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Global Trend in Medication Safety Tools and Technologies: Scoping Review

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ABSTRACT

Background: Patient safety is a practice that focuses on preventing, reducing, and avoiding injuries that can occur to patients during medical care. One of the efforts is the safety and monitoring of drugs to ensure safety standards for patients. Medication errors are a significant patient safety problem and a critical indicator in assessing patient safety. The development of technology and informatics in nursing can help prevent medication errors. Objectives: To identify the tools used to address medication safety. Methods: Literature review using the PRISMA model approach. The analysis included articles from seven electronic databases published in the last five years. Results: 54 articles were collected and 15 relevant articles were selected. These studies are compiled from various countries and describe the tools used in implementing medication safety. Conclusion: The tools and technologies found can help medicinal programs and prevent errors in the care and administration of drugs in various hospitals worldwide.

Keywords: Medication Error Tools, Patient Safety

1. INTRODUCTION

Patient safety aims to avoid medical errors that could endanger patients while they are receiving treatment (Janmano et al., 2018). Risk assessment, patient management and identification, incident reporting, and risk-reduction solution implementation are all included in this. Accurate patient identification, efficient medical staff communication, safe medication use, enhanced surgical safety, decreased risk of infection, and decreased risk of patient injury from falls are the six target indicators for improving service quality in the context of patient safety (PERMENKES NO. 11, 2017).

Medication errors seriously threaten patient safety (NCCMERP, 2020). Medication errors include Errors in the prescription, distribution, administration, and monitoring of medications, as well as errors in the treatment process. These errors, which frequently happen during the drug administration process, can negatively affect patients. Medication errors are a global problem that can cause detrimental side effects for patients, even death. Inadequate communication with patients, mistakes made by nurses when administering medication, and disregard for the “six rights” to medication are some factors contributing to medication administration errors (Janmano et al., 2018; PERMENKES NO. 11, 2017).

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Medication errors are a global issue, particularly during the crucial drug administration phase of patient care (Jember et al., 2018). Every year, at least 1.5 million preventable medication errors happen in the US (PERMENKES NO 11, 2017). Medication errors in Australia happen during the administration stage in 9% of cases (Hines et al., 2018). While information about medication administration errors in Indonesia is still opaque, a 2010 report stated that medication administration errors reached 11.11%, ranking third after patient falls (Indra Cahyani, 2007 in Tampubolon & Pujiyanto, 2018)

Several tools and systems have been developed in medical practice to prevent medication errors. These include Electronic Health Records (EHR), Barcode Medication Administration (BCMA), Automated Dispensing Cabinets (ADC), Clinical Decision Support Systems (CDSS), Smart Infusion Pumps, Medication Reconciliation Tools, and Electronic Prescribing (e-prescribing). These instruments work together to lower the possibility of medication errors and improve patient safety during medical treatment, especially when combined with appropriate training for healthcare professionals. The authors of this study are looking at these tools in the context of reducing medication errors and enhancing patient safety.

This Research do provide information on the use of technology and tools to improve medication safety, including the use of clinical decision support, electronic health records, and artificial intelligence. The results also highlight the need for guidelines, standard operating procedures, and risk assessment tools to improve medication safety.

2. RESEARCH METHODS

2.1 Search Strategy

Using the PICO search strategy—Population (P), Intervention (I), Comparison (C), and Outcome (O)—to find the key ideas in the selected main question is part of the process of looking for articles in order to prepare a literature review. Search using seven databases, namely (1) Biomed Central, (2) BMJ Journals, (3) Clinicalkey, (4) ProQuest, (5) Science Direct, (6) Pubmed, and (7) Google Scholar.

The main focus of this search was the international journals that best fit the features of the articles listed in the inclusion and exclusion criteria. The keywords used to search for information about the population are (P) *Hospitalized All of Ages*, intervention in the form of (I) All of *Medication Safety*, Comparison (C) in this case does not use a comparison, and Outcome in the form of (O) Reduction in medication errors and adverse drug events (ADEs). This study's selection procedure adhered to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) approach (Stovold et al., 2014).

