Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 1s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

A systematic review and meta-analysis of the prevalence of medication errors in hospitalized pediatric patients

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Cite this paper as: Sanjay Kumar Mire, Kishor Kumar Sahu, (2025) A systematic review and meta-analysis of the Prevalence of Medication Errors in hospitalized pediatric patients. *Journal of Neonatal Surgery*, 14 (1s), 41-49.

ABSTRACT

Medication Errors (MEs) are likely elevated in Pediatric Hospital (PH) environments. Estimations about the prevalence of MEs have failed to consider the variability in recognizing MEs methodologies and criteria among research, contextual disparities within wards, and the utilization of computerized versus prescription records. The objective was to perform a Systematic Review (SR) and Meta-Analysis (MA) to yield distinct predictions of the incidence of MEs among Pediatric Inpatients (PIP), categorized by hospital wards, and the utilization of electronic versus paper medicine charts while considering variations in recognizing MEs methodologies and explanations. The research systematically searched five databases to uncover research that evaluated ME rates by pharmaceutical chart audits, personal observation, or a combination of methods. The research found 70 studies, 20 of which were about PH utilizing electronic charts. Most research evaluated MEs, while only a limited number examined MEs in administration. Research on PH utilizing electronic charts typically indicated fewer MEs than those employing paper records, albeit with occasional discrepancies. MEs identification techniques influenced the frequency of MEs across the wards; no additional differences were observed. The definition of MEs did not consistently influence claimed ME rates. MEs frequently occur in PHs, especially in intensive care and emergency rooms. Hospitals utilizing electronic charts exhibited a reduced incidence of MEs compared to manual charts. Future research utilizing controlled settings is necessary to ascertain the actual effects of electronic records and other treatments on MEs and related damage in hospitals.

Keywords: *Medication errors, pediatric patients, hospital, review.*

1. INTRODUCTION

Patient security is a fundamental objective in all medical facilities and essential for delivering high-quality care. Medication Errors (MEs) and avoidable Adverse Drug Events (ADEs) occur in any medical facility and can result in patient damage [1]. MEs include incidents arising during pharmaceutical usage, such as prescribing, recording, dispensing, managing, and tracking medications. Preventable ADEs are illnesses caused by pharmaceutical use that occasionally stem from MEs.

Children are more susceptible to MEs in medical facilities, and when these MES occur, they have three times the likelihood of causing direct injury to individuals compared to adults [9]. The combination of dosing, diverse development and growth trajectories, the availability and precision of forms of administration, the utilization of off-label products, restricted physiological reserves to mitigate interest overdose MEs, and inconsistent communication abilities all exacerbate the dangers of MEs in this demographic.[2]. These characteristics underscore the necessity for pediatric-specific preventative methods to reduce MEs and avoidable ADEs.

Various solutions have been examined to diminish the frequency of these incidents in healthcare environments [3]. One option is the integration of a medical pharmacist within the ward. The position of the Clinical Pharmacist (CP) has evolved over the past years into that of a medical professional with experience in the secure and efficient administration of medications. Numerous Systematic Reviews (SR) and Meta-Analyses (MA) have demonstrated that interventions by CP can diminish MEs and preventable ADEs in hospital individuals, including incidents that could result in actual damage before patient administration [16]. These treatments raised the standard of patient care and decreased overall healthcare costs, improving medical effectiveness. Most of this research concentrates on the involvement of a CP with adult clients.[4]. It is imperative to examine the impact of a CP on youngsters, as they are particularly susceptible to MEs.[5].

This review aimed to deliver thorough estimates of ME prevalence, including total, prescription, and ME administration in Pediatric Hospital (PH) patients [11].[13]. The research presents the initial estimations that evaluate the influence of (1) research quality (a comprehensive evaluation of error detection techniques), (2) the description of MEs in studies, (3) various hospital rooms, and (4) the utilization of Health Information Technology (which includes Computerized Physician Order Entry with and without Clinical Decision Support).

2. METHODS

This SR and MA adheres to the Preferred Reporting Items for SRs and MA (PRISMA) criteria and the Cochrane Handbook guidelines to guarantee the incorporation of relevant data [6].

2.1 Criteria for Qualification and Search Methodology

The research was conducted by querying five electronic bibliographical databases. The search approach was executed, and terms related to medicine and terms about MEs were incorporated. In light of established discrepancies in the categories of MEs among studies, the research incorporated terminology for avoidable ADEs.[17]. The findings were confined to PH patients, at least 90% of the sample under 19 years of age, in medical wards utilizing paper prescription graphs, Computerized Physician Order Entry (CPOE), or Clinical Decision Support (CDS) [18]. The included PH rooms comprised Emergency Departments (ED), Intensive Care Units (ICUs), and regular wards (pediatric wards from all hospitals and regular wards from PHs) [14].[15]. The research must be in English, and chart review or inspection must be utilized to identify MEs and quantify the frequency of such MEs.[8]. Investigations with limited generalizability were omitted, such as those concentrating solely on a particular patient situation (e.g., cancer sufferers) or pharmaceutical type (e.g., injection medicines).[7]. A PRISMA flow chart illustrates the outcomes of implementing the exclusion requirements (Fig. 1).[12].

