CASE STUDY REDUCING PHARMACY MEDICATION ERRORS USING LEAN SIX SIGMA: A THAI HOSPITAL

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ABSTRACT

Medication errors in hospitals are expensive and have a negative impact on patient outcomes, morbidity, and death rates. Errors are more frequently the consequence of bad system design than of subpar healthcare personnel work. Process design should therefore be given special attention. This action research project looks at how Lean Six Sigma is used in a public hospital in Thailand to lower inpatient pharmacy dispensing errors. Between March 2018 and November 2019, the adoption of Lean Six Sigma successfully decreased monthly dispensing errors from 29 occurrences to 6 events over 14,000 total inpatient days. This was achieved through the use of numerous Lean Six Sigma tools, and improved patient safety. Lean Six Sigma tools used in this study were cause-and-effect diagrams, spaghetti diagrams, five-why analysis, project charters, brainstorming, control charts, and hypothesis testing. This case study can improve hospital manager and medical director awareness of Lean Six Sigma and its benefits relative to the prevention and reduction of medication errors.

Keywords: Lean Six Sigma; Quality Improvement; Patient Safety; Medication Errors; Pharmacy.

I.   INTRODUCTION

Over the past few decades, Lean Six Sigma (LSS) has been widely applied in the healthcare industry; nevertheless, it has not been applied to reduce errors in a specific area where mistakes can have life-threatening consequences: inpatient medicine distribution problems.

In order to bridge that gap, the current study shows how effective LSS application can be in lowering inpatient pharmacy prescription dispensing errors in a Thai hospital. Application of particular and widely used tools and methods was found to contribute in LSS define-measure-analyze-improve-control (DMAIC) phases where such methods have not previously been used in medication dispensing processes, whether inpatient or other medication dispensing contexts. This was a by-product rather than an intentional outcome of this demonstration.

Medication mistakes are recognized as a global problem by recent studies. Throughout the course of treatment, patients should be given the recommended drug at the appropriate quantities and concentrations on schedule. Errors in the prescription, transcribing, dispensing, administering, and/or monitoring of medications are considered medication process errors (Lisby et al., 2005; Baril et al., 2014). According to the World Health Organization (2016), 38% of individuals 75 years of age and older and 12% of primary care patients in the UK have prescription errors. 15% to 20% of prescription administration errors occur in Australia (Runciman et al., 2003), whereas 58% of prescription errors occur in Mexico (World Health Organization, 2017), primarily as a result of improper drug selection and dosing regimen. Medication errors continue to be a major concern for patient safety in Thailand's hospitals, despite multiple measures to safeguard patients, primarily because of insufficient hospital quality control systems (Limpanyalert, 2018). It is expensive to rectify the effects of medical blunders. For instance, in 2016, 885 patients and/or their families who had experienced the unfavorable effects of medical error received payments from the National Health Security Office, which paid an average of USD 7,200 per case (National Health Security Office, 2016).

The severity of the issue in Thailand is sufficient to warrant an in-hospital case study as a way to learn what works, what doesn't, and what parts of the solutions are transferable to other hospital pharmacies or other contexts; all while "doing well in real time."

When distributing medication, preparation and According to Weant, Bailey, and Baker (2014), administering medication to a patient follows a prescription or medication order. According to James et al. (2009), dispensing

is a complicated process where mistakes can happen at any point, from getting prescriptions or orders for medications to giving medication to a particular patient. Errors in the pharmaceutical sector could cause harm, death, or financial loss if they go unnoticed.

Since no previous LSS study has focused on reducing dispensing errors in public hospital inpatient pharmacy services, this case study is unique and significant. Rather, the majority of research on medication errors has concentrated on lowering errors related to prescription and administration (Kaosayapandhu, 2013). Despite the relatively low incidence of pharmaceutical dispensing errors, study into the discovery and application of pharmacy distribution system interventions and enhancements is warranted due to the potentially fatal effects (Crane and Crane, 2006). In order to answer the following research questions, this case study will look at how LSS and related tools and techniques are used and implemented:

(1) Is LSS appropriate for lowering medication mistakes in hospitals?

