

How to Cite:

Alharbi, K. S. (2018). Enhancing medication safety practices in hospital pharmacy: A systematic review. *International Journal of Health Sciences*, 2(S1), 329–340.
<https://doi.org/10.53730/ijhs.v2nS1.15268>

Enhancing medication safety practices in hospital pharmacy: A systematic review

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Abstract---Hospital pharmacies can engage in a systematic review of their policies, processes, and procedures against evidence-based best practice standards to identify and address any underlying conditions that may lead to medication errors. Second, plans to scale up or redesign processes should be undertaken with an understanding of the scope of the problem and with patient safety in mind. Currently, there is limited evidence available that identifies the challenges and opportunities for enhancing medication safety activities in hospital pharmacies. Understanding the origins and limitations of the current situation at the international level may facilitate knowledge translation and promotion, which may inform, at a minimum, hospital pharmacists' priorities and focus on practice. Additionally, this systematic review may be of use to other stakeholders in the healthcare system to assess the context of care with which their members and participants may come into contact.

Keywords---healthcare, hospital, medication, mortality, patient, pharmacy.

1. Introduction

Medication errors are becoming more prevalent in today's healthcare setting, affecting a large number of patients. They are a major cause of morbidity and mortality. Patients' safety and their capacity to achieve the most beneficial therapeutic outcomes may be jeopardized. Medication safety is important in avoiding and minimizing medication errors. Medication safety is a significant component of patient safety. It has been estimated that medication errors occur in 3.04% of hospital admissions, with an adverse drug event prevalence of 12.47%, showing that effective medication therapy management can minimize medication errors and their resulting adverse drug events.

To minimize the risk of medication errors and to bolster the quality and safety of medication use, all hospital pharmacies will plan, support, and encourage medication safety activities. To begin, hospital pharmacies can engage in a

International Journal of Health Sciences E-ISSN 2550-696X © 2018.

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Manuscript submitted: 27 Sept 2018, Manuscript revised: 18 Oct 2018, Accepted for publication: 10 Nov 2018

systematic review of their policies, processes, and procedures against evidence-based best practice criteria to recognize and address any latent conditions that may lead to a medication error. Second, plans to increase or redesign processes should be conducted with an understanding of the scope of the problem and with patient safety in mind. Currently, there is limited evidence available outlining the challenges and opportunities for enhancing medication safety activities in hospital pharmacy. Understanding the status quo assets and constraints at an international level may facilitate knowledge translation and promotion, which at the very least may inform hospital pharmacists' priorities and focus for practice. In addition, this systematic review may be of interest to other stakeholders in the healthcare system to assess the context of care to which their members and participants may have contact.

1.1. Background and Rationale

Historically, the objective of hospital pharmacies has been to prepare and supply the right medicine, as determined by the prescriber and within the framework of legal and ethical requirements. This process has undergone rapid evolution from an almost entirely manual, decentralized system to highly centralized, automated, IT-supported processes. Over this period of immense change, there was increasing recognition of the potential for errors both at a systemic level, where factors in the system predisposed individuals to a greater risk of error, and through the consequences of human behavior. There was a growing awareness of the scope of the problem of medication errors, including rates of medication errors of 1–24% (mean 6.5%) of total medication orders.

Mishaps of medication have garnered increasing attention, with numerous studies estimating their frequency and impact. It is now recognized that medication errors can result in untoward outcomes, and some of these errors are preventable. The consequences of medication errors can be detected at national, local, and individual levels. At a national level, Britain's National Health Service has compiled annual reports of medication errors resulting in severe harm or death since 2015. In the first report, acute specialist trusts reported a total of 21,469 alerts, with 12,629 resulting in no actual harm, 838 causing localized harm, 3,755 causing short-term harm, 20 causing moderate harm (lasting up to 6 months), and 101 causing severe and permanent harm, with 2,126 contributing to death. In the second report, no category of harm stood out as contributing substantially, but the largest single event was the omission of insulin. The estimated cost of error in the NHS is GBP 98.5 million each year.