This scoping review was not formally registered with the international systematic review database (PROSPERO). It was not required to register scoping reviews with PROSPERO at the time this text was written (Salim 2024).

2.2 Inclusion criteria

The present literature review's inclusion criteria are (1) the articles have to have been released in the previous five years, specifically between 2019 and 2023; (2) The complete text of the article is available for access; (3) Articles written in English; (4) publications that address methods, devices, or frameworks that patients in health services employ to prevent medication use errors; (5) The article is a unique piece of research, either qualitative or quantitative; (6) The study's population comprises medical records from health services and patients.

2.3 Exclusion criteria

The exclusion criteria in this literature review are tools, innovations, or systems used on patients outside of health services to prevent medication use errors.

2.4 Quality Appraisal

The author went through the 15 chosen texts before beginning the quality assessment. The author read the work carefully and performed a critical evaluation using the checklist supplied by JBI (*The Joanna Briggs Institute*) for Analytical Cross-Sectional

Studies, Qualitative Research, Quasi-Experimental Studies, Cohort Studies, and Case-Control Studies. This approach determines an article's suitability for processing at the synthesis stage based on several quality criteria. These requirements include the validity of the intervention offered, the research subjects and samples, the reliability and validity of the measuring tools, and statistical analysis. After completing this quality assessment, the analysis of the final results showed no exceptions.

2.4 Extraction and Analysis Data

On fifteen previously obtained articles, analysis and data extraction were performed. The information is then organized into groups according to several criteria, such as the following: (1) Author's name; (2) Year of publication; (3) Title; (4) Research design; (6) Research location; (7) Type of tools; and (8) Effectiveness of tools.

3. RESEARCH RESULT

3.1 Search result

Using seven search databases Pubmed, Biomed, Proquest, Google Scholar, Clinicalkey, BMJ, and ScienceDirect, the search was conducted in September 2023. There were 2785 articles obtained. After screening 2,785 articles based on criteria such as five-year coverage, open access, language (English or Indonesian), and topics related to the themes discussed in this literature review, we extracted 54 pertinent articles from the seven databases. Then, duplication checks were carried out on the articles manually using google scholar or pubmed and comparing titles, abstracts, and keywords to determine whether the journals were duplicates or not, and from the results of the examination did not find any similarities in the articles. The next step involved choosing abstracts and article contexts based on the inclusion and exclusion criteria to produce fifteen articles. Once 15 publications could be found that could be included in this literature study, the next stage involved evaluating the articles' quality through critical review using JBI Tools for research. The PRISMA flow diagram (Figure 1) shows the process of article selection flow