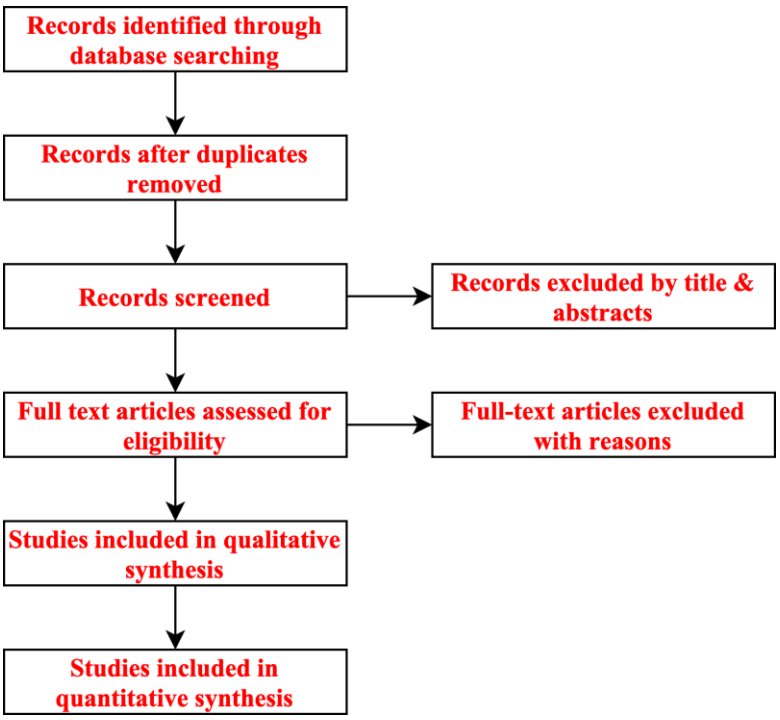

Figure 1: Workflow of the PRISMA

The literature research executed the title and abstract assessment, evaluated every possible full-text publication, and ascertained eligibility. The research performed data extraction on the included papers and assessed research quality. Similar documents were detected utilizing Endnote X8 software. Researchers of published studies were solicited for supplementary information as necessary. Numerous reports of identical research were incorporated and evaluated for distinct information; no singular report of multiple investigations was identified.

2.2 Factors Influencing the MEs

Examination Excellence

Research designated as 'good' was awarded one point in the entire quality assessment, as were those attaining an above-average rating, resulting in a potential total quality rating of three out of three. Research was evaluated as 'excellent' grade

(three levels), 'good' (two levels), 'fair' (one level), and 'poor' (zero points). Discrepancies were reconciled through dialogue. Each MA presented two figures to evaluate the influence of research quality when applicable: one derived from research rated as 'poor' or 'fair,' and another from those rated as 'good' or 'outstanding.'

Definition of MEs

The research evaluated the influence of ME classification by examining the quantity of ME subcategories incorporated in every investigation. The median number of categories evaluated across research for 'recommending ME's categories was six, encompassing clinical and procedural MEs. The mean number of sub-categories for ME descriptions was six. In conducting the MA for prescription and handling MEs, the research categorized studies into those with fewer than the median MEs sub-categories and those with a median number or more, as applicable. In conducting the MA for publications detailing ME stages, the research evaluated the MEs included (i.e., prescription, recording, distributing, management, and/or surveillance errors). The research presented two projections where applicable: one for trials encompassing solely prescribing and administering MEs and another for studies that included recording, distributing, or tracking errors.

Medical Ward and Utilization of Electronic Records (ERs)

According to the hospital ward, the research offers distinct estimates regarding utilizing paper medication lists or Health Information Technology (HIT). Distinct estimations are provided for studies in a mix of broader and ICU or ED wards, termed 'multiple ward' research. Distinct estimations are shown for ME rates among hospitals utilizing paper prescription graphs and those utilizing CPOE only. For every unit and medical environment, a maximum of four estimates generated from MA might be obtained, two based on research quality categorization and two based on error criteria categorization.

