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

OPEN ACCESS

Smartphone-based application for preventing medication errors among pediatric nurses

Vinay Kumar Jaiswal[1], Varri Srinivasa Rao[2]

[1]Assistant Professor, Department of Pharmacy, Kalinga University, Raipur, India.
[2]Research Scholar, Department of Pharmacy, Kalinga University, Raipur, India.

Cite this paper as: Vinay Kumar Jaiswal, Varri Srinivasa Rao, (2025) Smartphone-based application for preventing medication errors among pediatric nurses. *Journal of Neonatal Surgery*, 14 (1s), 262-270.

ABSTRACT

Medication Errors (MEs) harm patient safety incidents across all age demographics. Medical emergencies are incredibly perilous in the juvenile demographic, especially for individuals necessitating specialized care due to the elevated frequency and severity of illness. This research sought to assess the impact of a smartphone messaging application on medical students' education concerning the avoidance of MEs in kids. This quasi-experimental research was conducted with 85 nursing pupils arbitrarily assigned to intervention and control categories. Data was obtained via a researcher-developed checklist. The research engaged with learning via Telegram, a smartphone messaging service, for three weeks. Information was examined using SPSS, employing descriptive and inferential statistics, with $P < 0.04$ deemed significant. The average age of the pupils was 25.4 ± 3.1 years. The predominant MEs associated with medicine events in the control categories encompassed inadequate management of the following MEs: management of high-risk medications, identification of medication incompatibilities, utilization of prescribing cards, estimation of medication dosages, understanding of adverse drug reactions, acknowledgment of pharmaceutical names during drug choice, compliance with clean and sterile techniques, practices for flushing microbore intravenous tubing, modification of intravenous drip rates, and adhering to medication management. The median scores of pupils regarding knowledge of avoiding MEs were markedly different among the two groups. Using the Telegram messaging software for smartphone learning enhances nursing students' understanding of preventing MEs in children's hospitals. The research advocates for implementing this learning method in nursing colleges to mitigate the MEs associated with drug placing an order, dosage, and delivery.

Keywords: Smartphone, Medication Errors, Pediatrics, Nurses

1. INTRODUCTION

Medication Errors (MEs) continue to be among the most common medical errors, resulting in mortality and morbidity [1]. MEs are a metric for assessing facility safety. A ME is an avoidable drug-related incident resulting from any failure in the medical process that poses potential harm to consumers [4] [18]. The number of ME institutions report significantly underrepresents the actual occurrences that can be monitored and carefully documented. In Iran, 9% of hospitalizations result in problems, including adverse medication events, surpassing the United States rate of 2.5%–7.3% [15]. In adults, the actual number of MEs ranges from 2% to 35% of all hospitalizations, with 6% of these MEs about drug orders. The incidence of MEs in kids in hospitals is three times more than that in adults, resulting in considerably severe effects. These MEs can be ascribed to medicine dosage estimations predicated on the child's weight, pharmaceutical dilution, the difficulties in children's communication abilities, the heightened susceptibility of young and ill children, and subsequent renal and hepatic failure resulting from MEs [9]. These MEs result in prolonged hospital stays and related expenses. Adhering to the five rights of giving medication (correct caution, right drugs, proper dosage, the right moment, and the right channel) ensures the safe use of pharmaceuticals. It establishes a foundation for secure nursing care [3]. In recent years, five further items have been incorporated, comprising proper examination, correct to decline, accurate assessment, adequate instruction, and proper governance. Medicine delivery is a critical element of treating patients and a significant feature of nursing effectiveness [14]. To mitigate this avoidable damage, pediatric healthcare systems and professionals must design and execute initiatives to decrease pediatric MEs.

Notwithstanding the initiatives of higher education institutions to instruct on the safe handling of drugs, nursing students continue to make MEs, and data reveals a significant prevalence of MEs among both nursing graduates and registered nurses [8]. The nursing curriculum aims to equip students for their professional careers as proficient and empowered nursing staff

with the requisite information, attitudes, and abilities to sustain and enhance community wellness [5]. Clinical settings can also be unpredictable, intricate, and demanding for new nurses. This fact diminishes their capacity for critical thinking and proper functioning. People arrive at an erroneous conclusion concerning the safe use of drugs. Nursing educators saw a pressing necessity to discover innovative and enhanced methods for student training [13]. Nursing instructors have embraced technology-based education as an answer. The smartphone is one of the most frequently utilized technologies [2]. This use of technology in the nursing classroom aims to augment educators' capacity to boost enthusiasm and educational results while also assisting nurses in enhancing their expertise and skills.