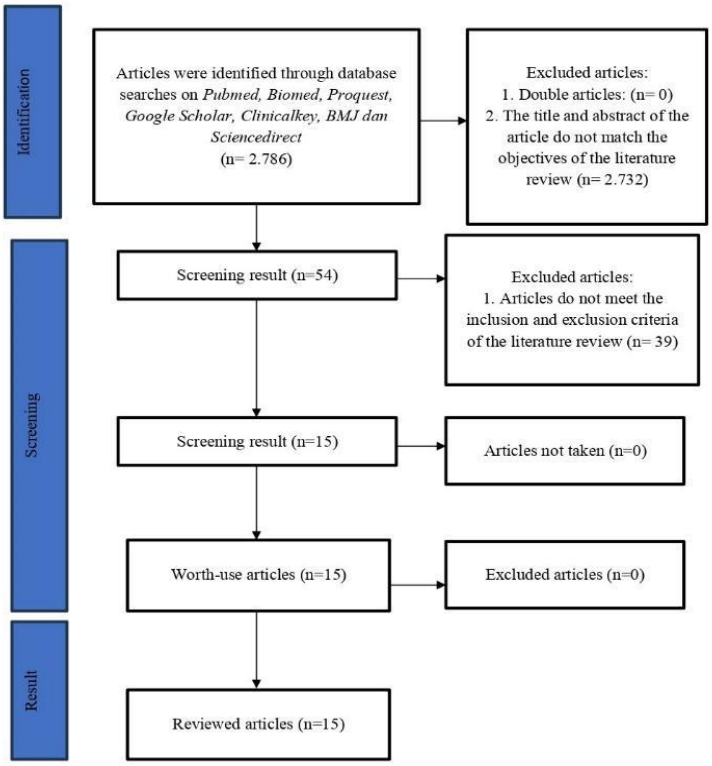

Figure 1. PRISMA Flow Diagram
(Source: Page et al., The PRISMA 2021)

3.2 Descriptive Characteristics and Summary of Article Extraction and Synthesis Results

Fifteen articles in total, sourced from multiple countries, satisfied the inclusion criteria for the study based on the search results. Table 1 below displays the general information characteristics of the research and Following the acquisition of a summary of the findings from multiple literature studies, the author groups the information according to various criteria, including author and year of publication, title, research design, kind of tools, and tool effectiveness, as shown in Table 1 below:

Table 1. Characteristics and Summary of data extraction results

Researcher and year of publication	Nation	Title	Research design	Tools Types	Tool Effectiveness
Sriboonruang et al., 2023	Thailand	Barcode Scanning Technology to Improve Pre-dispensing Errors	Prospective and quasi experimental.	barcode scanning technology with handheld computers	Barcode scanning technology combined with portable computers can help lower medication errors, particularly with LASA medications. This technology can also enhance patient efficacy and safety with chemists' and nurses' use of barcode scanning devices and barcode medication administration (BCMA).
Vaghasiya et al., 2023	Australia	The Impact of an Electronic Medication Management System on Medication Deviations on Admission and Discharge from Hospital	Retrospective pre-post and post-EMMS study	Electronic Medication Management Systems (EMMS)	The findings of the study demonstrated fewer omissions and inconsistencies between inpatient orders and discharge medications in the post-EMMS group compared to the pre-EMMS group. The proportion of treatment omissions has decreased, consistent with earlier research findings.
Wimmer et al., 2023	German	Impact of a computerized physician order entry system on medication safety in pediatrics-The AVOID study	Prospective Research	Computerized Physician Order Entry (CPOE)	The results of this study demonstrate a significant decrease in treatment errors in paediatrics following the implementation of Computerised Physician Order Entry (CPOE), with a value of ($p < 0.01$).
Trakulsunti et al., 2021	Thailand	Reducing medication errors using lean six sigma methodology in a Thai hospital: an action research study	Action Research Study	Lean Six Sigma (LSS)	Improved performance of the medication administration process in inpatient pharmacies resulted from the successful application of Lean Six Sigma (LSS). From April 2018 to August 2019, there were two instances instead of six drug administration errors. The relevance of the LSS methodology to other hospital departments and pharmacy services has also been brought to the attention of participants and staff, thanks to this study.
Corny et al., 2020	France	A machine learning–based clinical decision support system to identify prescriptions with a high risk of medication error	Cross Sectional Studies	Clinical decision support (CDS) system and a literature-based multicriteria query prioritization technique.	The developed hybrid clinical decision support system evaluated prescription review priorities favourably. Upon employing performance metrics like the area under the recall-precision curve (PR-AUC) and the area under the receive operating characteristic curve (ROC-AUC) for testing, the system demonstrated remarkable accuracy.

