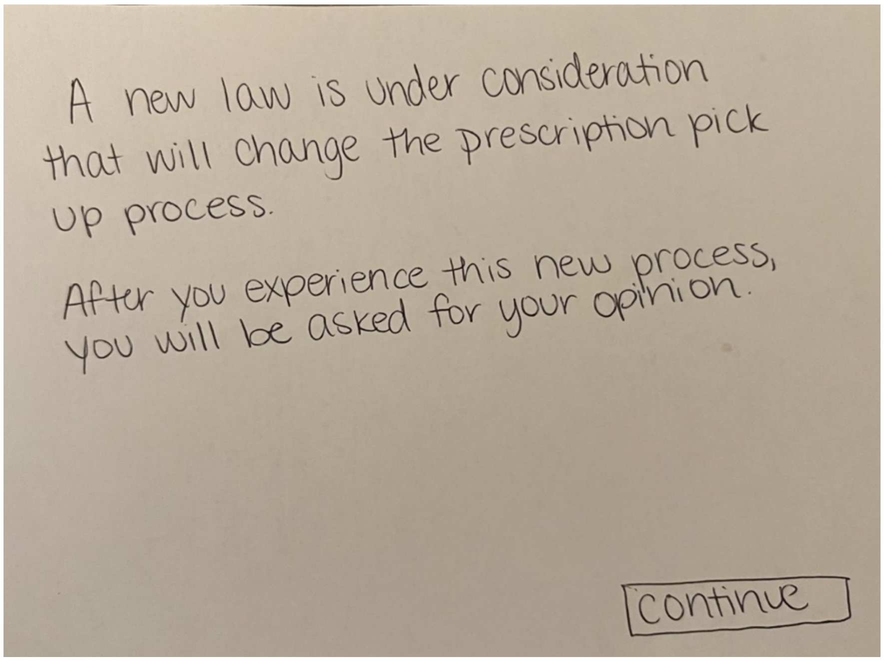


4. Screen 4: User provides their feedback on the process.

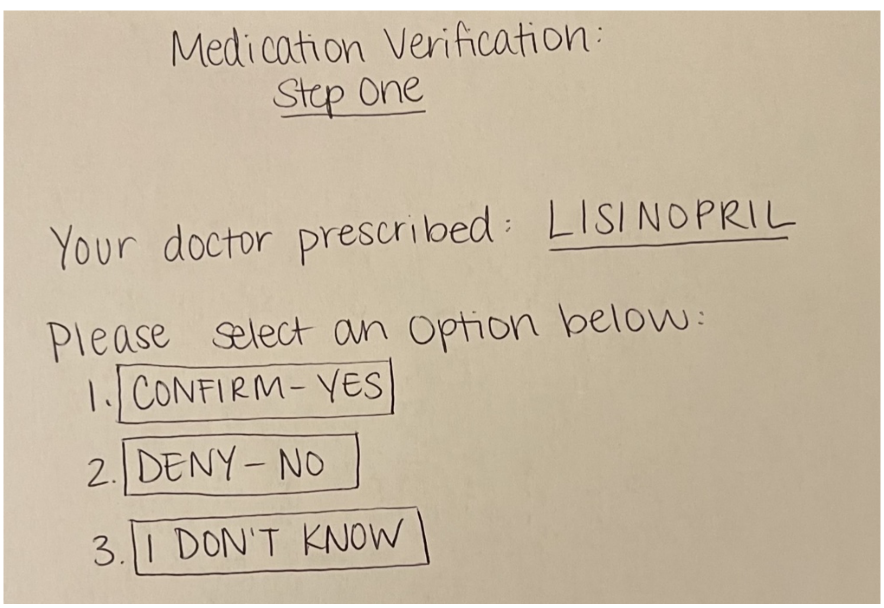


Scenario: Medication given to the user did not match what was presented on the prototype.