(2) What are the advantages, difficulties, contributing elements, and takeaways from applying LSS to lower prescription error rates?

(3) Which LSS instruments and methods that can be employed to lower medication errors?

LSS in Healthcare: LSS analyzes process flow and pinpoints waste's underlying causes in order to decrease variation and enhance process performance (Snee, 2010). When combined, Lean and Six Sigma produce greater results than when used alone because they increase consistency (Six Sigma) and speed up processes (Lean) (George, 2002; Salah et al., 2010).

Research indicates that Lean Six Sigma (LSS) can enhance intricate procedures, care quality, patient safety, and staff and patient happiness. The following characteristics set LSS apart from earlier quality improvement methodologies: 1) enhanced bottom line results; 2) a structured DMAIC approach; and 3) the integration of human factors (e.g., leadership and customer focus) and process improvement aspects (e.g., process capability and process management) (Antony, 2011). All extremely dependable and safe businesses (such as aviation and the US Navy) use LSS, a widely used and well-documented process improvement manufacturing technique (Dumitrescu and Dumitrache, 2011). Increased revenue and cost savings, improved key performance metrics, down operating costs and cycle times, and enhanced customer satisfaction are some of the main advantages of successfully implementing LSS in the industrial sector (Snee, 2010). According to Laureani et al. (2013), LSS has just as much of an impact on manufacturing as it does on healthcare. Although LSS was effectively implemented by the Commonwealth Health Corporation in 1998, other healthcare organizations, such as hospitals and healthcare functional areas, have since adopted LSS (Thomerson, 2001).

LSS in Reducing Medication Errors

This Taiwanese pharmacy department's successful use of LSS led to a 30% decrease in dispensing errors (Chan, 2004). In a different study, Esimai (2005) employed LSS in a mid-sized US hospital to reduce order entry mistakes from 0.33% to 0.14% while also cutting labor expenditures by $550,000 over a five-month period. In a similar vein, the implementation of LSS in a mid-sized US hospital resulted in an annual savings of $82,650 by lowering the quantity of missed doses and other hospital inpatient pharmacy errors (Hintzen et al., 2009). Over the course of four months, hospital transcription and order entry mistakes decreased by 90% as a result of the implementation of LSS in a US hospital context (Benitez et al., 2007). On the other hand, the use of LSS in Norwegian public health is presently in its young children (Antony et al., 2019).

In conclusion, effective LSS deployment has decreased pharmaceutical errors while simultaneously enhancing staff performance, patient safety, general satisfaction, and hospital profitability (Ching, 2013).

II.   RELATED WORKS

Related publication on reducing pharmacy medication errors

S. No.	Focus Area	Contribution	Reference
1.	The Journal of Clinical Pharmacology	Reducing medication errors and improving patient safety have become common topics of discussion for the president of the United States, federal and state legislators, the insurance industry, pharmaceutical companies, health care professionals, and patients. But this is not news to clinical pharmacologists. Improving the judicious use of medications and minimizing adverse drug reactions have always been key areas of research and study for those working in clinical pharmacology. However, added to the older terms of adverse drug reactions and rational therapeutics, the now politically correct expression of medication error has emerged. Focusing on the word error has drawn attention to "prevention" and what can be done to minimize mistakes and improve patient safety. Webster's New Collegiate Dictionary has several definitions of error, but the one that seems to be most appropriate in the context of medication errors is "an act that through ingnorance, deficiency, or accident departs from or fails to achieve what should be done." What should be done is generally known as "the five rights": the right drug, right dose, right route, right time, and right patient.	**David M Benjamin North-eastern University**
2.	Reducing medication errors for adults in hospital settings	included 65 studies: 51 RCTs and 14 ITS studies, involving 110,875 participants. About half of trials gave rise to 'some concerns' for risk of bias during the randomisation process and one-third lacked blinding of outcome assessment. Most ITS studies presented low risk of bias. Most studies came from high-income	**Agustín Ciapponi,corresponding author Simon E Fernandez Nievas, Mariana Seijo, María Belén Rodríguez, Valeria Vietto**

