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The role of advanced practice nurses and clinical pharmacists in reducing medication errors in emergency care: Review

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***Abstract*---Background**: Medication errors are a significant issue in healthcare, especially in emergency neonatal care, where infants are particularly vulnerable due to their unique physiological characteristics and the complexity of drug management. This systematic review explores the roles of advanced practice nurses (APNs) and clinical pharmacists in reducing medication errors in this high-risk environment. **Methods**: A comprehensive search of PubMed and EMBASE was conducted for studies published from 1966 to 2018, focusing on interventions aimed at minimizing medication errors in neonatal care. **Results:** The review identified 86 comparative studies, revealing varied methodologies and outcomes. Notably, while no single intervention emerged as the most effective, multifaceted strategies incorporating both technology and clinical expertise demonstrated promise in enhancing medication safety. Advanced practice nurses and clinical pharmacists were found to significantly contribute to reducing medication errors through direct involvement in prescribing, monitoring, and patient education. Despite the positive findings, the review highlighted the need for standardized methodologies and consistent reporting criteria across studies to draw definitive conclusions. **Conclusions:** The findings underscore the importance of integrating APNs and clinical pharmacists into neonatal care teams to mitigate medication errors and improve patient safety. Future research should focus on evaluating the cost-effectiveness of various interventions and developing standardized protocols to enhance medication management in neonatal settings.

***Keywords*---**Medication errors, emergency care, advanced practice nurses, clinical pharmacists, patient safety.

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1. Introduction

Medication mistakes constitute a substantial strain on the healthcare system [1]. They are described as avoidable events that may result in improper drug use or patient damage, occurring at any step of the medication-use process, including prescribing, transcribing, dispensing, administering, and monitoring of medicines [2]. Neonates are more susceptible to medication mistakes at every phase of the medication management process because of the heightened need for calculations, dilutions, and manipulations of drugs [3,4]. Additionally, several drugs are used off-label in newborns, indicating that they lack particular licensing for this population and are often accessible just in adult formulations and doses [5]. Consequently, issues in prescription and administration often expose newborns to the danger of potentially lethal dosage mistakes of 10-fold or 100-fold [6,7]. The difficulty of restricted dosage guidelines and a lack of evidence-based data about the effectiveness, safety, dose, pharmacokinetics, and therapeutic use of medicines in newborns persists [6].

Furthermore, relative physiological immaturity indicates that newborns possess a diminished ability to mitigate the unwanted effects of pharmaceutical mistakes [8]. The vulnerability to medication errors in neonates, as previously noted, is further underscored by research indicating that medication errors with the potential for substantial harm were three times more prevalent in the neonatal intensive care unit (NICU) compared to adult wards [9]. Moreover, an examination of all medical mistakes in the NICU revealed that pharmaceutical errors were the predominant factor, representing 47.2% of all errors [10].

Due to the intricacies of drug administration in newborns, the prevalent use of high-risk pharmaceuticals, and the possibility of significant adverse effects from even modest mistakes, intervention options to enhance medication safety in neonatal care must be routinely evaluated. The identification and assessment of these treatments are crucial for aiding healthcare systems and providers in comprehending, executing, and enhancing measures to mitigate newborn medication mistakes [11] Notwithstanding its significance, there have been few comprehensive systematic reviews on treatments aimed at minimizing medication mistakes in the newborn context, with the most recent evaluations including research only up to 2013 [12–14]. Moreover, none of these evaluations included both comparative and noncomparative investigations. This systematic study sought to identify and evaluate several strategies designed to reduce newborn drug mistakes.

2. Methods

PubMed and EMBASE were examined for papers published from 1966 to 2017, with no language constraints imposed. The search included a drug errors/safety concept and a neonatal concept, using both restricted vocabulary and keywords across all databases. MeSH search keywords comprised: ‘medication errors’ AND ‘Infant, Newborn’, OR ‘Intensive Care Units, Neonatal’, OR ‘Intensive Care, Neonatal’, OR ‘Pediatrics’. Reference lists of all publications subjected to full-text examination, together with other review articles, were examined for further research.

3. The Risk of Medication Mistakes

Our review's results indicate that no one intervention was distinctly more effective in mitigating the risk of medication mistakes, with the considerable variety seen across research both within and between themes regarding methodologies, definitions, and outcomes. Identified treatments often address many facets of the medication management process, indicating that a multifaceted approach is likely necessary to achieve a substantial decrease in medication mistakes.