2.3 MA

The frequencies of MEs, prescription MEs, and MEs in administration are documented based on the numerators employed in the respective research. The denominators comprised MEs per 100 orders, per 100 drugs administered, per 100 registrations, and/or every 1000 patient days. To get a more precise estimation of ME rates, corrected for sample size, the research computed pooled average ME rates (where information from a minimum of three separate investigations was accessible) utilizing MA modeling of random effects with 95% confidence intervals. The Q statistic is presented to indicate the reliability of estimates. The figures and Tau demonstrate variability. A p-value of less than 0.05 was employed to denote statistically significant. When the statistics were not necessary, pooling was deemed inappropriate, and the findings of each study were provided individually. Sub-group study (based on research quality and ME definitions) was deemed suitable when a minimum of two investigations provided data for each estimation, and the p-value associated with the value for the combined effect research was statistically significant (<0.05). Publications bias was mathematically assessed using Egger's method and determined insignificant. Studies were conducted with the Complete MA program.

2.4 Evaluation of quality

The academic merit of the papers included was evaluated utilizing the Crothe Critical Assessment Tool (CCAT). This approach was chosen due to the expectation from the past that the studies incorporated would exhibit markedly diverse methods. The CCAT comprises eight groups and 22 elements. Every item possesses several descriptions for efficient evaluation, with every group assigned a score on a 6-point level (0-5). The total score for every investigation can be represented on a scale of 40 points. Two independent raters evaluated each study. Differences were reconciled following discussions among theologians. The Intraclass Correlated Coefficients (ICC) were computed using SPSS® analytical program version 22 to assess the uniformity among the two raters, ensuring dependability.

2.5 Statistical examination

MA comprised research that provided a comparable primary outcome measurement with a quantitative disparity in MEs before and after the therapy. An MA was performed utilizing the Cochrane Review Manager Program. A random-effects framework was employed to calculate the significant evaluations' pooling Odds Rates (ORs). The variability is anticipated due to the varying locations (divisions within the hospitals) and different kinds of pharmacist interventions. ORs and adjusted mean variations were calculated for categorical factors, accompanied by 95% Confidence Intervals (CIs). Stochastic variability between papers was assessed utilizing scores.

3. MEDICAL ERROR ANALYSIS

3.1 Definitions of Errors

Definitions of pharmaceutical error, prescribing MEs, and administration oversight differed among research. Despite significant diversity in the requirements of MEs, all instances encompassed prescription and handling MEs, including those that might or might not have been rectified before reaching the patient. A possible exemption was the criteria provided by the American Association of Medical Pharmacies, which indicated that MEs do not include those rectified before patient administration. The majority of research evaluating prescription MEs encompassed both medical and procedural inaccuracies. The number of ME subcategories encompassed under these two categories differed among research studies.

The most commonly assessed categories of clinical MEs were incorrect dosage, medication, and frequency MEs. The most frequently evaluated sub-categories of procedural MEs were ambiguous and missing order MEs. The subdivisions of managerial MEs varied among the studies. The most commonly assessed MEs categories were omitting errors, incorrect dosage, and timing MEs.

3.2 Overview of ME Frequencies in Medical Wards

Prescription MEs constituted the largest share of MEs and were the primary focus of most investigations. Limited research on administrative MEs has been performed in specific hospital rooms; in studies encompassing numerous places, the overall incidence of administration MEs was significantly lower than that of prescribing MEs. The result presents data from ME where applicable, and when the ME was deemed unsuitable, it displays a variety of ME rates recorded in various research. The sub-sections give the rates of MEs by research ward, distinguishing between hospitals utilizing paper drug charts and those employing electronic prescription ERs.

3.3 Incidence of MEs in Pediatric Inpatients (PIP) Utilizing Paper Dosage Charts

Nine studies evaluated MEs across several pediatric units utilizing paper prescription ERs. Seven studies were assessed as having outstanding quality. The incidence of MEs varied among research: 8.5-54.2 per 100 prescriptions (seven research); 6.8 per 100 doses provided (one study); 22.4-72 per 100 hospitalizations (four research); and 43.5-165 per 1000 patient-days (four research). Fourteen research studies evaluated prescribing MEs across several PH using paper prescription charts. Six studies were assessed as having outstanding quality. The frequency of MEs in prescribing varied from 2.5 to 75.4 per 100 prescriptions (12 research), 17.5 to 48.4 per 100 hospitalizations (four research), and 72 per 1000 patient days (one study).

Eleven research studies evaluated medication use MEs in various PH using paper charts. Seven investigations were assessed as having outstanding quality. Sub-group ME indicated that better-quality papers documented considerably fewer MEs in administration than poor and average-quality research. In all investigations, distribution MEs ranged from 0.4 to 32.5 per 100 prescriptions (five research), 0.3 to 85.7 per 100 doses provided (six research), 6.5 to 33.5 per 100 admittance (three research), and 26.5 to 55 per 1000 patient-days (two research).