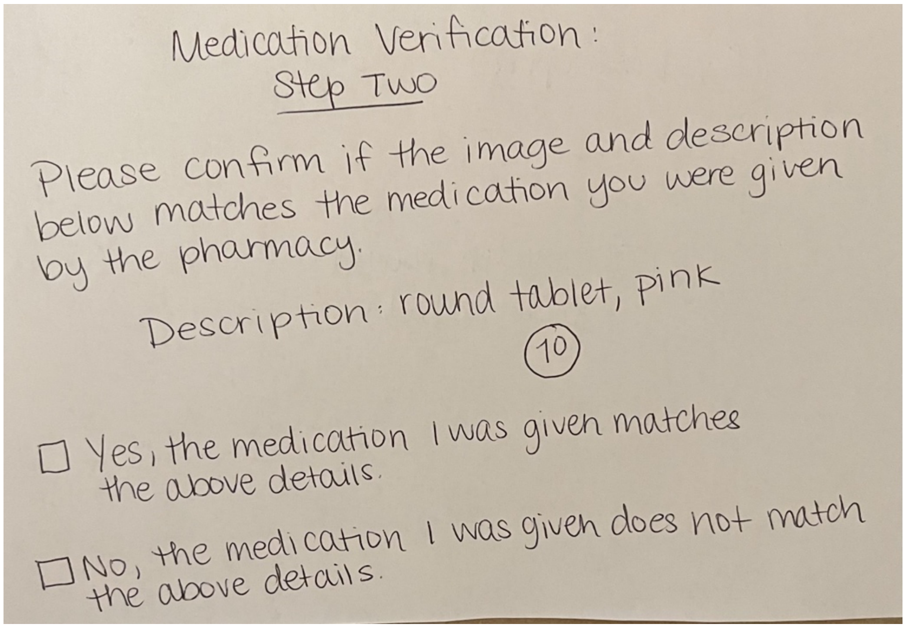
1. Screen 1: User selects "Continue":



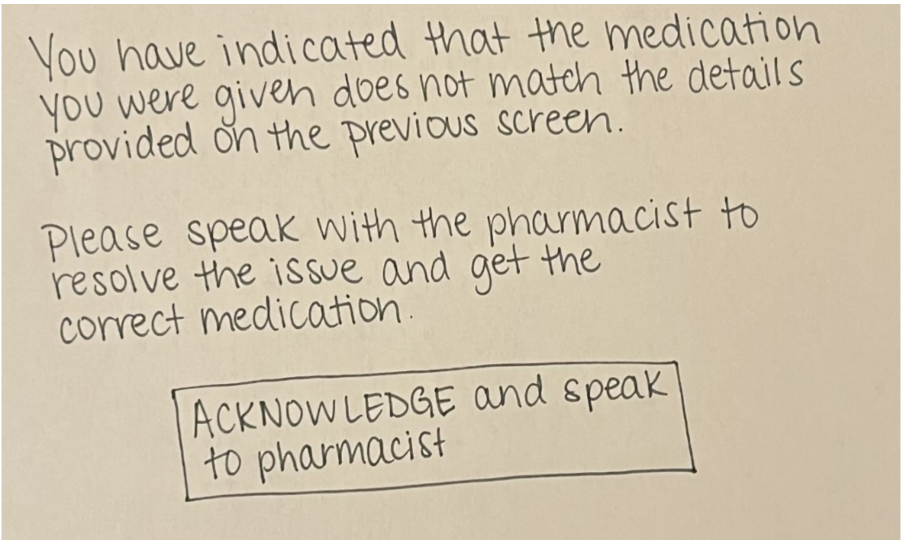
2. Screen 2: User selects "Confirm - Yes":



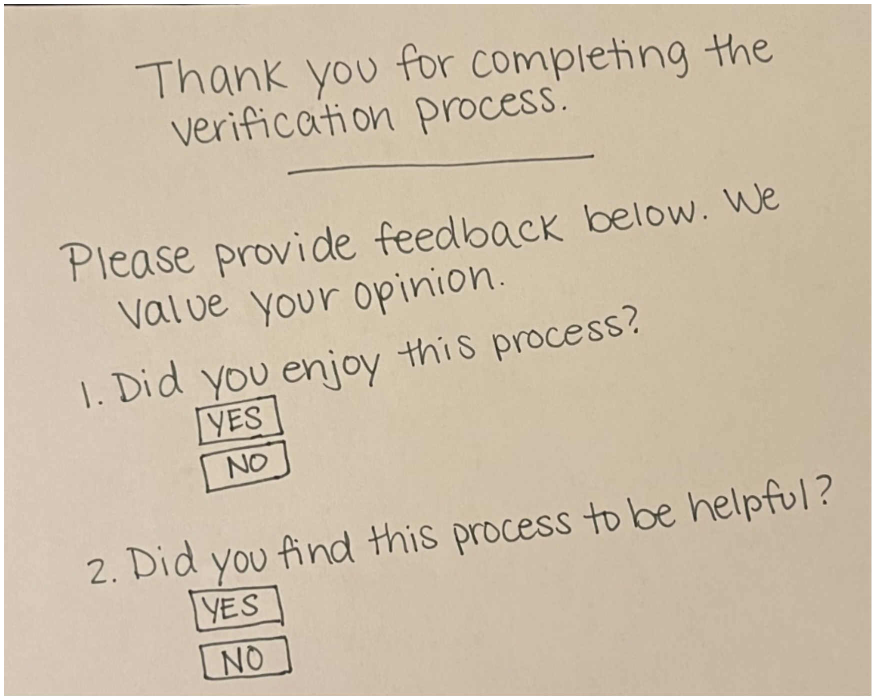
3. Screen 3: User selects "No, the medication I was given does not match the above details.":