Until lately, limited research has been undertaken to examine the prevalence of MEs and ways to avoid them in juvenile patients relative to the population of adults [7]. Nurse instructors should identify more pragmatic strategies pupils can implement to mitigate MEs. The influence of smartphone messaging programs, such as Telegram, on medical students' efficacy in preventing MEs in pediatric children in Iran remains unexamined [10] [6]. This study assessed the impact of smartphone messaging application learning approaches on nursing learners' skills regarding avoiding MEs in young patients [16]. The research examined the subsequent question: Does using a smartphone application such as Telegram Messaging influence nursing students' understanding of preventing MEs in pediatric clients?

2. METHODS

2.1 Study Users and Setting

The participants consisted of senior nursing pupils. The research evaluated participants according to the subsequent inclusion standards: (1) learners' consent to engage in the study, (2) pupils who fulfill institutional course requirements, and (3) learners lacking prior knowledge regarding the prevention of MEs.

Nursing pupils without smartphones and those who missed two group discussion meetings during treatment were removed. The research employed a random number table to assign 85 eligible individuals to either a control or treatment group during two consecutive periods. Two individuals withdrew owing to personal reasons preventing them from using the Telegram messaging application. The research recruited 85 people in the investigation over two terms. Forty respondents were allocated into four groups, with 12 individuals each term. The research designated the initial two groups of trainees as control populations and the latter two as treatment groups for every term to mitigate data communication across the two types of groups—Figure 1.

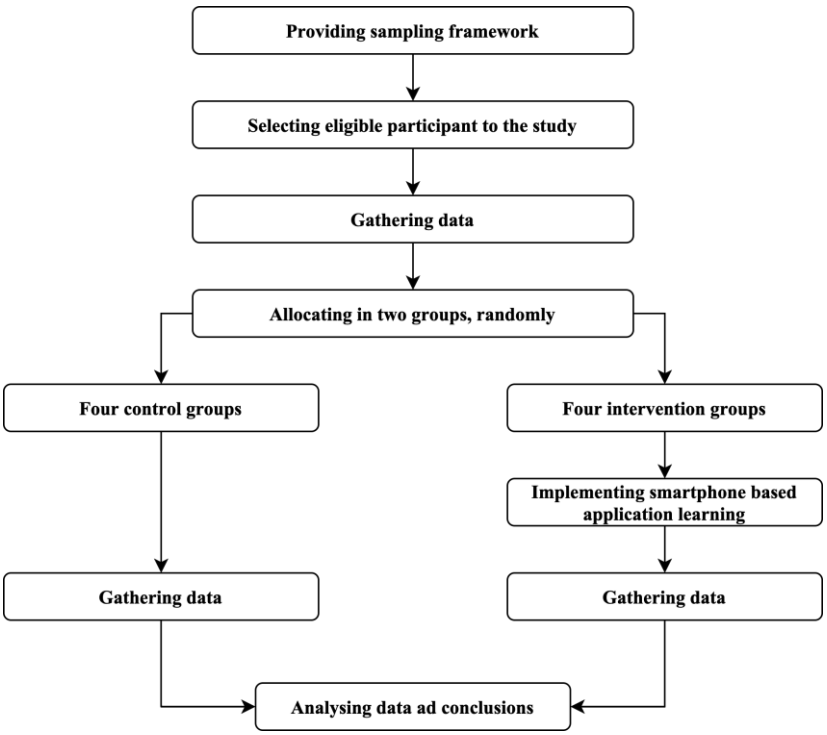

Figure 1: Workflow of the study

2.2 Treatment

The research utilized the Telegram messaging application to instruct learners in nursing. Telegram is a complimentary social network [11]. It is an application for messaging that allows the transmission of many file types, including text messages,

images, and videos, efficiently, swiftly, and securely, at no cost. The majority of colleges are utilizing advanced smartphone technology extensively. Prevalent smartphone messaging applications used for instructional and learning reasons are Telegram (45%), WhatsApp (21%), Viber (12%), and Facebook (6%), among others (13%). Telegram is the predominant messaging program in Iran, Uzbekistan, and Eritrea. Over 45 million Persians use the Telegram application on their smartphones.