		countries or high-resource settings. Medication reconciliation –the process of comparing a patient's medication orders to the medications that the patient has been taking– was the most common type of intervention studied. Electronic prescribing systems, barcoding for correct administering of medications, organisational changes, feedback on medication errors, education of professionals and improved medication dispensing systems were other interventions studied.	
3.	Pharmacist-led educational interventions provided to healthcare providers to reduce medication errors: A systematic review and meta-analysis	Medication errors are avoidable events that can occur at any stage of the medication use process. They are widespread in healthcare systems and are linked to an increased risk of morbidity and mortality. Several strategies have been studied to reduce their occurrence including different types of pharmacy-based interventions. One of the main pharmacist-led interventions is educational programs, which seem to have promising benefits.	**Mojtaba Vaismoradi, Editor**

III.   RESEARCH GAP

Because of current constraints or unresolved issues in the literature, research gaps in the context of medication errors in pharmacies are topics that require additional investigation. Potential research gaps in this field include the following:

1. Impact of Workflow and Technology: Research is required to determine how medication errors are affected by various pharmacy workflows as well as the use of technology (such as barcode scanning, computerized prescription writing, and automated dispensing systems). More efficient mistake avoidance techniques may result from an understanding of how these components interact.

2. Human variables: Studies may look into how human variables, such as expertise level, workload, and distractions among pharmacists, affect prescription errors. Interventions targeted at lowering these risks can be informed by identifying particular factors that raise the probability of errors.

3. Categories Types and Frequencies of Errors: Future research might concentrate on classifying and measuring the many drug errors that happen in pharmacies. This covers mistakes relating to prescription interpretation, medication reconciliation, and communication breakdowns between healthcare practitioners in addition to dispensing problems.

4. Interventions and Their Effectiveness: It's critical to assess how well the existing initiatives working to lower prescription errors in pharmacies are working. Studies that compare and evaluate alternative approaches (such as educational initiatives, automated alarm systems, and double-checking practices) might shed light on the interventions that work best in particular pharmacy environments.

5. Patient Perspectives: There is a dearth of research on drug errors that takes patients' perspectives into account. Prioritizing treatments that enhance patient safety can be aided by having a thorough understanding of how patients view and are impacted by drug errors.

6. Effects of Regulatory and Policy Changes: Researching how new regulations, such as those pertaining to medication safety, affect the frequency of prescription errors in pharmacies might yield data that can help shape future practices and policy choices.

7. Health Disparities and Vulnerable Populations: Older patients, people with little health literacy, and patients who do not speak English are examples of vulnerable populations who are frequently ignored in research on drug errors. Targeted actions to lessen inequities can be informed by research on the pharmaceutical errors that different populations encounter and how they affect them.

8. Longitudinal Studies and Trends: Studies that monitor pharmaceutical errors over an extended period of time may be able to spot new trends or regions with consistently high error rates. Resource allocation and efforts towards continual improvement can be guided by this information.

By filling in these research gaps, we may advance our knowledge of pharmaceutical errors that occur in pharmacies and help create preventative measures that will improve patient safety.

IV.   OBJECTIVES OF THE STUDY

• To compare and contrast different pharmacist-led teaching programs offered to medical professionals and assess both the qualitative and quantitative effects on the rates of medication errors.

• To ascertain whether strategies aimed at lowering adult hospital medication mistakes are beneficial.