4. Screen 4: User selects "Acknowledge and speak to pharmacist":



5. Screen 5: User makes appropriate selection to provide their feedback:



System Usability Scale (SUS) Survey

After completing the user testing session for this study, participants were asked to complete the system usability scale survey to evaluate the paper prototype of the medication identification system, as well as rate their experience when interacting with the prototype. The medication identification system received a system usability scale score of 97.25, much higher than the industry goal of 80. The score of 97.25 indicates that participants in the study found the system easy to use, and that participants would not need assistance to use it successfully.

Table 4 below summarizes each participant's raw and total SUS scores.

Table 4 - *Participant SUS Scores*

#	Raw SUS Score	Total SUS Score
1	27	100
2	25	87.5
3	25	90
4	28	95
5	26	90
6	26	102.5
7	26	102.5
8	25	100
9	25	100
10	27	105
Average	26	97.25

Chapter Five: Discussion

The pill identification system was easy for users to interact with due to the simplicity of it. When presenting an image along with the written description of the medication, the participant's used visual processing made it easy and almost automatic to compare the image to the actual pill. The identification screens were simple, which also helped to make it easy for participants to make the comparison successfully. Giving participants a picture to use in immediate comparison eliminated the need for them to remember the physical appearance of their medicine; instead, they only needed to do a simple visual comparison. The prototype transformed a demanding cognitive task (remember & compare) into a simple cognitive task (look & compare), making it easier and thus more likely that patients would succeed at this task. Out of the ten total participants, none struggled to complete the identification process. There was also a gender segregation identified when participants were asked "Without first looking at your current prescription medications, are you able to describe what they look like? Are you confident that you would be able to correctly identify a medication by seeing a picture of it?" – with male participants being less confident than female participants.

During the user testing sessions, users were encouraged to think aloud and provide any comments or feedback about the pill identification screens. Below is a list of participant feedback and potential points that could be addressed in the future if the pill identification system were actually implemented.

- "If this were a real process and actual screens with color images of the pills were used, I think identification would happen even quicker."
- "Would this become time consuming for a customer picking up multiple medications at once, or would they be presented each medication screen back-to-back to quickly identify all?"
- "What happens when a customer receives the incorrect medication? Do they get assisted by another staff member to keep service going? This could potentially cause longer wait times when a pharmacy is busy."

- "How would this work for someone picking up for another person, or both themselves and another person?"
- "I primarily use the pharmacy drive through when I can, but it would be nice if it were possible to implement this when picking up through the drive through, too."
- "What would happen if the user confirmed that what they got was correct, but then a medication error occurs? Are pharmacies no longer liable for any harm that could be caused to patients due to the errors if a patient confirms what they received was correct?"

These are all points that could be addressed if this study were expanded to larger participant groups and eventually be implemented in community pharmacies.

I believe all the above contributed to the high SUS ratings. The simplicity of the system led participants to regard the system as simple and easy to use. They believed it was well integrated into an already existing system that they were familiar with and that it would not require any assistance or education to be used successfully.