The learners in nursing utilized this application to review and deliberate on the educational material supplied by the investigators. The research designed the instructional content to avoid MEs based on a pediatric chemistry textbook, an individual safety manual, and best practices from children's hospitals [12]. The instructional materials had been authorized by the doctor and a nurse practitioner for children before the commencement of the treatment. The instructional materials were sent to each student via Telegram messaging in nine meetings lasting sixty minutes. Digital education occurred thrice weekly using a Telegram channel established for online intimate discussions and exchange of ideas.

To recap the prior meeting's topic, the researcher performed a question-and-answer review during the initial 20 minutes of every session. After every educational meeting, the researcher disseminated the content of the forthcoming lesson to nursing attendees in PDF format via a Telegram group. The research instructed students to consult the source and examine the fresh materials. In the control group, pupils received solely standard training from their professors.

2.3 Measurements and Tools

The data collection comprised a demographic profile form and an evaluation checklist developed by the individual's safety procedure and safe drug administration standards for youngsters. The assessment comprised fifty questions with a 2-point score (measured = 0, unknown = 1). Five nursing instructors and two pharmacists validated the face accuracy of the assessment. The research utilized the Laws Table to verify the numerical value of the material's validity ratio. The research retained the elements with a ratio exceeding 0.45. The material's coherence index was 0.80. The study calculated the Pearson correlation factor ($r = 0.89$) to assess the interdependence of the questionnaire after 12 nursing pupils completed it.

The research regarded age, gender, chemistry score, rating grade, medical MEs, individuals' knowledge of observing medical MEs, and their enrollment in an illness safety program as demographic variables.

2.4 Data Acquisition and Methodologies

The research enlisted students who desired to partake in the study. On the inaugural day of the internship scheme, attendees came to the pediatric unit punctually. Respondents underwent a brief orientation before commencing the study. The research executed individual performance evaluations, dedicating 20 minutes to each student throughout the inaugural week of employment. Research in the treatment groups utilized their smartphone messaging application frequently for three weeks. Everyone involved could access their smartphone data through the provided personal telephone number. A team of investigators comprising an instructor of nursing and a licensed nurse with over five years of nursing practice conducted the pre- and post-assessments.

2.5 Ethical issues

The Ethics Board of the Urmia University of Medicine sanctioned the research. Throughout participant recruiting, the principal investigator, who had not previously interacted with the pupils, administered informed consent to mitigate any potential coercive influence.

2.6 Data Examination

Every statistical analysis was conducted utilizing Statistical Package for the Social Sciences (SPSS) [16] [17]. Descriptive statistical techniques (mean, standard deviations) and inference statistics (without regard to t-assessment, chi-square assessments, and Fisher's exact assessment) were employed to examine the data. The research used the Shapiro-Wilk assessment to assess the consistency of individuals' attributes. The threshold for statistical significance was established at $P < 0.05$.

3. RESULTS

Data were analyzed utilizing the SPSS. The quantitative results were presented as Average and Standard Deviation ($M \pm SD$) and evaluated with the Friedman assessment for variance and Analysis of Variance (ANOVA) for mean comparisons. The qualitative information was represented as numerical values and percentages. The analysis was conducted using the chi-square assessment (χ^2). The Pearson correlation coefficient was employed to elucidate the link between distributed measurement variables. A statistically significant distinction was deemed present if $p < 0.04$. The distinction was considered statistically significant if $p < 0.002$.

