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MEDICATION ADMINISTRATION ERRORS IN NEONATAL INTENSIVE CARE UNITS: AN INTEGRATIVE LITERATURE REVIEW

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ABSTRACT

INTRODUCTION: The Neonatal Intensive Care Unit (NICU) provides comprehensive care to critically ill newborns, requiring safe practices, especially in the preparation and administration of medications. Errors in this step can cause significant harm to the patient, increasing morbidity and mortality. Due to the physiological vulnerability of neonates and the particularities of drug therapy — such as weight-adjusted dosages and communication difficulties — there is a greater propensity for failures, reinforcing the need for rigorous protocols. Medication errors are considered avoidable adverse events, and can occur in several phases, such as prescription, preparation, dispensing, and administration. **OBJECTIVE:** To analyze the available evidence on the most common errors in medication administration in NICUs. **METHODOLOGY** : This is an integrative review based on the methodology of Whittemore and Knafl (2005). The search was carried out in the Web of Science, PubMed, Scopus, Embase, and CINAHL databases, in March 2025, using specific strategies for each database. After screening and inclusion criteria, 12 studies were selected for analysis. **RESULTS:** The analysis of the studies revealed methodological diversity, with a predominance of observational and documentary studies in different countries. The most prevalent errors involved illegibility of prescriptions, erroneous dosage calculations, preparation failures such as non-homogenization of the drug, in addition to delays in administration, inadequacy of the infusion route and speed, and problems with the management of infusion pumps. Serious errors, such as administering tenfold doses and failures in critical medications, were also observed. Organizational factors, such as insufficient nursing staff and similarity between medication packaging, contributed to the increase in errors. The prevalence of underreporting makes it difficult to assess the scenario and implement improvements in the health service. **FINAL CONSIDERATIONS:** It is concluded that the NICU environment requires continuous interventions to prevent errors, professional training and strengthen the safety culture, aiming to protect the health of neonates and promote safer care practices.

Keywords: Medication Errors; Newborn; Nursing; Neonatal Intensive Care Units.

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1 INTRODUCTION

The Neonatal Intensive Care Unit (NICU) is an inpatient service responsible for the comprehensive care of critically or potentially serious newborns. Equipped with care structures that have adequate technical conditions, the NICU offers specialized care through adequate physical facilities, equipment and human resources (Ferraresi, Arrais, 2018; Brazil, 2013). Within this context, the procedure of preparing and administering drugs is of critical importance.

Because it is an essential care for the reintegration of the newborn's health, it represents a significant challenge in the construction of a safe practice. Errors in the different stages of drug therapy can cause damage and increase the risks to the patient, requiring extra attention and strict protocols for prevention (Brasil, 2013; Llapa-Rodriguez et al,.2018).

In the context of the NICU, medication error is highlighted as one of the main risks to the safety of the newborn (Gaíva, Sousa, 2015). During this care process, it is observed that nurses and other team members need to have extensive technical-scientific knowledge (Guzzo et al., 2018). Neonates are highly vulnerable to preventable medication errors due to their extensive drug exposure in neonatal intensive care units (NICUs). These mistakes, which can be made by doctors, nurse practitioners, or pharmacists, are costly and can be fatal (Daher, et al,.2020).

The fragility of the newborn and the potential danger of the drugs in developing humans require special attention. Medication error is defined as an avoidable event that can improperly intervene in the medication administration process, causing or not harm to the patient. (Brazil, 2014; Volpatto et al, 2019). Such events can occur at any stage of drug therapy, which can be in the prescription, dispensation, preparation and/or administration (Santos, Rocha, Sampaio, 2019).

To promote a safe practice in the use of medicines, the National Health Surveillance Agency (ANVISA) instituted the Safety Protocol for the prescription, use and administration of medicines (Brasil, 2013). This protocol is especially relevant in the context of the Neonatal Intensive Care Unit (NICU), an environment characterized by high vulnerability to the occurrence of adverse events, notably those related to medication errors (National Coordinating Council for Medication Error Reporting AND Prevention, 2016; Oliveira, et al,.2024).

Nursing plays an important role in the drug therapy process and it is essential that these professionals are aware of the importance of safe practices in drug administration (Schwendimann et al,.2018). Errors occurring during this stage can cause irreversible damage to the newborn (Antonucci, Porcella, 2014, Souza Neta et al., 2019).