Researcher and year of publication	Nation	Title	Research design	Tools Types	Tool Effectiveness
Qin et al, 2023	China	Development and psychometric assessment of self-reported patient medication safety scale (SR-PMSS)	Instrument development study	Self-Reported Patient Medication Safety Scale (SR-PMSS). S	The R-PMSS has a robust model, respectable validity, and substantial dependability. The SR-PMSS has a 0.929 Cronbach's α coefficient, a 0.855 split-half reliability coefficient, and a 0.978 test-retest reliability coefficient.
Eman Kamal, P. J. Parameaswari 2023	Saudi Arabia	Testing of Defects per Million Medication Orders as a SMART Indicator for Monitoring Medication Safety in Admission and Discharge Orders	cross-sectional retrospective	Defects per Million Medication Orders (DPMMO)	This study demonstrates that the Defects per Million Medication Orders (DPMMO) measure, intended to monitor and assess medication safety in healthcare facilities, complies with the SMART indicator. It can test incoming and outgoing orders and their suitability for measuring and evaluating medication safety in those facilities.
Sandbæk *et all*, 2022	Denmark	Involving patients in medicines optimisation in general practice: a development study of the "PREparing Patients for Active Involvement in medication Review" (PREPAIR) tool	Participatory co-producing approach	PREparation of Patient for Active Involvement in Medicine Review (PREPAIR)	PREPAIR offers tools that support, involve, and enable patient-centred care to maximize medication efficiency.
Pons-Mesquida, M. À., et al. 2021	Spanish	Safer prescription of drugs: impact of the PREFASEG system to aid clinical decision-making in primary care in Catalonia	Descriptive cross-sectional study	PREscripcion FArmaceutica SEGura (PREFASEG)	Findings from the study indicate that patients may be more likely to experience medication administration errors due to PREFASEG, which may raise concerns about appropriate prescription medication dosages for various illnesses.
Liao, C. Y., et al. 2019	Taiwan	Improving medication safety by cloud technology: Progression and value added applications in Taiwan	Cross Sectional	PharmaCloud dan HIMICIS	Over time, the use of PharmaCloud can improve medication safety and reduce medical expenses. It also demonstrates a decrease in the average number of prescribed drug items and the degree of drug duplication in hospitals.
Dabliz, R., et al. 2021	Australia	Medication safety improvements during care transitions in an Australian intensive care unit following implementation of an electronic medication management system	Historical Control Study	Electronic Medical Records (EMR) are transcribed into EMMS.	EMMS implementation found that there was a significant reduction in medication errors during the care transfer process and medication errors after workflow adjustments.
Valkonen et al., 2023	Finland	Evaluation of Global trigger tool as a medication safety tool for adverse drug event detection—a cross-sectional study in a tertiary hospital	observational using regression analysis methods	Global Trigger Tool (GTT)	This study demonstrated how well the Global Trigger Tool (GTT), a drug safety tool, identified adverse drug events (ADEs) in a Finnish tertiary hospital. Based on the examination of 834 medical records, GTT found 53 ADEs, or

Researcher and year of publication	Nation	Title	Research design	Tools Types	Tool Effectiveness
					about 6% of all patients, or 13 ADEs for every 1000 patient days.
Gleeson et al., 2022	Ireland	Changes to primary care delivery during the COVID-19 pandemic and perceived impact on medication safety: A survey study	survey study	Healthmail, secure clinical email service	According to the study's findings, Healthmail, a secure clinical email service, significantly improves medication safety in pharmacy and general practice settings.
Russmann et al., 2023	Switzerland	Identification of Medication Prescription Errors and Factors of Clinical Relevance in 314 Hospitalized Patients for Improved Multidimensional Clinical Decision Support Algorithms	Cohort study	Pharma VISTA with MediQ	In order to prevent related adverse drug events (ADEs), reduce clinical practice costs, and rectify clinically relevant prescribing errors, the CDSS algorithm can decrease the number of pointless alerts while simultaneously improving specificity.
Liu et al., 2020	China	Establishment of a pediatric trigger tool based on Global Trigger Tool to identify adverse drug events of children: experience in a Chinese hospital	retrospective cohort study	Global Trigger Tool (GTT)	Comparing GTT to voluntary reporting systems, the former could be more effective. This figure initiates the PPV and ADE positive detection rate in this investigation. To sum up, this tool can detect ADE effectively, but it still requires optimization.