Santesteban et al. have released the latest systematic evaluation of strategies aimed at minimizing medication mistakes in newborn care [14]. Their search was confined to research conducted only in newborn units, resulting in the identification of 16 intervention studies published by 2013. Our investigation was far more comprehensive, uncovering 34 comparison studies conducted in the newborn context, from a total of 86 comparative studies included in this review. Despite the variation in the number of trials, the results are consistent in indicating that while several strategies showed considerable promise in decreasing medication mistakes, definitive conclusions on the most beneficial interventions could not be established [15-22]. Our results align with those of a prior systematic analysis conducted by Rinke et al. [12], which included 63 research in neonatal and pediatric contexts, as well as a recent Cochrane review that incorporated data from just seven investigations. Both assessments noted that the failure to reach definitive findings stemmed partially from the scarcity of studies in some domains, as well as from considerable methodological variation identified throughout the research. A recurring concern highlighted in evaluations is whether reductions in drug mistakes correlate with patient benefits in terms of minimizing actual damage [23-27].

Although it is difficult to explicitly associate pharmaceutical mistakes with patient damage, data suggests that certain strategies provide additional benefits beyond just decreasing medication errors [28-35]. Myers and colleagues noted that implementing a computerized physician order entry (CPOE) system with clinical decision support (CDS) correlated with a decrease in pharmacy phone calls [36]. Vardi and colleagues similarly found that this technique reduced the time required to order resuscitation drugs from 14.4 minutes to 2.1 minutes ($p < 0.001$) [37]. Maat and colleagues notably found no decrease in medication mistakes linked to their adoption of Clinical Decision Support (CDS) for controlling hypo/hyperglycemia; however, they did detect a reduction in the time required to execute basic (1.3; 0.3–2.3 min) and complicated orders (8.6; 5.1–12.1 min) [38].

Abboud and colleagues highlight the possibility of diminished intervention efficacy attributable to local variable variables, noting that the use of CDS in the prescription process did not lead to a decrease in gentamicin monitoring mistakes [39]. The authors posited that the intervention had negligible benefits due to the existing presence of a clinical pharmacist tasked with maintaining proper monitoring; however, outcomes may vary in environments without clinical pharmacists.

Research consistently indicates that optimal advantages from CPOE were not realized until the integration of CDS occurred.46.48. This is logical since Clinical Decision Support systems or computer programs are often designed to tackle tasks identified as high risk, hence offering a larger opportunity to mitigate prescription mistakes [40-44]. Significantly, these enhancements were not exclusively confined to technology-driven treatments. Inexpensive treatments using paper-based prescription and clinical decision support, such as preprinted order forms, were shown to provide comparable reductions in pharmaceutical mistakes to more costly, computer-based methods [45-49]. Consequently, in environments lacking accessible CPOE systems, cost-effective alternative strategies for CDS are preferable.

A prevalent concern identified in several research was the need to sufficiently assist personnel in the execution of interventions, particularly those that markedly alter existing procedures [50]. The use of automated infusion devices in drug libraries necessitates that personnel utilize the technology comprehensively to get optimal benefits. Due to different factors, such as personnel seeing the new procedure as too complex or time-consuming, alternative methods may be devised, potentially resulting in medication mistakes. Manrique and colleagues observed the use of automated infusion devices, reporting a compliance rate of 78–85% [21,22]. Although the automated infusion devices demonstrated significant efficacy in mitigating potentially catastrophic drug mistakes, adherence remained suboptimal. Hennings and associates found that newborn ICU personnel were almost twice as likely (RR 1.68; 1.18–2.38) to reprogram pumps compared to adult ICU personnel [20]. The ambiguity is in whether the issue resulted from personnel neglecting or bypassing the alarms, or whether the medicine library and its related features were inadequately developed for use in the newborn unit. These instances underscore the need for comprehensive implementation methods and the imperative to continuously monitor and assess the use of new technology inside the neonatal unit. There is a continual need to study and upgrade these technologies as time progresses and more breakthroughs occur [51,52].

The strengths of our study include a thorough literature search method and the incorporation of a wide array of comparative and noncomparative studies to examine the extensive research previously conducted on therapies aimed at minimizing medication mistakes in newborns. This is particularly beneficial for examining the assessment of various therapies to facilitate application in clinical practice and to inform future research goals.