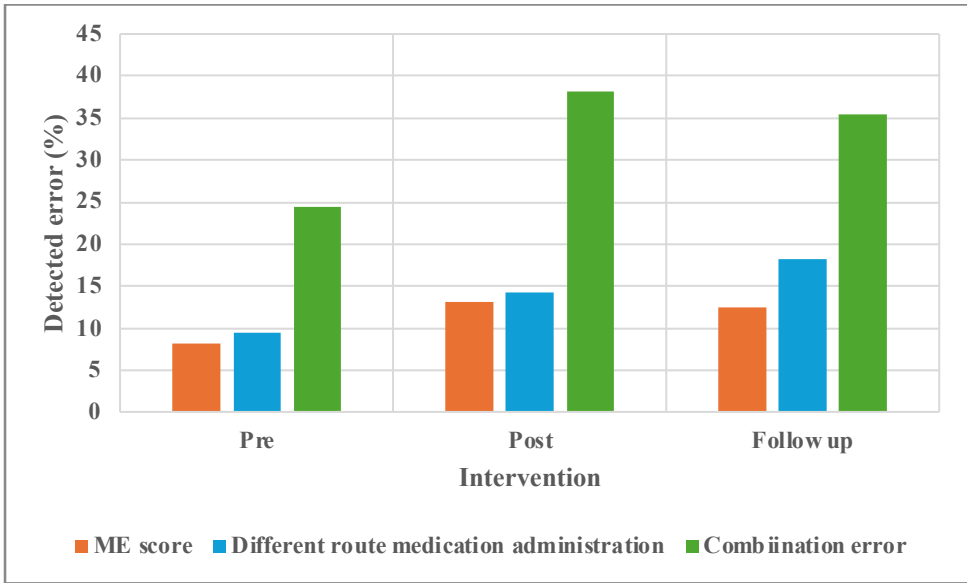

Figure 2: Detected error analysis

Figure 2 presents the traits of the examined nurses. It indicated that 55% of the surveyed nurses were over 32 years old. Analysis of their years of work showed that over half of the surveyed nurses (65%) have more than five years of expertise. None of the nurses studied had participated in any prior medication security courses.

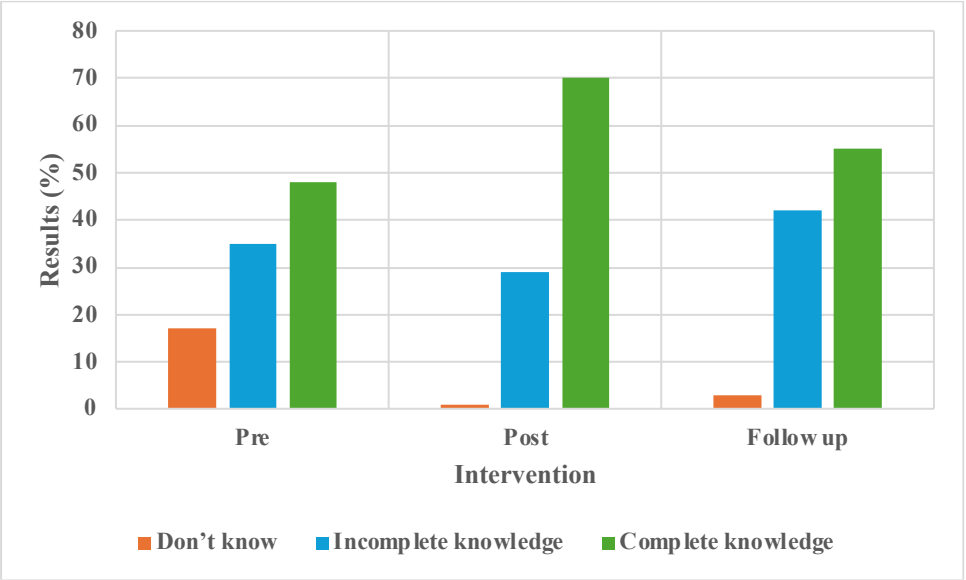

Figure 3: Testing result analysis

Figure 3 illustrates nurses' understanding of the rights associated with properly giving medication across pre-assessment, post-assessment, and follow-up assessments. This indicates that 17% of nurses lacked knowledge regarding these rights in the pre-assessment, whereas 70% and 65% demonstrated a complete understanding of the post-assessment and follow-up examination.

Figure 4 shows the allocation of nurses based on MEs in the planning, management, and reporting of drugs during pre-, post-, and follow-up assessments. The data indicated that MEs during planning, management, and paperwork occurred in 23%, 25%, and 17% of healthcare professionals before treatment. Only 15% and 9% of nurses made MEs in paperwork and medication post-assessments.