3.4 Incidence of MEs in PIP Utilizing CPOE

Three investigations evaluated MEs in various PH utilizing CPOE. The initial study was performed in a US university hospital and assessed as high value. The investigation evaluated the implementation of CPOE, documenting 45.2 MEs per 1000 patient days seven months before the program's implementation and 28.2 MEs per 100 enrollments, or 52.5 per 1000 patient days nine months post-introduction. This indicated a negligible rise in MEs. The subsequent study was evaluated as outstanding quality and examined adverse medication occurrences in two Japanese educational hospitals utilizing CPOE technologies. The analysis indicated 65.1 MEs per 100 patients or 69.5 per 1000 patient days. The third research was assessed as fair quality and was done in the pediatric departments of a Danish hospital. It indicated that 8 out of 100 medicine deliveries had MEs.

An SR evaluated the incidence of MEs in several PH utilizing CPOE. The research encompassed three medical centers utilizing CPOE and indicated a rate of 17.2 prescription MEs per 100 prescriptions. An SR evaluated administrative MEs in various PHs at a French institution utilizing CPOE. The study stated 32.5 delivery MEs per 100 dosages or 44.5 per 100 patients.

4. RESULTS SYNTHESIS

4.1 Treatments

A total of 45 distinct treatments were discovered, designed to mitigate errors at one or more of the three specified Medication Use Process (MUP) phases. Eight of the investigations examined interventions at a specific point in the MUP, focusing on either the distribution or administering of drugs. No research examined surveillance MEs in isolation from other MUP phases. The remaining 12 research examined interventions to reduce MEs across many stages of drug use and were thus categorized as combined MEs studies. The measures used in these trials to address the distribution, handling of drugs, and/or monitoring have been extracted for a descriptive study. Fourteen research, encompassing 35 actions, demonstrated a significant decrease in ME rates as defined by the individual research; three studies exhibited a legally non-significant variation in ME rates, while the remaining three yielded contrasting findings.

4.2 Interventional Methodology of the Research

In most studies (n = 35), the effect of a singular treatment was examined, while seven research studies employed a combination of treatments. A non-statistically considerable preference ($p = 0.32$) for a bundle of therapies was noted in studies addressing multiple stages of the MUP, with 43% of combining medication failure investigations employing a bundling of remedies compared to 27% of studies examining one phase in the MUP.

4.3 Single-Intervention Research

Only a single study examined dispensing MEs at the pharmacy stage, independently of other phases in the MUP. This

investigation employed a singular intervention involving setting up a novel electronic processing system connected with the existing electronic dosage system, resulting in a substantial decrease in error rates. Five out of eight studies concerning MEs employed a singular intervention. The research examined the effect of a CP in a medical facility to decrease missed or delayed prescriptions, revealing a total reduction in risk of 16.2%. The four surviving single-intervention research addressing pharmaceutical administration MEs employed instructional strategies: Research integrated practical and theoretical training with management processes in a single instruction program for nurses in a neonatal critical care unit, resulting in a total decrease in risk of 16.2%. Research implemented a CP-led initiative that included monitoring the use of drugs by the pharmacies, then providing feedback and training for nursing and medical staff concerning identified hazards or MEs, resulting in a total decrease in risks of 14.2%. Research conducted a comparable educational initiative in two distinct environments; a brief presentation was integrated with a presentation and a manual for nursing staff in a PH ward and a pediatric critical care unit (absolute decrease in risk 6.8% and 42.5%). The individual interventions applied in the seven studies addressing various stages of the MUP comprised teaching strategies, utilizing automatic notifications, and the uniformity of paperwork. Four of these achieved markedly positive outcomes.

4.4 Collections of Interventions

Seven research studies implemented a combination of treatments, namely multiple methods, to target one or more phases of MUP. The actions taken were diverse and frequently incorporated an educational component. The impact of a singular treatment could not be determined, as the results reported in the research were attributable to the amalgamation of multiple treatments. No research was found that completely mitigated the risk of MEs; only four treatments (8%) were assessed as having implemented a substitution, such as equipment replacement, to diminish the risk. Seven treatments (17%) were categorized as technological controls, such as implementing barcoded medication. At the same time, the predominant majority were classified as managerial measures (35 out of 45 actions), including classes, rules, regulations, and alert signs.