Despite the thoroughness of our systematic assessment, certain limitations need attention. Initially, considerable diversity was seen across the included studies, characterized by disparities in intervention strategies, trial methodologies, categories of medication mistakes assessed, and the identification and evaluation of medication errors. Previous systematic studies of strategies aimed at reducing pediatric drug mistakes have shown such variability [12]. A crucial factor in addressing the limitations of the current database highlighted in this study is the standardization of criteria and research methodology for studies on drug errors. Consistent evaluation of medication errors utilizing universal reporting standards, such as those advocated by the National Coordinating Council for Medication

Error Reporting and Prevention, would enhance comprehension of the effects of interventions on detrimental medication errors [53]. This is important given only eight of the analyzed studies reported separately on minor and large drug mistakes, indicating a notable disparity in error reduction based on the criterion used.

One study saw a 16% rise in small medication mistakes after the intervention was implemented, mostly attributed to heightened awareness and reporting of errors, but there was a significant 100% decrease in serious errors [54]. There have been calls for a more consistent application of denominators that accurately represent the total opportunities for error (e.g., prescribing errors per 1000 medication orders), instead of utilizing alternative denominators like medication errors per patient or patient day. The latter is deemed more prone to bias from variables such as patient criticality and the number of medications ordered, thereby hindering the capacity to compare results across studies effectively.

4. Conclusion

Although several treatments help mitigate newborn medication mistakes by enhancing the drug use process, no singular strategy proved to be more effective than the others. Although there has been a substantial rise in published research aimed at mitigating newborn drug mistakes, our understanding of effective therapies is hindered by inconsistencies in study design, data-collecting methods, and outcome reporting. This variability complicates the formulation of definitive recommendations for the most effective strategies to implement. Additional study is necessary to assess the comparative cost-effectiveness of different pharmaceutical safety strategies to inform judgments about their adoption and integration into clinical practice. The selection of optimal strategies for enhancing pharmaceutical safety will likely be individualized, factoring in local resources and an awareness of the kinds and degree of mistakes present within the business.

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دور الممرضين المتقدمين والصيادلة السريريين في تقليل الأخطاء الدوائية في رعاية الطوارئ: مراجعة

الملخص

الخلفية :تُعد الأخطاء الدوائية مشكلة كبيرة في مجال الرعاية الصحية، وخاصةً في رعاية الطوارئ لحديثي الولادة، حيث يكون الرضع عرضة بشكل خاص لهذه الأخطاء نظرًا لخصائصهم الفسيولوجية الفريدة وتعقيدات إدارة الأدوية. تستعرض هذه المراجعة المنهجية أدوار الممرضين المتقدمين (APNs) والصيادلة السريريين في تقليل الأخطاء الدوائية في هذا البيئة ذات المخاطر العالية.

الطرق :تم إجراء بحث شامل في قواعد بيانات PubMed و EMBASEللدراسات المنشورة في الفترة بين 1966 و2018، مع التركيز على التدخلات التي تهدف إلى تقليل الأخطاء الدوائية في رعاية حديثي الولادة.

النتائج :حددت المراجعة 86 دراسة مقارنة أظهرت منهجيات ونتائج متنوعة. ورغم عدم بروز تدخل واحد كالأكثر فعالية، أظهرت الاستراتيجيات متعددة الجوانب التي تجمع بين التكنولوجيا والخبرة السريرية وعودًا بتحسين سلامة الأدوية. ووجدت المراجعة أن الممرضين المتقدمين والصيادلة السريريين يساهمون بشكل كبير في تقليل الأخطاء الدوائية من خلال مشاركتهم المباشرة في وصف الأدوية، ومراقبتها، وتعليم المرضى. ورغم هذه النتائج الإيجابية، أشارت المراجعة إلى الحاجة إلى منهجيات موحدة ومعايير تقارير متسقة عبر الدراسات للوصول إلى استنتاجات واضحة.

الخلاصة :تؤكد النتائج على أهمية دمج الممرضين المتقدمين والصيادلة السريريين ضمن فرق رعاية حديثي الولادة لتقليل الأخطاء الدوائية وتعزيز سلامة المرضى. ويجب أن تركز الأبحاث المستقبلية على تقييم فعالية التكلفة للتدخلات المختلفة وتطوير بروتوكولات موحدة لتحسين إدارة الأدوية في بيئات حديثي الولادة.

الكلمات المفتاحية :الأخطاء الدوائية، رعاية الطوارئ، الممرضون المتقدمون، الصيادلة السريريون، سلامة المرضى.