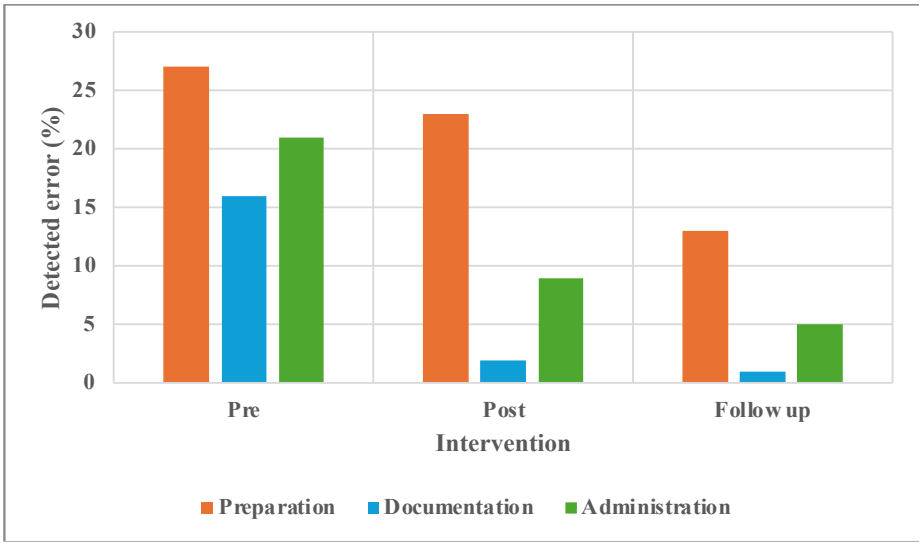

Figure 4: Detected error analysis

Figure 5 shows the Average scores of nurses' thorough understanding of MEs and medication routes on pre, post, and follow-up assessments. The results indicated that nurses scored superior drug safety awareness scores on the post-assessment and monitoring evaluation compared to the pre-assessment. The results showed that registered nurses achieved higher overall knowledge ratings on the post-assessment and monitoring assessment than on the pre-assessment. There were highly statistically significant distinctions in the expertise of nurses at the 0.001% level of relevance.

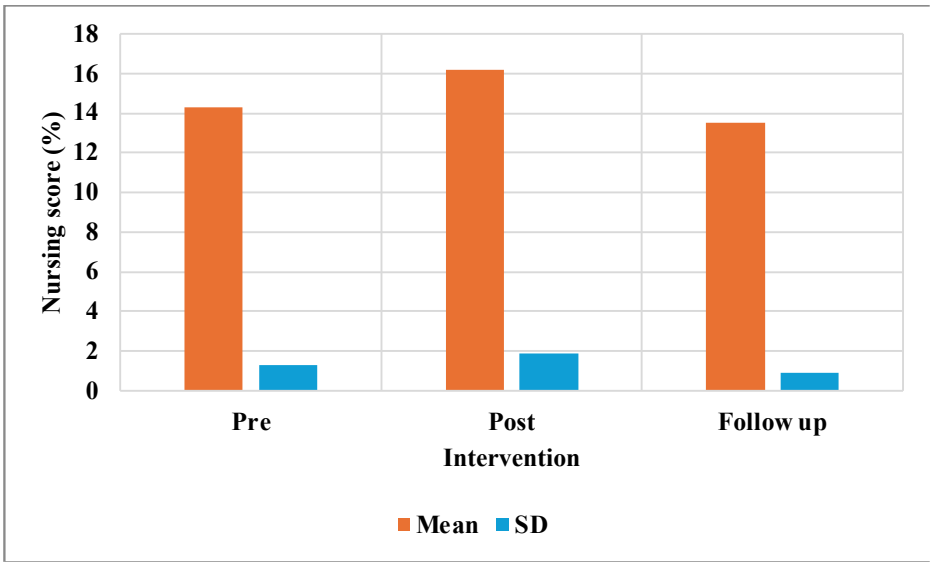

Figure 5: Nursing score analysis

Figure 6 illustrates average ratings of overall nursing methods for safety preparations and drug delivery during pre-, post, and follow-up assessment stages. The complete medication monitoring form demonstrated a higher score in the post-assessment than in the follow-up and pre-assessments. It illustrates the overall means of the drug security audit list for pre-, post, and follow-up assessments. The results indicated that the average score of the pharmaceutical safety auditing list was higher in the post-assessment and follow-up assessments compared to the pre-assessment. There were statistically significant changes at the 0.002% level of relevance.