V.   METHODOLOGY

Using rigorous approaches, it is possible to identify the causes, effects, and potential remedies of medical errors in pharmacy. An overview of popular study approaches on medical errors in pharmacy is provided below:

1. Retrospective Chart Reviews: To find cases of drug errors, researchers look back at patient records. Prescription orders, dispensing records, and patient outcomes are reviewed in order to identify the types and frequency of errors that were made.

2. Prospective Observational Studies: In order to pinpoint possible mistake causes, researchers closely monitor pharmacy workflows and interactions between pharmacists, patients, and other medical professionals. This technique enables the collecting of data in real-time and can offer insights into the contextual elements causing errors

3. Studies on simulation: By simulating tasks and settings in pharmacies, researchers are able to examine how mistakes are made in controlled environments. Without putting patient safety at danger, simulation studies can be used to find weaknesses in procedures and evaluate how well interventions work.

4. Surveys and organized interviews with pharmacists, pharmacy techs, and other healthcare professionals can yield qualitative information on their perceptions of drug errors, contributing factors, and potential remedies. This approach facilitates comprehension of the organizational culture and human aspects associated with errors.

5. Quantitative Data Analysis: Pharmacy databases or mistake reporting systems can be statistically analyzed to determine the types, frequencies, and long-term trends of prescription errors. This method is crucial for finding trends and evaluating the effects of treatments.

6. Root Cause Analysis (RCA) is a methodical approach to examining the reasons behind certain drug errors or adverse occurrences. To stop recurrence, it entails figuring out the underlying causes, which could be human error, system malfunctions, or breakdowns in communication.

7. Human variables Analysis: This method aims to determine how human variables such as workload, exhaustion, distractions, and cognitive biases contribute to pharmaceutical errors. Human factors analysis frequently includes observational studies, task analysis, and usability testing of pharmacy technologies.

8. Systematic Reviews and Meta-Analyses: These methods combine existing research findings on medication errors in pharmacies to provide a complete picture of the present state of knowledge. Systematic reviews assist in identifying gaps in the literature and guiding future research objectives.

9. Quality Improvement Initiatives: Collaboration across healthcare teams to implement and assess quality improvement initiatives targeted at lowering pharmaceutical mistakes. These projects frequently entail repeated testing of treatments and outcome measurement in order to enhance procedures.

10. Mixed-Methods Approaches: Using both qualitative and quantitative methods can provide a more comprehensive understanding of pharmaceutical errors in pharmacies. For example, combining survey data with observational findings might provide information about the prevalence and underlying causes of errors.

Each of these procedures has advantages and disadvantages, and researchers frequently combine approaches to triangulate findings and improve the validity of their conclusions. Methodological decisions are made based on study objectives, available resources, and ethical considerations such as patient safety and confidentiality.