4.5 Intervention Category by the Hierarchy of Constraints

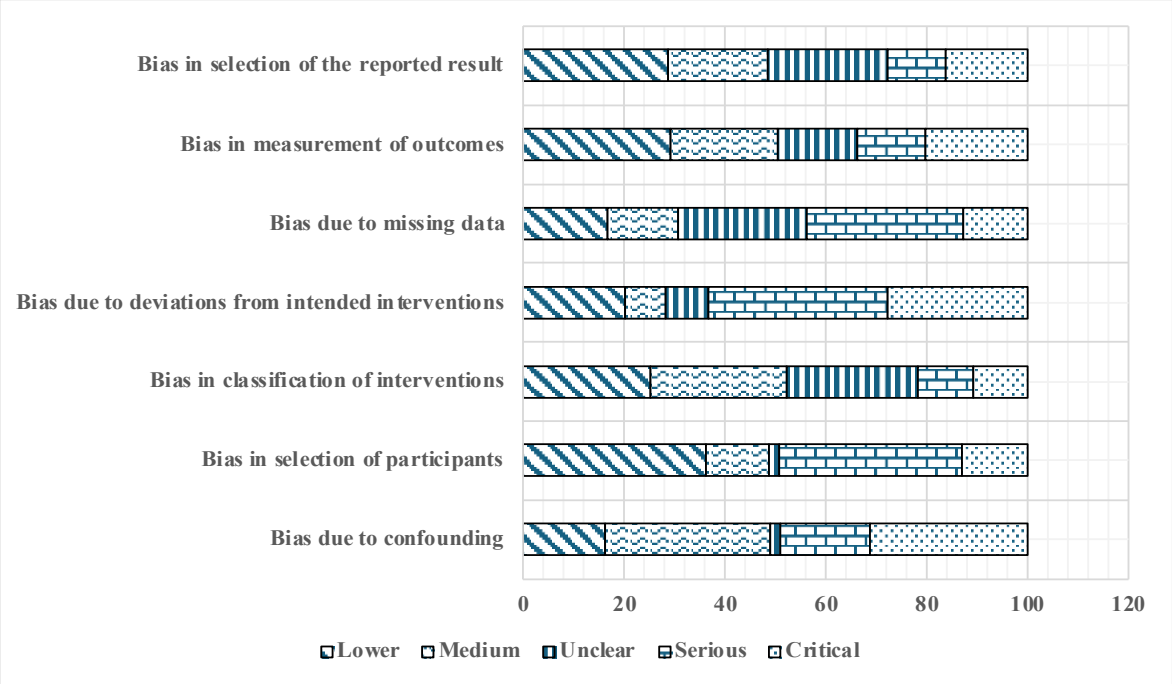

Figure 2: ME analysis

Two studies separately categorized the 44 identified treatments based on the hierarchy of variables. Fig. 2 shows the ME analysis results. Before the conversation, the agreement stood at 74.5%. A total consensus was achieved following the debate. Among the 45 identified treatments, 35 were executed in the 15 investigations, demonstrating an essential reduction in ME rate. Three measures associated with diminished ME rates were classified as replacement controls, seven as technical controls, and twenty-four as managerial controls. Six of seven investigations that included elevated control measures (replacement or engineering procedures) showed a substantial decrease in ME rate (85%). Merely 9 out of 15 studies that exclusively employed managerial controls indicated substantial ME decreases (63%). Studies that included substitution or technical controls were 1.7 times more probable to achieve decreased ME rates than those utilizing administrative measures alone (1.5). The difference did not attain statistical importance ($p = 0.25$). Research utilizing replacement or engineering safeguards had an average time frame of 48 months for data collection from control and treatment groups, while research focused on administrative barriers had a mean duration of four months. The disparity among these average research durations

was significant, indicating that the impacts of management restrictions have been evaluated during shorter intervals, hence complicating the assessment of their long-term consequences.

Substitution restrictions comprised the establishment of a new pharmacy mixing unit, the use of smart motors, and the utilization of standardized dilute solutions. These replacements constituted components of effective intervention packages, resulting in markedly decreased error rates in aggregated ME trials. The implementation of voice-recorded and written instructions did not result in a decrease in MEs. Seven engineering measures were discovered across four distinct trials; five were executed as components of intervention packages in conjunction with administrative measures. They consistently proved beneficial by significantly reducing MEs. Treatments encompassed implementing a workflow control system, providing supplementary supplies to enhance the utilization of pneumatic containers, hands-free connection technologies, and barcoded administration of medicines. The alerts in the individuals were effective, having been meticulously designed to mitigate the potential of alert tiredness, as recognized by the researchers.

The vast majority of evaluated treatments were categorized as managerial controls. The categories can be classified as follows: education and learning, rules, standards, and processes, reorganization of staff/material, specialist consults, and warning indications. Figure 3 shows the treatment analysis.