Table 2. Critical Appraisal Cross-Sectional Study

Table of Critical Appraisal Cross-Sectional Study

Checklist	Corny et al., 2020	Eman Kamal, P. J. Parameaswari 2023	Pons-Mesquida, M. À., et al. 2021	Liao, C. Y., et al. 2019	Valkonen et al., 2023	Gleeson et al., 2022	Russmann et al., 2023
Were the criteria for inclusion in the sample clearly defined?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were the study subjects and the setting described in detail?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was the exposure measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Were objective, standard criteria used for measurement of the condition?	Yes	Yes	No	Yes	Yes	Yes	Yes
Were confounding factors identified?	Unclear	Yes	Yes	Yes	No	No	Yes
Were strategies to deal with confounding factors stated?	Yes	Unclear	No	Yes	NA	NA	Yes

Were the outcomes measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Was appropriate statistical analysis used?	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table of Critical Appraisal Cohort Study

Checklist	**Vaghasiya et al., 2023**	**Liu et al., 2020**
Were the two groups similar and recruited from the same population?	Yes	Yes
Were the exposures measured similarly to assign people to both exposed and unexposed groups?	Yes	Unclear
Was the exposure measured in a valid and reliable way?	Yes	Yes
Were confounding factors identified?	Unclear	Yes
Were strategies to deal with confounding factors stated?	Unclear	Yes
Were the groups/participants free of the outcome at the start of the study (or at the moment of exposure)?	Yes	Yes
Were the outcomes measured in a valid and reliable way?	Yes	Yes
Was the follow up time reported and sufficient to be long enough for outcomes to occur?	Yes	Yes
Was follow up complete, and if not, were the reasons to loss to follow up described and explored?	Yes	Yes
Were strategies to address incomplete follow up utilized?	Unclear	Yes
Was appropriate statistical analysis used?	Yes	Unclear

Table of Critical Appraisal Qualitative

Checklist	**Trakulsunti et al., 2021**	**Qin et al, 2023**	**Sandbæk *et all*, 2022**
Is there congruity between the stated philosophical perspective and the research methodology?	Yes	Yes	Yes
Is there congruity between the research methodology and the research question or objectives?	Yes	Yes	Yes
Is there congruity between the research methodology and the methods used to collect data?	Yes	Yes	Yes
Is there congruity between the research methodology and the representation and analysis of data?	Yes	Yes	Yes
Is there congruity between the research methodology and the interpretation of results?	Yes	Yes	Yes
Is there a statement locating the researcher culturally or theoretically?	No	Yes	Yes
Is the influence of the researcher on the research, and vice- versa, addressed?	No	No	No
Are participants, and their voices, adequately represented?	Yes	Yes	Yes

Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?	No	Yes	Yes
Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?	Yes	Yes	Yes

Table of Critical Appraisal Quasy Eksperimen

Checklist	**Sriboonruang et al., 2023**	**Wimmer et al., 2023**
Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	Yes	Yes
Were the participants included in any comparisons similar?	Yes	Yes
Were the participants included in any comparisons receiving similar treatment/care, other than the exposure or intervention of interest?	Yes	Yes
Was there a control group?	No	Yes
Were there multiple measurements of the outcome both pre and post the intervention/exposure?	Yes	Yes
Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	Yes	Yes
Were the outcomes of participants included in any comparisons measured in the same way?	Yes	No
Were outcomes measured in a reliable way?	Yes	No
Was appropriate statistical analysis used?	Yes	Yes
Is it clear in the study what is the 'cause' and what is the 'effect' (i.e. there is no confusion about which variable comes first)?	Yes	Yes