Research Methodology

This study employed the action research methodology to enhance the drug dispensing procedure. Five action research stages were followed by the project team, which included the head of the inpatient pharmacy, two pharmacists, and three pharmacy technicians: problem identification, reflection, planning action, taking action, and evaluation. The project team used the DMAIC methodology, applying certain LSS tools in each DMAIC step, during the taking action phase. Table 1 provides an overview of the DMAIC methodology procedure. Additionally, a survey instrument called a questionnaire was utilized to find out how satisfied the five patients were with the caliber of pharmacy services both before and after the LSS was put into place.
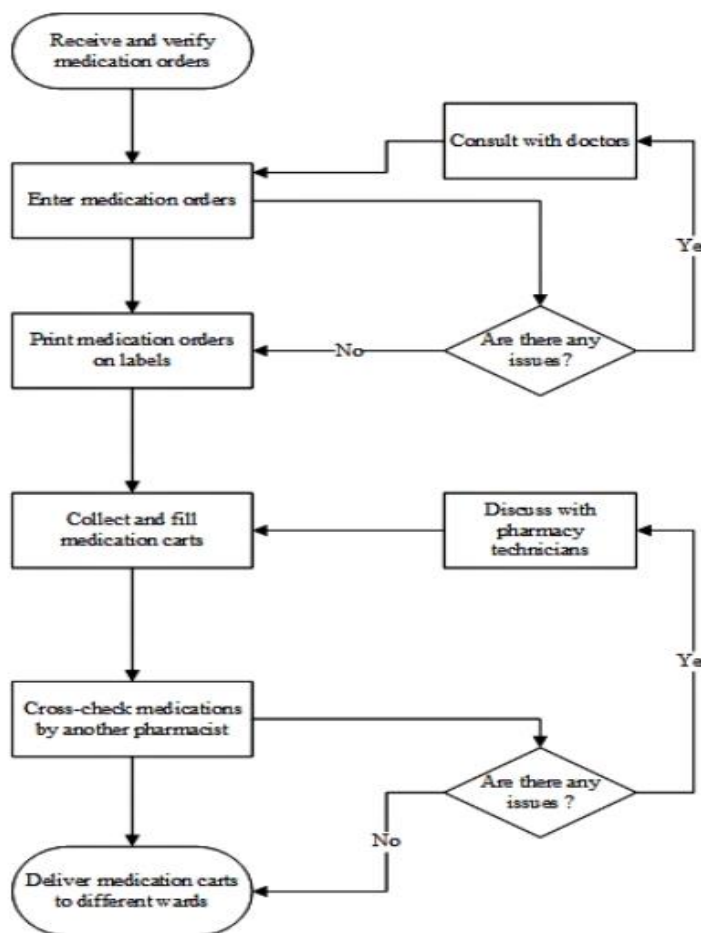
VI. FINDINGS

Reducing medication errors in pharmacies is an important topic of research and practice for improving patient safety and healthcare outcomes. The following are some major results and solutions for effectively reducing pharmacy medication errors:

1. Technology Implementation: The use of automated dispensing systems, barcode medication administration (BCMA), and computerized physician order entry (CPOE) has been demonstrated to drastically minimize medication mistake rates. These tools aid in eliminating transcription errors, assuring accurate medicine dosages, and enhancing communication among healthcare personnel.

2. Clinical Decision Support Systems (CDSS): CDSS incorporated into electronic health records (EHRs) notify and remind healthcare practitioners of potential drug interactions, allergies, and dosage problems. According to research, CDSS can help avoid drug errors by encouraging doctors to reconsider their Prescription choices.

3. Medication Reconciliation Programs: Using structured medication reconciliation processes during care transitions (e.g., admission, discharge, and transfer) helps to assure correct medication lists and eliminate discrepancies that can lead to errors. This entails comparing the prescriptions a patient should be taking with the meds they are now taking.

4. Educational Interventions: Educating pharmacists, pharmacy technicians, and other healthcare providers about medication safety principles and error prevention measures can help raise awareness and adherence to best practices. Educational treatments frequently focus on improving pharmaceutical labeling, storage, and dispensing standards.

5. Workflow Optimization: Streamlining pharmacy workflows and avoiding interruptions can reduce distractions and cognitive burden on pharmacists and technicians, lowering the risk of errors. This includes developing clear guidelines for medicine dispensing, verification, and counseling.

6. Improved Communication and Collaboration: Proper communication among healthcare providers, such as pharmacists, physicians, nurses, and patients, is critical for reducing drug errors. Effective communication ensures that medicine orders are transmitted correctly, clarifies patient information, and allows for timely action.

7. Quality Improvement Initiatives: Continuous quality improvement activities, such as conducting root cause analyses of errors, developing feedback mechanisms, and monitoring performance indicators, assist in identifying systemic issues and executing focused actions to reduce errors.

8. Patient Involvement and Education: Encouraging patients to actively participate in their medication management understand their prescriptions, and report inconsistencies or unpleasant effects will assist to reduce errors. Patient education programs emphasize drug adherence, prescription comprehension, and identifying potential side effects.