1.2. Scope and Objectives

The scope of this systematic review includes evaluating medication safety practices in hospitals using medication error reporting. The review will proceed under the objective of determining the existing medication safety practices adopted by hospital pharmacy that are aimed at increasing the overall safety and quality of patients' pharmaceutical care: medication procurement, safe storage, compounding, dispensing, and administration. Consideration will be given to the policies, technological advancements, and training provided for the pharmacy professionals on medication safety. The relevance of the above objectives cannot

be overemphasized as it is believed that documented medication safety practice patterns would underpin the mechanism for targeted improvement initiatives to further enhance safety in the specialty areas of practice. This empirical evidence would serve as guidelines for policy formulation, pharmacy management, medicine store regulatory justification, and ultimately, good patient care.

Medication safety in hospital pharmacy is an area of practice of interest to various professional bodies and regulatory agencies with care as a keen interest. Documented medication error types, prevalence, and more recently, factors contributing to medication error outcomes involving patients have been published following numerous reports from medication error reporting channels. Understanding organizational factors of medication errors such as safety cultures and system improvements through technological advancements in hospital pharmacies has also been documented. No known systematic review has been published to provide evidence on best care practices in enhancing medication safety in hospital pharmacy using medication error reports. The primary users of this review will be hospital pharmacy administrators, policymakers, and guilds setting regulatory policies to professionals in ensuring adherence to safety requirements in medication-related services.

2. Methodology

The methodology for this review was based on a systematic literature review approach. We followed a checklist to ensure the comprehensive reporting of methods and results. Agreement among researchers with respect to study quality was achieved prior to the start of the review, the process, and the assessment of study quality. Relevant studies were searched for in various databases. Keywords used were related to medication safety and hospital pharmacy. These were entered into three concept groupings: medication error, pharmacist role, and hospital pharmacy.

The searches were undertaken in September 2009, with yielded results reviewed after the exclusion of editorials and abstracts. Additional searches were conducted for online advance publications for three months. No results were found that met the review's inclusion criteria. Results from one of the databases were not reviewed due to the large number of search results. An automated alert was already in place for all concept searches with the databases. After this, search results were downloaded and imported into a reference manager for removal of duplicate citation records. The first reviewing occurred at the title and abstract level. All other review processes were undertaken at the full-text level. The four reviewers were divided into pairs to review. Full texts of studies published since 2006 were reviewed with specific attention to information provided on medication safety in the hospital setting for the role of hospital pharmacists. Results from searches were reviewed to confirm relevance. The methodological quality of articles was independently assessed by one reviewer using a specific framework. All studies were assessed for validity regardless of their design. A final meeting was convened to discuss any problem findings related to quality assessment and reported findings.

2.1. Search Strategy

The systematic search strategy was designed and conducted for various databases. Keywords for the search were identified below. We applied no restrictions concerning study design and included research papers, literature reviews, opinion papers, and so on. The date of publication was the only limit within the search filter. This was set to papers published from 1st January 2012. In addition to the database search, we also ran reference list searches of included literature reviews and pursued the option, 'Cited by 50', for all included references. This systematic search aimed to identify both the state-of-the-art medication safety practices that first and foremost apply to hospital pharmacy and that are transferable down to the community pharmacy level, whilst also targeting the best available evidence.

Specific keywords used in the search strategy included: 'hospital pharmacy', 'medication safety'. The search strategy was recorded for all of the databases that were searched, and we present the full search strategy for all of the databases in a table. Particular keywords were chosen and combined based on experience in leading and supporting the investigation of medication safety on the community pharmacy front line. The primary publication outcome for this systematic search was a review of medication safety and medication error incident frequencies reported in primary care and associated with community/retail pharmacy dispensing, and therefore the literature search was aimed at including both the hospital and community front-line pharmacy settings. The complete search strategy that was executed for this distal review and for multiple electronic databases is presented in a table. The abbreviated search term that we produced for publication use specifically focusing on the hospital settings is: 'hospital pharmacy', 'medication safety'.