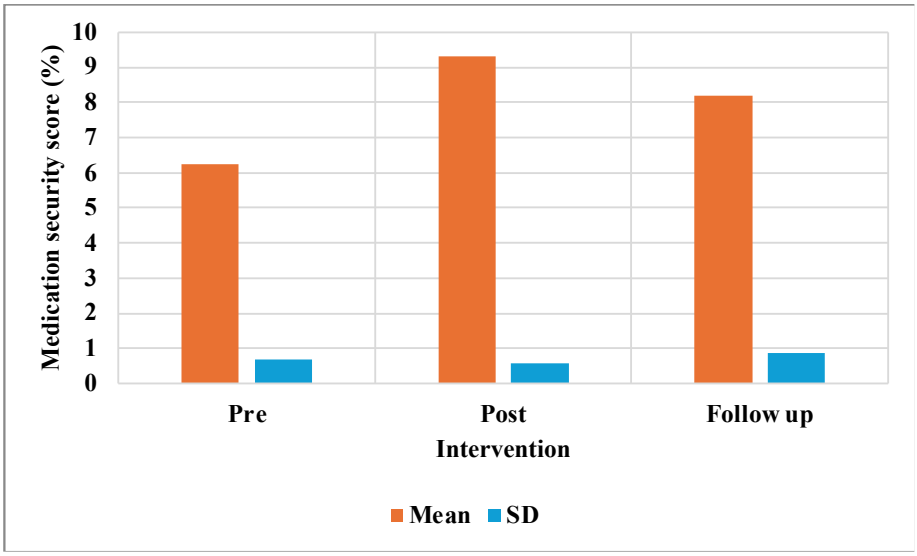

Figure 6: Medication security score analysis

4. DISCUSSION

4.1 Strategies for the prevention of medication MEs

The primary aim of this study was to identify preventative techniques. The introduction or enhancement of the electronic physician order process was the most examined technique (27.1%) in the reviewed research, demonstrating reduced medication ME rates following the interventions. This application diminishes reading MEs and enhances communication among groups. A study examining nursing professors' understanding of patient safety identified electronic prescriptions as a prominent strategy for preventing and mitigating medication MEs.

The research employed a clinical dosing guidance system, automated electronic warnings for comparable nomenclature, and the application of pediatric dose protocols to enhance electronic prescribing. The computer's interface resembles a calculator, inputting the kid's height and age to calculate the drug dosage while providing alerts in the event of a fatal overdose or underdose, for instance. Uniformity of dosage, timing, and injection pump programming computations was instituted for ongoing infusion medications in a Pediatric Intensive Care Unit (PICU) to mitigate adverse events.

A study conducted in Madrid, Spain, focused on standardization and creation of procedures for pediatric dosage administration, revealing that one-third of nursing staff do not verify the given standard dosage. A study at an academic medical center created a computerized tool to enhance drug reconciliation upon patient admission. The tool displays, concurrently, the patient's pre-admission medication list alongside the list of prescribed medications during hospitalization.

This technique detected and measured the decrease in events following the treatment by examining ME complaints. Verification is crucial to avert MEs at the most pivotal stages of drug manufacturing. This was emphasized in a study that evaluated nurses' comprehension of the technique. Specific research sought to establish preventive strategies, including utilizing checklists, clinical procedures, drug administration flowcharts, and dosage management procedures. These measures aimed to reorganize and streamline the pharmaceutical process to minimize MEs.

The natural reporting mechanism for adverse medication events is a preventive strategy in the evaluated trials. A five-year study revealed that evaluating drug MEs promotes learning from MEs and preventing future recurrence. Other research investigated implementing ME screening systems via trigger instruments or specialized surveys. Key suggestions were found, including enhanced professional training for pediatric nursing, enhanced interaction regarding safe medication administration within the multidisciplinary group and among members and parents, and recognition of the problems associated with administering medications safely. The reorganization of processes predicated on MEs encompasses educational initiatives, enhanced collaboration among teams, the integration of reporting within the training of nurses, the utilization of laboratory simulations, the cultivation of a culture of privacy and suggestions, and the significance of raising consciousness about MEs in online simulations. Educational strategies should be promoted to avert drug MEs in pediatric healthcare.

Regarding the involvement of medical professionals, pharmacies are distinguished as essential contributors to medication procedures and avoiding adverse events. A study in Spain revealed the substantial influence of clinical pharmacist actions in mitigating prescription ME occurrences.

A recent research in Brazil included ongoing instruction on handling drugs. The intervention resulted in a decrease in the

dosage of MEs and an increased rate of ME identification at the PICU. Instructional initiatives facilitated by discussions, educational resources, and online simulations have proven significant treatments for enhancing multidisciplinary interaction, fostering a safety culture, and decreasing drug-related event occurrences.

The examination of the research revealed an absence of preventive techniques to mitigate MEs during the medicine delivery period. The significance of establishing barriers across all process stages is underscored; management, as the ultimate barrier, requires additional investigation to identify this process's primary vulnerabilities and develop preventive solutions.