Chapter Six: Conclusion

The research on medication errors as well as the results from initial user surveys suggest that a system that double-checks the work of pharmacists and pharmacy staff and verifies medication(s) being given to patients is potentially valuable. Out of the ten total participants in this study, 5 out of 10 participants were initially not completely confident in their ability to identify their medications, either by name or appearance. Participant responses ranged from those who said they could not successfully identify their current medications to those who said that they only knew the color or name of the pills they are prescribed but were not 100% confident in their ability to successfully identify their pills by looking at a picture or seeing a comparison against similar medications (*see all participant responses in Table 3*). Yet all the participants were able to successfully identify the incorrect medication when using the prototype.

Patients are an untapped resource when it comes to ways to help reduce errors in a retail pharmacy setting. The identification process in this study was developed with the goal that a new process being introduced to patients should be natural and easy and should not burden patients. The implementation of a medication identification system such as the one in this study would be both easy and cost-effective, as it would utilize technology that already exists within retail pharmacies. These medication identification screens would be presented to patients at a point in the prescription pick-up process that they are already familiar with when acknowledging receipt of the medicine, indicating whether they would like counseling from a pharmacist, and then provide their signature for confirmation of pick up. The new identification screens proposed in this study could be presented to patients prior to providing their signature.

Benefits

This new process could help patients become more familiar with the appearance of their medications when they are prompted to verify that what they received from the pharmacy is correct. Because many patients are used to taking medications directly from the bottle provided by the pharmacy, taking their pills becomes an automatic daily process, and the pills may not even be looked at before being taken. If patients become more aware of their medication's appearance, this could help to identify prescribing errors and thus protect patients from potential harm or side effects. Patients who are familiar with their prescribed medications may still catch a medication error even if this process is not implemented, but patients who are not familiar with their medications would benefit from seeing an image during a confirmation process.

Implications

Based on the outcome of the user testing sessions and SUS scoring from participants, this proposed pill identification system has a high potential to be successful if implemented. Ten out of the 10 total participants were able to successfully recognize the deliberate error during one of the scenarios presented to them, demonstrating that the process was simple and direct and achieved the desired outcome. For the intent of the study, it was decided to approach the process as though it were being trialed in a pharmacy. If this process was implemented in retail pharmacies, patients would not be presented with introduction screens and would go right into the identification process naturally, as an addition to the process that is currently followed.

During the user testing sessions, two participants did state that they often utilize their drug store drive-through to pick up prescriptions rather than going inside. The intervention explored in this study would not benefit patients who use a drive-through at the pharmacy. Thus, this would be an area that would need additional design and testing for feasibility. Including this process in a drive-through setting would also require new technology to be purchased or put in place, as the touchscreen technology leveraged for this study is only currently utilized inside of the pharmacy.

Limitations

In an ideal world, this research could be more expansive, with more time, participants, money, etc. If more time and resources were available to expand this research, additional studies like this one would be conducted with larger groups of participants to further assess the effectiveness of this proposed system. Rather than a random sample, a convenience sample was used for this study. Although the results of the study were positive, the use of the convenience sample causes an inability to generalize the results of the survey to the population as a whole. With this study, the small sample size means that this was only a proof of concept, and we cannot generalize to the larger population until the intervention is tested with a larger group.

Additionally, this study was performed in a lab setting instead of a contextual setting where there are additional stressors of distraction, time, and physical requirements, such as actually opening a pill bottle to look at the items inside. Due to these differences, had the study been done in a setting similar to that of a pharmacy, the results may have been different. Factors within a true pharmacy setting could include distractions within the pharmacy (from staff and other customers around participants), potential stress to complete the task quickly in a busy setting, and more. These additional potential stressors were not presented to participants in this study.

Next Steps

Next steps for larger studies would be to beta test an electronic prototype in an actual retail pharmacy setting, as opposed to paper prototypes as in this study. For this system to truly be successful, a database of medication images and descriptions connected to the e-prescription system would be necessary.

After conducting more exploratory studies and validating the effectiveness of this process, the final step would be to advocate for the implementation of this system in retail pharmacies. Ideally, this process would be required for patients to complete during each medication pick up, prior to providing their signature for proof of pick up.