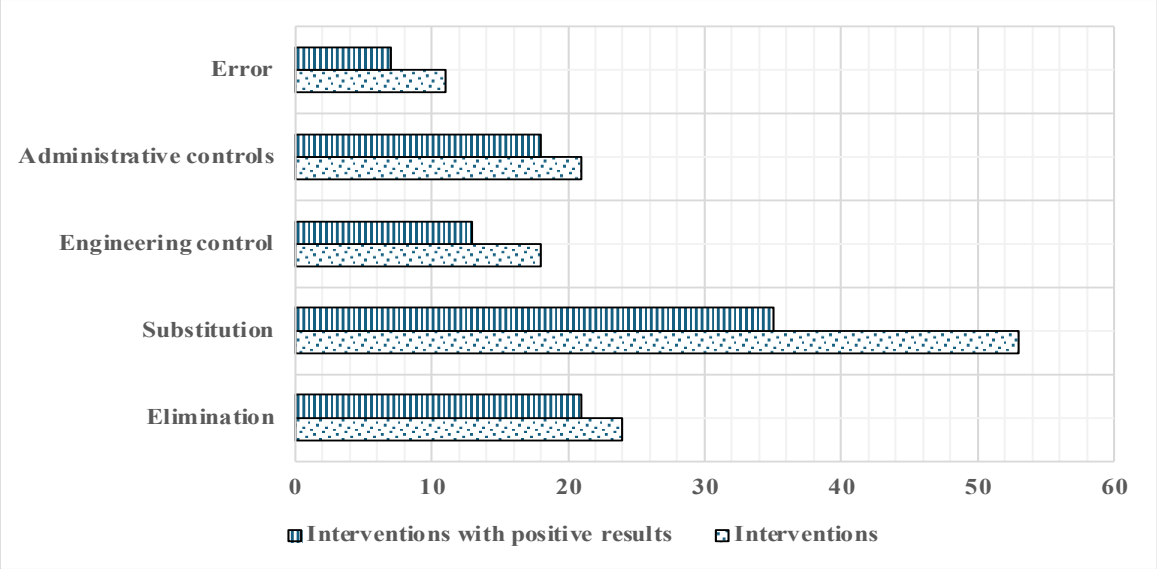

Figure 3: Treatment analysis

4.6 Potential for Bias Across Research

Given the substantial proportion of markedly positive outcomes (71%), the possibility of publication bias cannot be dismissed. Sixteen research studies (81%) indicated a completion date for data collection, facilitating the estimation of the time to publication. Research demonstrating substantially beneficial outcomes was published at an average of 25 months (interquartile range = 18.5-36 months), while studies with negative findings were released after a mean of 38 months (interquartile range = 31.5-46.5 months). A statistically significant variation could not be shown when juxtaposed with the pattern of substantial positive outcomes.

4.7 Supplementary Analyses

In 15 out of 20 complete texts, 15 meanings were discerned from 45 potential instances for description. Seven descriptions of MEs (32% of all-encompassed full texts), a single description of MEs (32%, totaling three full texts), seven explanations of drug management MEs (38.5%, totaling 17 research), and one description of tracking MEs (32.5%, totaling three full texts) were found. The descriptions exhibited content heterogeneity and frequently overlooked the patient; the description of MEs included the term "preventability" in only one instance, while the descriptions for "drug management MEs" lacked any patient-centered elements and were predominantly related to technology.

4.8 Constraints

The research initially employed the hierarchy of controllers approach to categorize treatments to mitigate PIP distributing, medication administration, and tracking MEs, demonstrating that the framework suits this context. The technique is constrained as the preliminary data collection was conducted by a single researcher, with modifications and/or enhancements supplied by a second impartial researcher. Due to the predominance of randomized before-after research, which includes a significant risk of bias, outcomes must be evaluated cautiously. The requirements for inclusion consisted solely of research released in English, resulting in a possible foreign language prejudice, but the evidence supporting this remains dubious.

This overview encompasses experimental research conducted over 8 years and should be understood in conjunction with the findings of prior and forthcoming reviews on the same subject.

5. DISCUSSIONS

This SR and MA examined the effect of CP assistance on prescription ME rates in PIP children and adolescents. It thoroughly examines and assesses the prevalent categories of errors prompting pharmacist measures, their importance levels (mild, modest, severe), and the reception rate of CP's suggestions. Prior research and evaluations have highlighted clinical pharmacists' significance in handling pediatric patients' care.

The emphasized benefits were as follows: recognizing drug-related issues, recommending appropriate drugs, enhancing medication utilization, decreasing medication-related expenses, and minimizing MEs with medication. Comparable advantages were noted with interventions to prevent MEs in the adult population. These findings underscore the necessity of pharmacist participation in mitigating drug errors, irrespective of the demographic concerned.