4.2 Incidents of safety for patients related to pharmaceuticals

The examined research lacked a defined methodology, complicating comparability and replication processes. A consistent study strategy for pediatric patient safety events would improve consistency in information and results. The frequencies of drug ME incidents varied from 0.91% to 54%, as reported in research conducted over periods ranging from three months to a decade. Only one study in the USA failed to show a substantial decrease in medication ME rates following adopting a computerized prescription system.

Of the 27 studies examined, 10 reported drug incident rates before and after the treatment. Most people exhibited a reduced number of events following the recommended intervention. A recent investigation in Japan revealed that the drug ME occurrence rate decreased from 2.23% to 0.66% following an intervention over 14 months. The rectification rate of close calls improved tenfold with the deployment of computerized doctor order systems with medical decision assistance. A study conducted in Canada assessed the efficacy of clinical simulations as well as simulated games in identifying MEs, revealing that 78.4% of pharmacists achieved an accurate response rate for pharmaceutical MEs. Doctors and nurses attained comparable rates of 67%. It was determined that increasing awareness of the hazards is a crucial pedagogical measure to enhance the safe use of medicines.

Research conducted in the United States evaluated 608 similarly named medicines, revealing that switched drug delivery happened in just 34% of the pairs tested. In 49% (298 pairings) of the medications with analogous nomenclature or phonetics, the drug was substituted in 3.7k instances, resulting in an accumulated rate of 0.1 per day over a decade. At a rate of 17%, the predicted incidence was 27 MEs per day, affecting 98k individuals who received substituted medications.

In 40.7% of the research, only the incidence rates were assessed following the execution of educational interventions. A natural reporting system within a pediatric teaching clinic in São Paulo recorded 120 ME incidents, with 45.8% occurring in 2020 and 54.2% in 2023. The heightened reporting is regarded as a positive outcome of advancing security culture.

Monitoring and analyzing ME occurrence rates should facilitate the adoption of prevention initiatives, showing their efficacy and allowing for necessary revisions. The data related to the medication procedure elucidate the issue and underscore the necessity of establishing educational initiatives to avert MEs.

4.3 Stages of the pharmacological process with an increased incidence of MEs

The prescription stage in the drug procedure accounts for the highest incidence of problems (42.5%). MEs in juvenile patients are closely associated with the necessity for precise weight-based dosing. Integrated with medical decision support systems and automated electronic notifications, a computerized prescription structure is essential for ME prevention. Incorrect drug dosing MEs were noted in four investigations. An examination of opioid painkillers and anti-diabetic medications revealed a significant incidence of dosage MEs.

In two studies conducted in Brazil, dosage omission was prominent. The causes are attributed to insufficient attention, excessive workload, stress, and inadequate staffing; the deficiencies in the prevention measures must also be considered. A study outlined the three stages of the drug process—prescription, distribution, and administration—highlighting that MEs were systemic. The participants in the simulation accurately identified 63.2% of the problems associated with the medical system.

In 35% of the assessed studies, the purpose was not to ascertain the stage of the treatment procedure during which MEs occur. The majority of evaluated studies concentrated on prescription MEs. All aspects of the pharmaceutical process are interconnected, and all healthcare workers, especially the nursing staff, bear obligations throughout this procedure.

5. CONCLUSION

Pediatric children are susceptible to MEs. This study highlights the efficacy and importance of mobile devices, such as smartphone applications, in nursing trainees' education, education, and clinical experiences. Secondly, it assists pupils by minimizing MEs and enhancing drug manufacturing and distribution times. Using novel smartphone applications is strongly advised, particularly in pediatric departments. This study demonstrates that nursing pupils have a knowledge of ME enhanced by using a smartphone messaging application.

6. LIMITATIONS

A limitation of this research is the accessibility of other instructional materials for nursing learners. To address this constraint, nursing students communicated their inquiries to investigators and fellow students via a smartphone messaging application on the Internet. They utilized simultaneous discussions in a Telegram group discussion or by sending emails. Conversely, the investigators endeavored to furnish content from the most recent and credible sources to address every learning requirement of students in avoiding MEs, eliminating the need to consult additional resources for learning. There is potential for communication and information exchange between the two subgroups during this research. The investigators designated the first and second sets of participants as the control categories. In contrast, the third and fourth categories were classified as the treatment categories to inhibit this data transmission. In light of the study's results, the investigators recommend additional investigations employing many instructional mediums, including video, audio, and graphics, integrating other pedagogical approaches such as e-learning and presentations.