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Appendix A

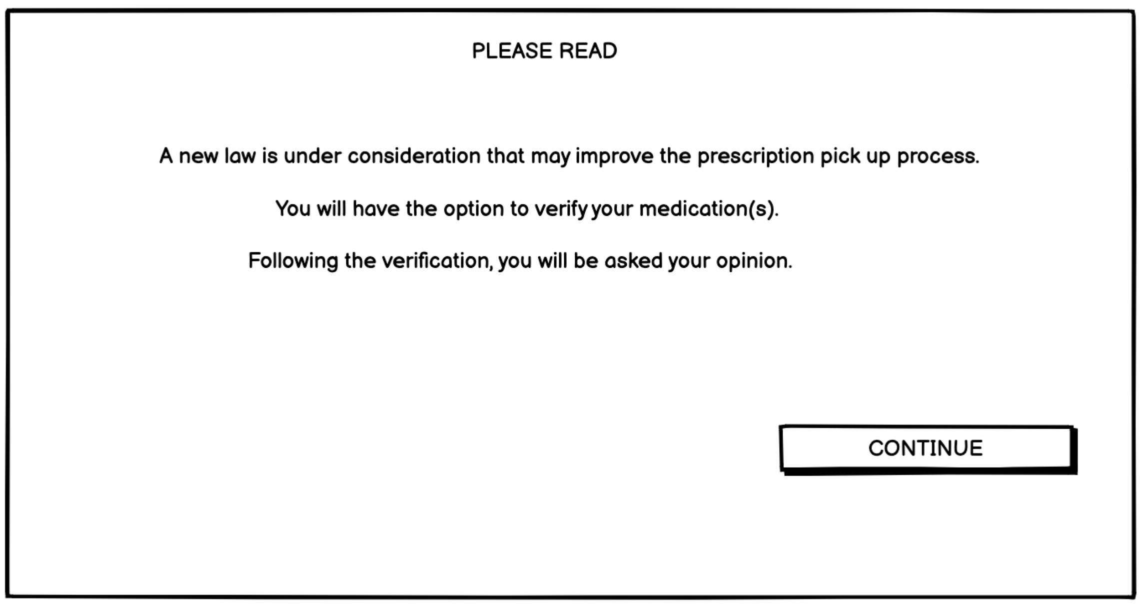
System Usability Scale Questions

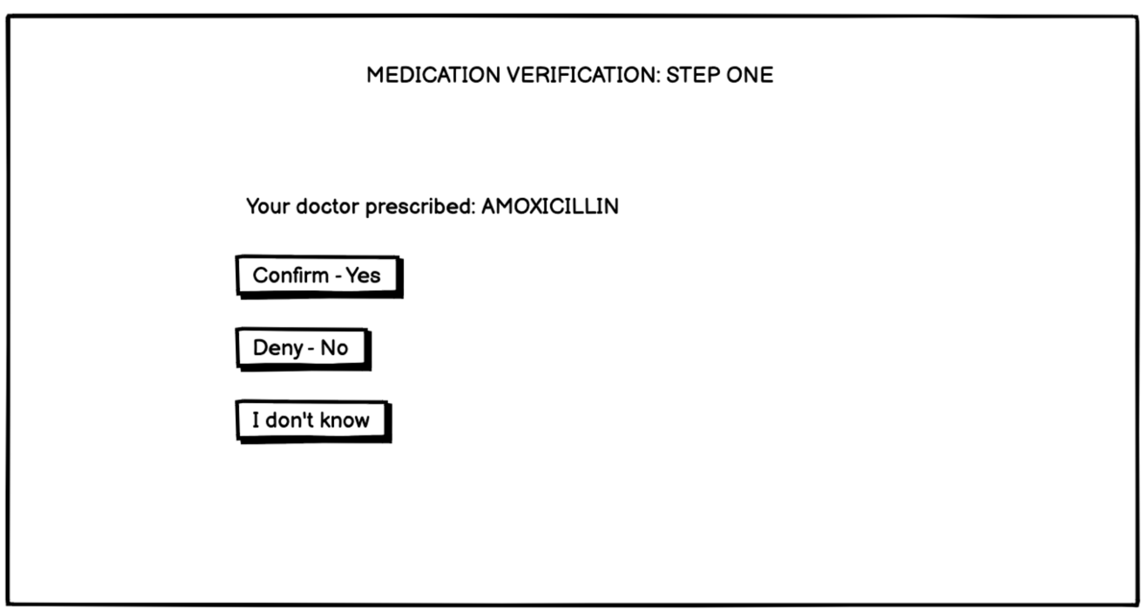
#	Question	Strongly Disagree				Strongly Agree
1	I think that I would like to use this system frequently	1	2	3	4	5
2	I found the system unnecessarily complex	1	2	3	4	5
3	I thought the system was easy to use	1	2	3	4	5
4	I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5	I found the various functions in this system work well integrated	1	2	3	4	5
6	I thought there was too much inconsistency in this system	1	2	3	4	5
7	I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8	I found the system very awkward to use	1	2	3	4	5
9	I felt very confident using the system	1	2	3	4	5
10	I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Appendix B

Potential Interactive Prototype Screens

Scenario: Medication given to the user matches what was presented on the prototype.