Overall, eliminating pharmacy drug errors necessitates a multimodal strategy that considers technical, educational, organizational, and systemic variables. Continuous monitoring, intervention review, and strategy adaptation in response to increasing evidence are critical to maintaining pharmaceutical safety improvements.

VII.   RECOMMENDATIONS

Reducing pharmacy errors necessitates a comprehensive approach that includes multiple strategies aimed at different stages of medicine use—from prescription to administration. Here are a few suggestions for reducing pharmaceutical errors:

Implement technology solutions:

Automated dispensing systems: medicine errors can be reduced by using automated dispensing cabinets or robotics, which ensure correct medicine counts and reduce manual handling errors.

Enhance Medication Reconciliation Processes:

Create established methods for medication reconciliation during care transitions (admission, transfer, and discharge) to ensure accurate medication lists.

Involve pharmacists in medication reconciliation efforts to confirm and reconcile discrepancies between prescribed drugs and what patients are taking.

Use Clinical Decision Support Systems (CDSS):

Integrate CDSS into electronic health records to deliver real-time alerts and reminders about potential pharmaceutical problems, such as drug interactions, allergies, and dose errors.

Customize CDSS to accord with evidence-based standards and local formularies to improve medication safety.

Promote Medication Safety Culture:

Foster a safe culture within the pharmacy by fostering open communication, disclosing errors without fear of repercussions, and learning from mistakes.

Implement ongoing safety training and instructional programs for pharmacists, pharmacy techs, and other staff members on error prevention measures and best practices.

Improve communication and collaboration:

Improve communication lines between prescribers, pharmacists, nurses, and patients in order to explain prescription orders, check information, and respond to inquiries or concerns quickly.

To avoid misunderstandings and errors, use established communication tools and protocols (for example, read-backs and vocal order explanation).

Standardize processes and workflows:

Create and execute standard operating procedures (SOPs) for drug dispensing, compounding, and administration in order to eliminate variability and ensure consistency in practice.

Streamline workflow processes to reduce disruptions and distractions.

Stay current with evidence-based practices:

Stay up to date on current pharmaceutical safety research, recommendations, and best practices in order to continually enhance pharmacy operations and prevent errors.

Participate in professional development programs, conferences, and collaborative projects that promote pharmaceutical safety and mistake prevention.

Implementing these suggestions necessitates commitment from pharmacy leadership, coordination among healthcare team members, and a proactive approach to regularly analyze and improve prescription safety standards. Pharmacies may drastically reduce medication errors and enhance patient outcomes by implementing technological solutions, standardized operations, good communication, and patient participation.

VIII. CONCLUSION

- The use of ADCs has made closed-loop computerized drug management systems more integrated, from prescription to administration. While the ADC system dramatically reduced drug errors, it did not remove the possibility of human errors. Multidisciplinary collaboration, education, and training initiatives are needed on a systemic level to improve pharmaceutical safety even more.

- Compared to standard care, medication reconciliation, electronic prescribing systems, barcoding, and professional feedback may minimize ADEs, medication errors, or both. Nonetheless, the optimum ways to administer these interventions, as well as the effectiveness of other interventions, remain unclear.

- The health-care community must acknowledge that pharmaceutical errors are caused by both individuals and systems. The emphasis should be on identifying error-prone areas of the pharmaceutical use continuum, with the goal of increasing system safety and dependability through corrective actions. Neither making nor reporting an error should be grounds for disciplinary or punitive action by an employer. Every error should be investigated to determine what system components caused it to occur. This allows individuals in charge of health-care systems to learn from mistakes and determine what changes are required to avoid such mistakes in the future.

- Medication error reduction programs are required to improve patient care and meet the public's need for a safer healthcare system. Consumers want a trustworthy system that will serve them effectively and not put them in danger when they require medical treatment. They want and deserve to have faith in the safety of the healthcare system. Those who pay for health-care services (the government, businesses, and individuals) would gain from cost savings as a result of fewer adverse events caused by drug errors.

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