REFERENCES

[1] Pinho RH, Nasr-Esfahani M, Pang DS. Medication errors in veterinary anesthesia: a literature review. Veterinary Anaesthesia and Analgesia. 2024 Jan 20.

[2] Cabra JL, Parra C, Trujillo L. Earprint touchscreen sensoring comparison between hand-crafted features and transfer learning for smartphone authentication. J. Internet Serv. Inf. Secur.. 2022 Aug;12(3):16-29. https://doi.org/10.22667/JISIS.2022.08.31.016

[3] Bante A, Mersha A, Aschalew Z, Ayele A. Medication errors and associated factors among pediatric inpatients in public hospitals of gamo zone, southern Ethiopia. Heliyon. 2023 Apr 1;9(4).

[4] 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

[5] Edwards AP, Nash AJ. Transformative care for people with disabilities: Empowering senior nursing students with competency based clinical education-A qualitative study of the impact. Nurse Education Today. 2023 Jul 1;126:105822.

[6] Odeh A, Taleb AA. A Multi-Faceted Encryption Strategy for Securing Patient Information in Medical Imaging. Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications. 2023;14(4):164-76. https://doi.org/10.58346/JOWUA.2023.I4.012

[7] Mi X, Zeng L, Zhang L. Systematic review of the prevalence and nature of drug-related problems in paediatric patients. Journal of Clinical Pharmacy and Therapeutics. 2022 Jun;47(6):776-82.

[8] Geng Y. Comparative Study on Physical Education Learning Quality of Junior High School Students based on Biosensor Network. Natural and Engineering Sciences. 2024 Sep 1;9(2):125-44. https://doi.org/10.28978/nesciences.1569219

[9] Agarwal TK, Tiwari M, Lamba SS. Modified histogram based contrast enhancement using homomorphic filtering for medical images. In2014 IEEE International Advance Computing Conference (IACC) 2014 Feb 21 (pp. 964-968). IEEE.

[10] Bosson N, Kaji AH, Gausche-Hill M. A standardized formulary to reduce pediatric medication dosing errors: a mixed methods study. Prehospital Emergency Care. 2022 Jun 21;26(4):492-502.

[11] Stevovic I, Hadrović S, Jovanović J. Environmental, social and other non-profit impacts of mountain streams usage as renewable energy resources. Archives for Technical Sciences. 2023;2(29):57-64. https://doi.org/10.59456/afts.2023.1529.057S

[12] Rhoney DH, Singleton S, Nelson NR, Anderson SM, Hubal R. Forces driving change in pharmacy education: opportunities to take academic, social, technological, economic, and political into the future. Journal of the American College of Clinical Pharmacy. 2021 May;4(5):639-51.

[13] Veerappan S. Digital management and sustainable competitiveness: using eco-innovation and green absorptive capacity in travel and hospitality enterprises. Global Perspectives in Management. 2024;2(3):32-43.

[14] Haleem A, Javaid M, Singh RP, Suman R. Medical 4.0 technologies for healthcare: Features, capabilities, and applications. Internet of Things and Cyber-Physical Systems. 2022 Jan 1;2:12-30.

[15] Alkaim AF, Khan M. Pharmacist-Led Medication Therapy Management: A Review of Its Effectiveness in Improving Patient Outcomes. Clinical Journal for Medicine, Health and Pharmacy. 2024 Dec 20;2(4):31-9.

[16] Alghamdi A, Alhulaylah F, Al-Qahtani F, Alsallal D, Alshabanat N, Alanazi H, Alshehri G. Evaluation of pharmacy intern-led transition of care service at an academic hospital in Saudi Arabia: A prospective pilot study. Saudi Pharmaceutical Journal. 2022 May 1;30(5):629-34.

[17] Roy J, Nihlani A, Talwar R, Gautam S. Assessing the social impacts of fisheries decline on fishing communities. International Journal of Aquatic Research and Environmental Studies. 2024;4(S1):77-82. https://doi.org/10.70102/IJARES/V4S1/13

[18] Darvish H, Shahhoseini FS. The role of synergies in the management and staff of administrative organizations (case studies: Governor of Tehran). International Academic Journal of Organizational Behavior and Human Resource Management. 2015;2(1):1-9.