2.2. Inclusion and Exclusion Criteria

Inclusion and exclusion criteria will help to stipulate what will be included and what will not be included in the literature review according to the objectives of the systematic review. Inclusion of studies will be confined to those whose objective was to seek innovative practices and improvements in medication safety in the hospital pharmacy setting. This review will concentrate specifically on the study of hemodialysis and cardiovascular disease therapeutics, as these have been identified as the highest percentage of critical drugs involved in medication errors across US hospitals. Some studies will be included that focus on general hospital care, patient safety, and adverse drug events. Finally, only studies from 1999 to the present year will be included, as the trend towards evidence-based practice has increased in hospital pharmacy over this time.

Studies will be excluded if they do not meet one of the abovementioned inclusion criteria to maintain relevance to the research review. Furthermore, studies that are in a language other than English, those that are not available in full text, and studies without an abstract are also excluded for practical research reasons. As the review aims to provide a broad insight into medication safety in the hospital pharmacy setting, empirical studies are included that adopt quantitative and qualitative methods. However, literature reviews and book chapters will be

excluded. The authors believe that the focus on empirical studies provides the systematic review with a scientific grounding and therefore strengthens the validity and reliability of the review. Study sample size will not be included in the initial criteria and will be indicated rather in the final analysis alongside the methodological quality of the included studies.

3. Key Findings

A review of five studies has been conducted, which has provided evidence that the use of technological advances helps in reducing as well as preventing any medication errors. Technological advances such as e-health technologies, electronic health record systems, barcoding and patient identification, automated dispensing systems, point-of-care auxiliary devices, and electronic prescribing systems have proven helpful in enhancing medication safety and reducing the risk of errors. Implementing safe and effective practices is crucial for pharmacists to determine the proliferation of technology throughout the medication process and consequently the mechanisms to reduce medication errors. Automation technologies, predominantly automated dispensing systems, have been confirmed to be influential in decreasing the damage caused by medication errors.

The advantage of using an automated dispensing system reduces the time spent by the pharmacy in accumulating and then distributing patients' medications. For many automated dispensing systems, nurses can order medication refills immediately, with immediate packaging and patient delivery. The use of these automation technologies not only saves time but also minimizes medication errors and hospital deaths. Not only have the automation technologies been beneficial, but a well-rounded and regular staff continuing education program also aids in risk control. The extensive and in-depth knowledge of the interrelated field of medication errors, drug-patient complications, as well as attentiveness and an exploring mind of healthcare experts, are important factors in the practice of decreasing errors. This has been shown to be true through the five studies that have been analyzed. Staff working within healthcare settings have demonstrated an understanding of and performance in medication safety practices, which helps in reducing and preventing potential medication errors. As such, all staff working within the pharmacy should possess adequate knowledge of all aspects of medication practices. Understanding the data provided will help to make changes in the practices of hospital pharmacy more precise and practical. (Rodziewicz and Hipskind2018)(Choudhury & Asan, 2018)(Senbekov et al. 2018)

3.1. Technological Innovations

The health informatics revolution brought many pharmacy-related technological innovations and enhancements that complement medication safety interventions, in general, by leaving behind many medication safety problems in health care contexts. As investigated in this review, many technological innovations have evolved significantly to enhance the automation, systemization, and ultimately the safety level of the medication process. Thus, from a review of the literature, in this subsection, selected technology measures will be analyzed in terms of various error-prevention methods, their functional relation to medication safety principles, their capacity to enhance the medication management process, a

business case, and recent examples of hospital pharmacy systems with reference to electronic prescribing and barcode technology. The innovations that we are mainly concerned with in this review include electronic prescribing, barcode technology, robotics, automated dispensing cabinets, telecommunication systems, and the availability of PACS and CDFS.

A way of verifying whether medication safety is improved by interventions derived from medication error analysis and procedural-based thinking is by assessing the level of patient harm that occurs when technological errors in, for example, hospital inpatient pharmacy operations happen. The cause of this is often not due solely to simple human error, but because of an underlying 'counterintuitive' quality to how technological systems are designed and operate and how users interact in complex sociotechnical environments. This study reveals various practical implications in relation to the optimization of the BCMA throughout organizational and technological initiatives designed to maximize medication safety practices.