In view of the above, the objective of the present study was to analyze the evidence on medication administration errors in the neonatal care unit.

2 METHOD

This is an integrative review, whose development was based on the approach of Whittemore and Knafl (2005), which includes five stages: (1) identification of the problem, (2) search in the literature, (3) evaluation of data quality, (4) data analysis and (5) presentation of results. The following research question guided the review: What are the most common errors in medication administration in the neonatal intensive care unit?

The inclusion criteria were studies that addressed medication errors that occurred in the neonatal unit and the exclusion criteria were: editorials, theses, dissertations, etc.
The search strategy and the entire review process was carried out in March 2025,. The bibliographic survey was carried out in the *Web Of Science, National Library of Medicine* (PUBMED), SCOPUS, EMBASE and *The Cumulative Index to Nursing and Allied Health Literature* (CINHAL) databases. Along with the descriptors, the Boolean term AND was used to compose the search keys. There was no time limitation for the search strategy, which is described in Chart 1.

Frame 1- Search strategy

WEB OF SCIENCE	Medication Errors AND Infant, Newborn AND Nursing AND Intensive Care Units, Neonatal
PUBMED/MEDLINE	Medication Errors AND Infant, Newborn AND Nursing AND Intensive Care Units, Neonatal
SCOPUS	"Medication Errors" AND "Infant, Newborn" AND nursing AND "Intensive Care Units, Neonatal"
EMBASE	('medication errors'/exp OR 'medication errors' OR (('medication'/exp OR medication) AND errors)) AND ('infant, newborn'/exp OR 'infant, newborn' OR (('infant,'/exp OR infant,) AND ('newborn'/exp OR newborn))) AND ('nursing'/exp OR nursing) AND ('intensive care units, neonatal'/exp OR 'intensive care units, neonatal' OR (intensive AND ('care'/exp OR care) AND units, AND neonatal))
CINAHL	Medication Errors AND Infant, Newborn AND Nursing AND Intensive Care Units, Neonatal.

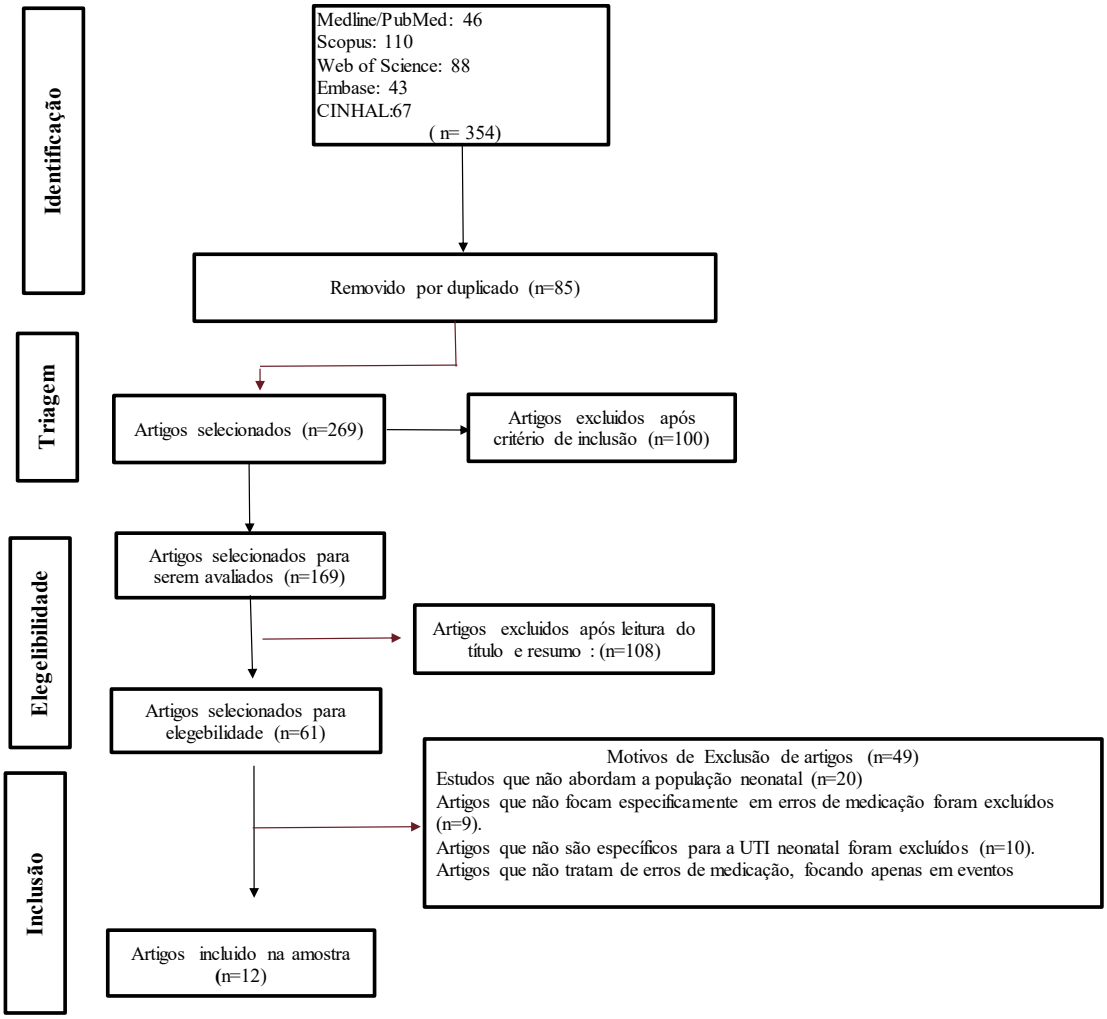
Source: The authors (2025).