Notwithstanding the variability of the research in this MA, the combined impact of pharmacist treatments revealed a substantial reduction in the likelihood of MEs by 72.5%. Treatments demonstrating the most impact encompass rectifying MEs, including dosage inaccuracies, measurement systems, administration routes, and frequency. Prior research indicates that the majority of MEs transpire during the prescribing phase. CPs and prescribers must be incorporated into medical ward rounds. This enables CPs to avert MEs initially, minimizing the waiting times associated with rectifying these errors.

This review concentrated on the PIP environment, as MEs are more prevalent in tertiary healthcare than primary ones. Due to the complexity of PIPs, CPs have a far more beneficial role in minimizing MEs in hospital environments than in hospitals and neighborhoods. It is essential to examine the CP's role in independently mitigating MEs in various situations and to see if a comparable benefit level is seen.

The primary intervention by CPs identified in the analysis was the instructional sessions conducted by CPs for other medical professionals, primarily nurses and doctors. The assessment or verification of prescriptions and implementation of unit-based CPs were prevalent treatments identified in this thorough investigation. A prior SR concentrating on critically ill patients indicated that the predominant treatment was integrating a CP into the healthcare team, which ranks among the foremost interventions in the analysis.

The primary strength of this MA is that it is the first study to quantitatively evaluate the effect of pharmacist measures on prescription ME rates in PIP inside hospital environments. The SR incorporated papers from several nations across the globe, thus augmenting the generality of the findings. The application of the CCAT provided more insight into the research encompassed in this study, allowing for a comparison of the overall data quality among the investigations. The CCAT was chosen for this analysis due to its superior reliability compared to informal evaluations of many research projects. The standardized assessment provided by the CCAT has nearly eradicated the rater operation, with no significant impact from subject matter expertise.

This study possesses certain shortcomings that warrant attention. The total score of every aspect was 25.42 out of 30, indicating a mediocre assessment. This was primarily attributable to inadequate sample reporting and approval for ethics, as these two areas had the poorest overall rankings on the CCAT.

While sampling is crucial to mitigate the danger of bias in selection, the admission of ethics does not bring any specific bias to the research. Hence, it does not impact the internal validity of the assessment. The research has appeared in peer-reviewed publications, many of which mandate ethical disclosures before release. Secondly, several studies incorporated an array of pharmacist treatments, making it impossible to ascertain which specific intervention led to decreased MEs. Substantial variation was observed in the studies in the MEs, potentially attributable to various factors, including discrepancies in the CP measures employed and differences in the methodologies for identifying MEs and the definitions of medication discrepancies across studies.[10].

Certain studies have classified outcomes as MEs, while others have identified them as preventable ADR. The extensive range of dates suggests that the methods of CP and the comprehension of MEs have evolved during this period. The results from prior research differ from those of more current investigations due to modifications in practice and shifts in the environment of general medicine.

Future research should assess the impact of CP actions on MEs in outpatient environments. This will provide a clearer understanding of the CP's effect on the community and facilitate the medical system's identification of regions or situations necessitating greater attention and enhancement. Additionally, a subgroup examination of the present research results is necessary to assess the influence of a CP on specific ME categories, such as prescription or administering MEs; this would aid in addressing the observed variability.

6. CONCLUSION

The incidence of MEs in PH utilizing paper prescription ERs is elevated. Every two to three hospitalized patients can

anticipate encountering a single ME, with an error arising in roughly every seven prescriptions. The rate of MEs in prescribing was significantly elevated in ICUs and EDs, where PIPs are particularly susceptible to damage. Research on MEs mainly concentrated on prescribing MEs, while MEs in administration and groups such as dispensing, tracking, and transcription MEs were infrequently evaluated. Wards in hospitals utilizing CPOE generally exhibited reduced rates of MEs, especially in ICUs; variations exist, and limited research has explicitly assessed the effect of CPOE on MEs in PH. Additional research on MEs in PIP environments is necessary to more precisely define the scope and characteristics of the issue within this at-risk demographic. An increased emphasis on administrative MEs and the utilization of HIT in medical facilities is required. All investigations require Enhanced efforts to quantify the harm linked to MEs.