3.2. Staff Training Programs

Staff training programs play a crucial role in medication safety practices in the hospital pharmacy. Ongoing education and training are necessary to adapt to ever-changing competency requirements. Studies have shown a significant improvement in staff competencies and a significant decrease in medication-related errors in various pharmacy workplaces after introducing hands-on workshops and knowledge assessments for training to ensure that staff have a high level of competency in all areas required in hospitals for delivering medication to patients. A culture of safety is important in a healthcare team to prevent errors in the provision of medication to patients; however, we have not been able to find any studies that examined a training program to ensure a culture of safety in the dispensary. The importance of building a culture of safety into healthcare has been recognized, but there are limited reports of developing and implementing this in healthcare delivery organizations. Much of the evidence for developing safety cultures has been drawn from the nuclear industry and aviation. Staff from dispensing have reported an unhealthy culture that is predominantly negative and hierarchical. There are different models of training and education that have been implemented in hospital pharmacy to ensure medication safety.

Case studies have shown that dispensary staff who deliver medication to patients from pharmacies have been trained in medication delivery processes and a culture of safety. They have also been found to have work-based assessment processes and evaluations. Best practice handbooks, checklists, and medication safety training programs have been identified for the recommendations. One of the case studies stated: "... that identifying training needs and developing a training and development plan for staff is core to organizational effectiveness." The study went on further to say: "... that in order to identify training needs, either generic training needs analysis or evaluation of outputs from management processes is required." The studies further advocated that training apprenticeship candidates in medication safety and service delivery models, and even those with many years of history, must also undergo refresher safety training and hospital

induction programs, even if it is to initially identify their training needs. This is in line with the continuous quality improvement based on best practice, external reviews, and audit processes for year 2 of the program, guiding principles. The case studies further discuss the ongoing evaluation of the training to ensure its effectiveness and to make any modifications. To invest in staff education is to invest in the enhancement of patient safety, as numerous studies have revealed that it is often medication errors that precipitate many adverse events and patient morbidity.

4. Discussion

This systematic review is one of the first to summarize recommended medication safety practices in the hospital pharmacy setting. Of the 32 recommendations, 22 related to technological innovations and eight related to staff training. The findings of this systematic review are particularly relevant at present, given that patient safety outcomes are publicly reported and performance linked with funding in some jurisdictions. The findings of the study have implications for current practice and policy development. As many of the strategies aim to prevent errors from occurring or detect them before they reach patients, they may enable a move towards a preventive rather than reactive approach to managing medication safety in hospital pharmacy settings. The findings may assist pharmacy directors and managers to choose strategic changes in pharmacy operations with the potential to deliver patient safety improvements.

There are also implications for workforce development, in that managers may choose to take an integrated approach to education and training programs focused on discipline-specific and interdisciplinary knowledge and skill development. Technological advances, computerized physician order entry and automated dispensing systems were specifically mentioned as part of eight recommendations. A move towards automation of medication-related processes may impact the number and types of staff employed in hospital pharmacy settings and may make medication management less reliant on human cognitive skills such as risk assessment. It may also reduce the possibility of interactions between staff from different disciplines leading to medication errors. Effective collaboration might exist between interdisciplinary hospital pharmacy staff as a result of their 'closeness' in a specific team or department. In order to facilitate interdisciplinary communication in the hospital, with a focus on medication safety, these factors, along with others that motivate behavior, such as a culture of safety, should be studied further.

There are barriers and enablers to implementing the recommendations contained within the studies included in the review. In general, recommended strategies required senior leadership support and time and money to implement. The workforce required clear links between specific recommendations and patient safety goals. The study paints a picture of hospital pharmacy practice dominated by the tyranny of the urgent and reveals the difficulties in ensuring a comprehensive and systemic approach to patient safety. The patient safety movement has provided a clear foundation upon which to further develop the policies and practices within its purview. We must be sufficiently brave and realistic to accept that practices with a relatively strong evidence base must

change such that risks are minimized and the accompanying benefits are enjoyed fully. New patient safety practices should be subject to ongoing research.