The titles, abstracts and descriptors were read and analyzed. 85 duplicate articles and 100 that did not meet the inclusion criteria by reading the titles were excluded. A total of 169 studies were selected for the abstracts, of which 108 were excluded because they did not

meet the inclusion criteria. The full text of 61 articles was then read; Of these, 49 were excluded and 12 were included in the final review.

The search and selection process for the studies in this review is presented in the flowchart (Figure 1), according to a checklist adapted from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). All identified studies were pooled and exported to *Mendeley*, and duplicates were removed. The full titles and articles were read by two independent reviewers for evaluation in relation to the inclusion criteria.

Figure 1. Flowchart of the study selection process, adapted from PRISMA



3 RESULT

The analysis of the included studies (Chart 2) revealed the diversity of methodological approaches used to investigate medication errors in the neonatal intensive care unit (NICU), with a predominance of observational and documentary studies. These studies were conducted in different countries, such as the United States, Spain, Denmark, Scotland, Qatar, the Netherlands, Iran, New Zealand and Malaysia, covering different profiles of participants, including neonates, nurses, physicians and pharmacists, which reinforces the multiprofessional character of neonatal care.

Regarding the identification of the most prevalent errors, the presence of significant errors in the medical prescription was observed, such as illegible data and errors in dosage calculations. In addition, errors related to the preparation of the drugs were identified, such as the failure to homogenize the drug, difficulties with scheduling and intervals between different drugs, inadequacies in the route of administration, infusion speed and management of the infusion pump to adjust the flow rate, as shown in the data in Chart 3.

From this analysis, it was possible to confirm that the most frequently identified errors, as described in Chart 3, are concentrated both in the prescription phase and in the preparation and administration of medications. Among the main problems observed are the illegibility of prescriptions, dosage calculation errors, failures in the homogenization of the drug, delay in the preparation and use of drugs after the expiration date.

In the scope of administration, difficulties related to scheduling, errors in the intervals of administration of different drugs, inadequacy in the route and speed of infusion, as well as failures in the management of infusion pumps were highlighted. More serious situations, such as the administration of doses ten times higher than prescribed and failures involving critical drugs such as fentanyl, morphine and vasoactive drugs, were especially worrying due to the potential negative impact on the health of neonates.

In addition, other systemic factors were pointed out as important contributors to the occurrence of errors, such as insufficient nursing staff, similarity between medication packaging, and the existence of unclear medical prescriptions. Underreporting of adverse events was also a relevant finding, reinforcing the need to encourage an organizational culture focused on patient safety, based on the identification and correction of failures without individual punishment.

Chart 2 - Characterization of the publications according to author, year, title, objective, study design, number of participants and country.