Table of Critical Appraisal Case Control Control Studies

Checklist	**Dabliz, R., et al. 2021**
Were the groups comparable other than the presence of disease in cases or the absence of disease in controls?	Yes
Were cases and controls matched appropriately?	NA
Were the same criteria used for identification of cases and controls?	Yes
Was exposure measured in a standard, valid and reliable way?	Yes
Was exposure measured in the same way for cases and controls?	Yes
Were confounding factors identified?	No
Were strategies to deal with confounding factors stated?	NA
Were outcomes assessed in a standard, valid and reliable way for cases and controls?	No
Was the exposure period of interest long enough to be meaningful?	Yes
Was appropriate statistical analysis used?	Yes

4. DISCUSSION

The occurrence of medication errors (MEs) presents a significant challenge in healthcare, leading to preventable harm to patients. A comprehensive evaluation is crucial to determine the legal responsibility for medication administration errors causing harm to patients. Inappropriate drug administration stands as a major cause of avoidable harm in healthcare systems globally, with losses due to medication errors estimated at $42 billion annually (Scanning et al., 2023). Hospitalized patients are particularly vulnerable, with MEs estimated at around 19%, and approximately 64% of these errors deemed preventable, especially those related to prescription errors (Woo et al., 2020).

Medication errors often stem from issues in drug storage and dispensing procedures, where deviations from intended practices can lead to errors. Inadequate storage procedures and drug arrangement on shelves can contribute to MEs (RI, 2009). Negligence and inaccuracies, such as delays in drug administration, can also result from factors like the heavy workload of nurses due to high patient volumes, potentially leading to errors (Donsu et al., 2016).

The World Health Organization (WHO) has highlighted the risk of MEs and drug-related harm, with 1 in 10 hospitalized patients at risk in developing countries (Tampubolon & Pujiyanto, 2018). Prescription errors account for a significant portion of ME incidents, with issues such as incomplete prescription writing, unreadable prescriptions, and missing drug information contributing to errors (Maalangen et al., 2019). Nurses play a critical role in preventing MEs, with competencies in providing patient care and ensuring accurate documentation to mitigate errors (Olfah & Ghofur, 2016).

Efforts to prevent MEs necessitate the implementation of technological systems to enhance patient safety. However, the potential negative impact of these systems on clinical workflow and associated complications must be considered. Standardization and certification of these systems can aid in preventing MEs, alongside creating supportive economic environments and policies to facilitate wider adoption in healthcare settings (Liu et al., 2020).

Ensuring safety in drug administration involves not only healthcare professionals and hospital management but also patient engagement. Patients must adhere to medication regulations and actively participate in medication safety management to prevent errors. MEs pose a significant threat to patient safety globally, necessitating a deeper understanding of the contributing factors, including system and human elements. Prioritizing medication safety management efforts and leveraging system-based technologies can help identify and mitigate risks associated with MEs in healthcare settings.

5. CONCLUSION

A literature study obtained from fifteen articles found that there are many patient safety tools in treatment programs, namely SR-PMSS, CDS, EMMS, CDSS, PharmaCloud and HIMICIS, PREFASEG, Global Trigger Tool, PREPAIR, DPMMO, Electronic Prescription (Health Mail), EMR, PharmaVISTA, Barcode Scanning, CPOE, Lean Six DMAIC. These are various instruments to support treatment plans, most located in medical facilities. The application of these tools can help health workers in prioritizing prescription checks, evaluate the level of patient safety in administering drugs, the safety of the medication, the involvement of patients with polypharmacy in

administering drugs, reduce the incidence of ADEs, help provide patient safety warnings in the act of administering drugs, help increasing the usability of drugs and dispensing drugs, helping the accuracy of using drugs to patients, reducing errors before distributing drugs in the ward, reducing prescription errors. This tool can assess the negligence and inappropriateness of the tool in administering drugs for patient safety instruments to assist medical professionals in lowering medication administration errors.

6. RECOMMENDATION

It is possible to conduct additional literature reviews to assess nurses' proficiency in using patient safety equipment to prevent mistakes when giving patients their medications.

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