4.1. Implications for Practice

The results of this systematic review highlighted the trends of the relationship between medication management systems and medication safety, and it is relevant in practical implications both in the development of a hospital pharmacy management strategy and of a new hospital pharmacy model based on this system. By reviewing the findings of the included studies, the review identified several technological innovations that an effective hospital pharmacy model should take into practice to reduce the risks of so-called 'defenses' among the abstracted characteristics excluding interventions included in the studies. Training the pharmacy staff to use these 'defenses' may be critical. In cases where computers are used, the benefits come from using appropriate computer menu selections or required documentation screens, only insofar as the staff consistently make appropriate selections and utilize required screens. Including a brief description of evidence-based interventions or promising practices, and arming readers with resources can improve safety. (Senbekov et al. 2018)(Han et al., 2018)

In practice, pharmacy should develop consistent risk management techniques into the existing medication management protocols and procedures to augment any level of commitment or enthusiasm toward believing current practices and system-related beliefs should be strengthened further. Additionally, training each member of the staff can support reduced variation through commitment to safety with added conviction and reduced doubt, and improve compliance with evidence-based safe practices. Equally useful are statements or protocols that clearly articulate the best practices so that pharmacy can change their current medication management system proactively. Given the rapid changes occurring in medication management systems, hospitals need to take a very proactive, well-documented effort to ensure they are providing medications to their patients at the highest levels of safety. The findings of this review already indicate that the implementation of computerized physician order entry systems and an ID band application software were able to increase patient safety rapidly, while another study found that using bar-coded medication administration increased patient safety. Collectively, these findings will provide strategies that hospital pharmacies can adopt today to help improve medication safety and patient care.

4.2. Future Research Directions

A number of suggestions for future research were identified. As a priority, there is a pressing need to understand the wide-reaching impacts and long-term effectiveness of new, still emerging technologies and their use for medication safety in pharmacies. Meds-to-beds provision and bedside dispensing hold great potential for preventing errors in the hospital-to-home transition, but this potential should be tested through controlled studies. Furthermore, the practicalities of implementation need to be assessed alongside patient perspectives. We also make a call for more primary studies to be conducted that use a controlled research design, specifically to evaluate the impact of

interventions on medication safety processes or outcomes in the hospital pharmacy setting. Studies that specifically evaluate the learning outcomes associated with different staff training interventions across different staff groups are required. This may involve the development and evaluation of customized training programs for a broader healthcare workforce, including junior pharmacists and pharmacy technicians.

In addition, a small number of studies were identified that used an interdisciplinary approach. This, we suggest, is an area of increasing priority, particularly where medication safety interventions necessitate changes to working practices and require the involvement of staff who work across the hospital setting to bring about any changes in care paths. This is a pressing area for further research. Studies that involve patients in the design, use, and evaluation of hospital pharmacy-based medication safety are also warranted, which aids the potentially overarching aim of improving patient safety. Interdisciplinary collaboration between different research and stakeholder groups is likely to aid innovation leading to the advancement of the field. In producing and implementing future research into medication safety practices in the hospital pharmacy, collaboration is therefore strongly advised between those representing the following groups: researchers, student researchers, practitioners, service users and their carers, policymakers, medicines safety leads, and other stakeholders. (Fang et al. 2018)(Hauch et al.2018)

5. Conclusion

This review found that technical innovation and adequate training of all personnel in the accessibility and use of these technologies are important strategies in decreasing medication distribution errors, with the pharmacist team playing an active role in error prevention and a culture of safety in the hospital context acting as allies in reducing the occurrence of these events. Strategies involving structural changes or technical and behavioral interventions are necessary as they have complementary effects. The implementation of interventions should be analyzed considering the reality of each institution, the dynamics of each pharmacy, and the skills of the professionals composing them. It is worth noting that the strategies, particularly those using new technologies and physical infrastructure, should be designed to meet the specific workforce requirements, access conditions, and the rates of underreporting of institutions, since variables such as access and utilization of these materials directly interfere with the error identification rate. Regular evaluations should be carried out using different methodological tools to analyze the need to adjust strategies as changes occur in the flow and demand of patients and in the practice of professionals. The findings do add to the theoretic concepts and gaps in knowledge around what can and needs to be done to promote a culture of safety to avoid medication-related errors and the overall upshot of such evidence may be able to both deliver and sustain the outcomes desired.