REFERENCES

1. Laatikainen O, Sneck S, Turpeinen M. Medication-related adverse events in health care—what have we learned? A narrative overview of the current knowledge. European journal of clinical pharmacology. 2022 Feb 1:1-2. https://doi.org/10.1007/s00228-021-03213-x
2. Ramachandran S. Comparative Analysis of Antibiotic Use and Resistance Patterns in Hospitalized Patients. Clinical Journal for Medicine, Health and Pharmacy. 2023 Oct 9;1(1):73-82.
3. Somani R, Muntaner C, Hillan E, Velonis AJ, Smith P. A systematic review: effectiveness of interventions to de-escalate workplace violence against nurses in healthcare settings. Safety and health at work. 2021 Sep 1;12(3):289-95. https://doi.org/10.1016/j.shaw.2021.04.004
4. Jara AJ, Zamora MA, Skarmeta AF. Intra-mobility for hospital wireless sensor networks based on 6LoWPAN. In2010 6th International Conference on Wireless and Mobile Communications 2010 Sep 20 (pp. 389-394). IEEE. https://doi.org/10.1109/ICWMC.2010.54
5. Vanan JT, Manalan J, Soundrarajan DJ, Raja T. Awareness and Utilization of Electronic Resources among Junior Research Fellows with Special Reference to Christian Medical College & Hospital, Vellore, Tamil Nadu. Indian Journal of Information Sources and Services. 2019;9(S1):32-6. https://doi.org/10.51983/ijiss.2019.9.S1.569
6. Mei F, Chen F, Hu K, Gao Q, Zhao L, Shang Y, Zhao B, Ma B. Registration and reporting quality of systematic reviews on surgical intervention: A meta-epidemiological study. journal of surgical research. 2022 Sep 1;277: 200-10. https://doi.org/10.1016/j.jss.2022.04.026
7. Surendar A. Internet of Medical Things (IoMT): Challenges and innovations in embedded system design. SCCTS J Embed Syst Des Appl. 2024;1(1):33-36.
8. Dhage PC, Thakker RA, Warhade KK. Security mechanism in MAMATA healthcare system using rule-based algorithm for maternal hospitals and pathology laboratories. J Internet Serv Inf Secur. 2024;14(4):292-311. https://doi.org/10.58346/JISIS.2024.I4.018
9. Kuitunen S, Saksa M, Tuomisto J, Holmström AR. Medication errors related to high-alert medications in a paediatric university hospital–a cross-sectional study analysing error reporting system data. BMC pediatrics. 2023 Oct 31;23(1):548. https://doi.org/10.1186/s12887-023-04333-2
10. Veerappan S. Digital management and sustainable competitiveness: Using eco-innovation and green absorptive capacity in travel and hospitality enterprises. Glob Perspect Manag. 2024;2(3):32-43.
11. Henry Basil J, Premakumar CM, Mhd Ali A, Mohd Tahir NA, Mohamed Shah N. Prevalence, causes and severity of medication administration errors in the neonatal intensive care unit: a systematic review and meta-analysis. Drug Safety. 2022 Dec;45(12):1457-76. https://doi.org/10.1007/s40264-022-01236-6
12. Jobson MC, Subhashini R. To Assess the Social Maturity Level among Congenital Heart Defect Children. Sciences. 2016;3(2):1-6.
13. Kumar TMS. Integrative approaches in bioinformatics: Enhancing data analysis and interpretation. Innov Rev Eng Sci. 2024;1(1):30-33.
14. Yamamoto R, Sato Y, Maeshima K, Tomita K, Takemura R, Katsura M, Kondo Y, Yasuda H, Kushimoto S, Sasaki J. Pediatric blunt liver and spleen injury treated in hospitals with pediatric intensive care units: Post-hoc analysis of a multicenter, retrospective observational study. Journal of Pediatric Surgery. 2025 Mar 1;60(3):162106. https://doi.org/10.1016/j.jpedsurg.2024.162106
15. Khudhur OI, Aziz AA. Determination of radon concentrations in selected soil samples from the city of Mosul using nuclear track detector CR-39. Int Acad J Sci Eng. 2024;11(1):169-173. https://doi.org/10.9756/IAJSE/V11I1/IAJSE1120
16. dos Santos Alcântara T, Carvalho GA, Sanchez JM, Ramos SF, Cunha LC, de Castro Araújo-Neto F, Valença-Feitosa F, Silvestre CC, de Lyra Junior DP. Quality indicators of hospitalized children influenced by clinical pharmacist services: a systematic review. Research in Social and Administrative Pharmacy. 2023 Oct 1;19(10):1315-30. https://doi.org/10.1016/j.sapharm.2023.07.003

17. Boopathy EV, Shanmugasundaram M, Vadivu NS, Karthikkumar S, Diban R, Hariharan P, Madhan A. Lorawan based coalminers rescue and health monitoring system using IOT. Archives for Technical Sciences. 2024 Dec 24;2(31):213-9. https://doi.org/10.70102/afts.2024.1631.213
18. Belagodu Sridhar S, Karattuthodi MS, Parakkal SA. Role of artificial intelligence in clinical and hospital pharmacy. InApplication of Artificial Intelligence in Neurological Disorders 2024 Jul 1 (pp. 229-259). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-97-2577-9_12