MEDICATION VERIFICATION: STEP TWO

Please confirm if the image and description below match the medication(s) you were given by the pharmacy.

Description: Round capsule, yellow

Yes, the medication I was given matches the details above.

No, the medication I was given does not match the details above.

Thank you for completing the medication verification process.

Please provide feedback below. We value your opinion.

1. Did you enjoy this process?

   Yes

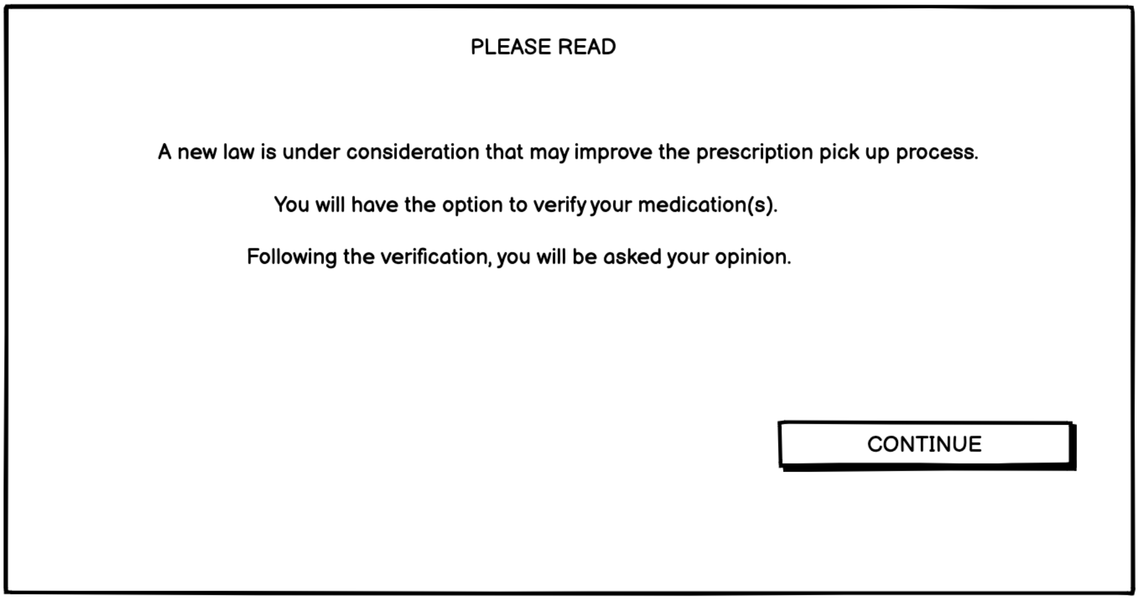
   No

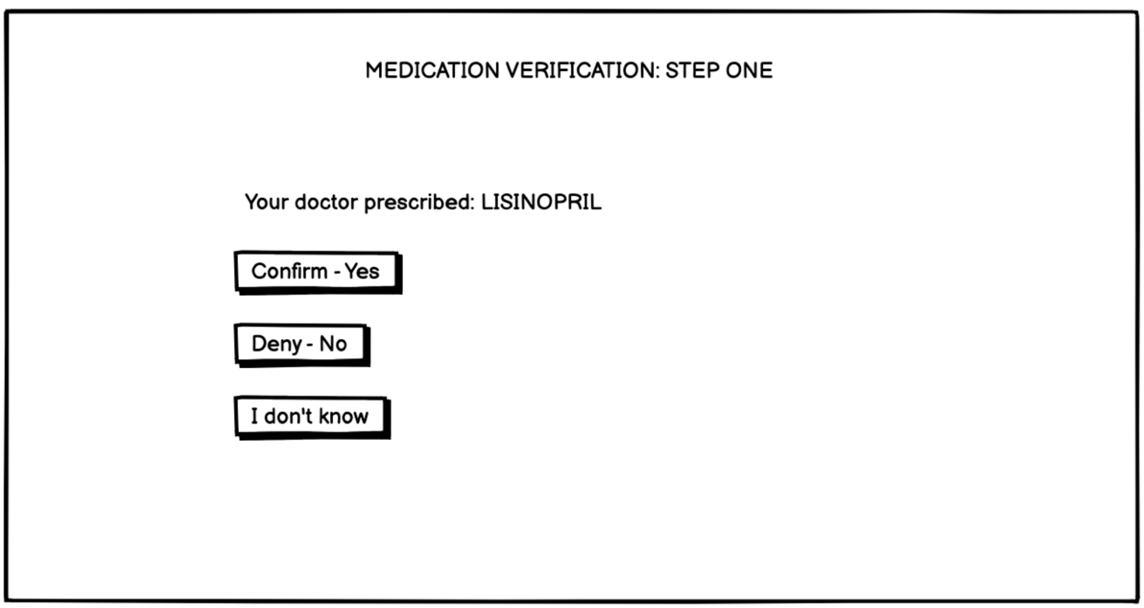
2. Did you find this process to be helpful?

   Yes

   No

Scenario: Medication given to the user did not match what was presented on the prototype.





MEDICATION VERIFICATION: STEP TWO

Please confirm if the image and description below match the medication(s) you were given by the pharmacy.