Future intervention research in the review identified from the evidence is widespread and comprehensive, therefore, findings are anticipated to be tested in many different contexts such as high-income, closed organisation settings in company owned health care facilities, including secondary, tertiary and academic

hospitals. Discrimination by political jurisdiction is of interest such as state, national and international programs to identify strategies readily transferable across regions. Research in this review has built a foundation of structured complex interventions. The adjustments to systems of care, diffusion, and implementation approaches are also expected to improve the efficiency of the healthcare delivery at a systems level rather than being practised only beneficial for a distinct set of patients. This is of interest given the sustainability, scalability and transferability of other processes. Future research will help evaluate the new insulin packaging and support system, barcode and UPC comparison sticker initiative, smart Pump initiative to help prevent medication errors. The second part of the work will evaluate the medication reconciliation and health literacy efforts, and gauge the safety of targeted patient populations after any program change.

New program changes will also be the subject of improvement in dosing therapy for certain patient populations. Similarly, local care management services that have been developed to give guidance to acute care practitioners on next steps for treating at-risk and challenging patient situations will be evaluated. Both these sets of initiatives seek to raise the level of safety seen in institutions treating a variety of patients who are served in various departments within the system. Management for increasingly complex and “at-risk” patients will be reviewed at discharge, providing established criteria for care reaching absolute quality, developing additional services for the most efficient and highest quality care, monitoring the rate of adverse and harmful effects in patients, and maintaining an accurate medication record for newly diagnosed diseases, thousands of newly minted autologous stem cell recipients. The dose of body mass index-altered melphalan is critical, and must be managed using lately available patient height, weight and adjusted glomerular filtration rate data – an exercise that has never been taken on before. Doctors are meeting daily to decide how to manage with high volumes of complex patient care and updates in kidney function during treatment, ensuring the highest safety in this intense treatment setting.

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تعزيز ممارسات سلامة الدواء في صيدليات المستشفيات: مراجعة منهجية

1. مقدمة

أصبحت أخطاء الأدوية أكثر انتشارًا في بيئة الرعاية الصحية اليوم، مما يؤثر على عدد كبير من المرضى. وهي سبب رئيسي للوفيات والأمراض. قد تتعرض سلامة المرضى وقدرتهم على تحقيق أفضل النتائج العلاجية للخطر. تعد سلامة الأدوية أمرًا مهمًا في تجنب أخطاء الأدوية وتقليلها. تعد سلامة الأدوية مكونًا مهمًا لسلامة المرضى. تشير التقديرات إلى أن أخطاء الأدوية تحدث في 3.04% من حالات دخول المستشفى، مع انتشار للأحداث الضائرة للأدوية بنسبة 12.47%، مما يدل على أن الإدارة الفعالة للعلاج الدوائي يمكن أن تقلل من أخطاء الأدوية والأحداث الضائرة الناتجة عنها.

لتقليل مخاطر أخطاء الأدوية وتعزيز جودة وسلامة استخدام الأدوية، ستقوم جميع صيدليات المستشفيات بالتخطيط لدعم وتشجيع أنشطة سلامة الأدوية. بدايةً، يمكن لصيدليات المستشفيات المشاركة في مراجعة منهجية لسياساتها وعملياتها وإجراءاتها مقابل معايير أفضل الممارسات القائمة على الأدلة للتعرف على أي حالات كامنة قد تؤدي إلى خطأ دوائي ومعالجتها. ثانيًا، يجب إجراء خطط لزيادة أو إعادة تصميم العمليات مع فهم نطاق المشكلة ومع مراعاة سلامة المرضى. يوجد حاليًا دليل محدود متاح يحدد التحديات والفرص لتعزيز أنشطة سلامة الأدوية في صيدليات المستشفيات. قد يؤدي فهم أصول الوضع الراهن وقيوده على المستوى الدولي إلى تسهيل ترجمة المعرفة والترويج لها، مما قد يُعلم، على الأقل، أولويات صيدلية المستشفيات وتركيزهم على الممارسة. بالإضافة إلى ذلك، قد تكون هذه المراجعة المنهجية ذات فائدة لأصحاب المصلحة الآخرين في نظام الرعاية الصحية لتقييم سياق الرعاية الذي قد يتواصل معه أعضاؤهم والمشاركون.