Description: Round tablet, pink

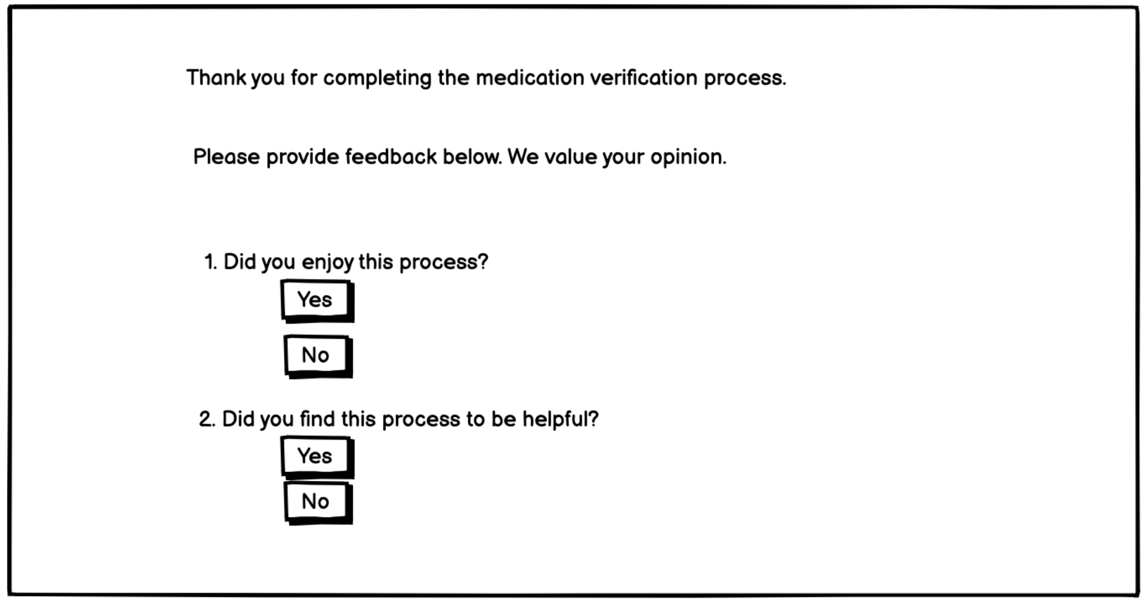
Yes, the medication I was given matches the details above.

No, the medication I was given does not match the details above.

You have indicated that the medication you were given does not match the details provided on the previous screen.

Please speak with the pharmacist to resolve the issue and get the correct medication.

Acknowledge and speak to pharmacist


Thank you for completing the medication verification process.
Please provide feedback below. We value your opinion.
1. Did you enjoy this process?
Yes
No
2. Did you find this process to be helpful?
Yes
No

Figures

Figure 1: Photo of CVS pharmacy counter with tablet – existing pharmacy hardware that would be leveraged to implement this system on.