Nº	Autor/Ano	Título	Objetivo	Desenho do estudo	Participantes	País
1	Stavroudis et al., 2010. [12]	NICU medication errors: identifying a risk profile for medication errors in the neonatal intensive care unit.	Identificar um perfil de risco para erros de medicação na unidade de terapia intensiva neonatal (UTIN).	Transversal retrospectivo	616 hospitais	USA
2	Campino et al., 2015. [13]	Medicine preparation errors in ten Spanish neonatal intensive care units	Medir as taxas de erro no preparo de medicamentos intravenosos em várias UTINs e identificar diferenças entre as preparações feitas na UTIN e as feitas por enfermeiros especializados em um serviço de farmácia hospitalar, com a expectativa de que a taxa de erro de preparo fosse menor neste último.	Observacional prospectivo	10 UTINs e o HPS do Cruces University Hospital.	Espanha
3	Rishoej et al., 2018. [14]	Identifying and assessing potential harm of medication errors and potentially unsafe medication practices in paediatric hospital settings: a field study	Identificar os erros com medicação (EM) e as práticas medicamentosas potencialmente inseguras (PUMPs) em crianças hospitalizadas, e avaliar o potencial de danos destas, utilizando avaliadores de diferentes profissões.	Observacional	Criança	Dinamarca
4	Simpson et al., 2004. [15]	Reducing medication errors in neonatal intensive care unit	Descrever os erros de medicação que ocorreram em uma UTIN e avaliar o impacto de um programa de educação sobre esses erros com uma combinação de gerenciamento de risco conduzido por farmacêutico clínico.	Estudo documental	Enfermeiros, Médicos Famacêuticos	Escócia, Reino Unido
5	Pawluk et al., 2016. [16]	A description of medication errors reported by pharmacists in a neonatal intensive care unit	Descrever a natureza dos erros de medicação que ocorrem em pacientes internados em uma UTIN	Estudo documental Transversal Retrospectivo	Prontuário eletrônico	Qatar
6	Chedoe et al., 2015. [17]	The effect of a multifaceted educational intervention on medication preparation and administration errors in neonatal intensive care	Examinar o efeito de uma intervenção educacional sobre a incidência de erros na preparação e administração de medicamentos na UTIN	Observacional Prospectivo.	Enfermeiros	Holanda
7	Eslami et al., 2019. [18]	Identifying medication errors in neonatal intensive care units: a two-center study	Avaliar os tipos e frequência de erros de medicação em UTIN	Transversal descritivo	Neonatos	Irã
8	Li et al., 2015. [19]	Automated detection of medication administration errors in neonatal intensive care	Automatizar a detecção de erros em unidade de terapia intensiva neonatal (UTIN) e reduzir os danos	Estudo documental	Neonatos	USA
9	Kunac e Reith, 2005. [20]	Identification of Priorities for Medication Safety in Neonatal Intensive Care	Identificar e priorizar potenciais falhas no uso de medicamentos na UTIN através da aplicação da análise de efeitos e modos de falha (FMEA)	Estudo documental	Neonatos	Nova Zelandia
10	Ruiz et al., 2015. [21]	Los errores de tratamiento en una unidad neonatal, uno de los principales acontecimientos adversos	Analisar os erros com medicação ocorridos em pacientes internados em um serviço de Neonatologia	Estudo documental	Neonatos	Espanha
11	Henry Basil et al,2025	Prevalence and Factors Associated with Medication Administration Errors in the Neonatal Intensive Care Unit: A Multicentre, Nationwide Direct Observational Study	Determinar a prevalência de erros de administração de medicamentos e identificar fatores associados a erros de administração de medicamentos entre neonatos em unidades de terapia intensiva neonatal.	Estudo observacional direto prospectivo.	Neonatos	Malasia
12	Henry Basil et al,2023	Nurses' perception of medication administration errors and factors associated with their reporting in the neonatal intensive care unit	Descrever as razões para a ocorrência dos erros de administração de medicamentos e as subnotificações	Estudo transversal	Neonatos	Malasia

Source: Authors, 2025.

Chart 3- Medication Administration Errors in Neonatology: Identification and Recommendations, 2025.

No.	Common Medication Administration Mistakes	Conclusion
1	Errors in the drug administration phase, failures in the delivery equipment/device	More than half of the errors occurred in the administration phase of drug processing. Interventions such as the smart pump would be useful to reduce these errors. However, caution should be exercised when introducing these devices into the NICU, as faulty equipment and drug delivery devices have been associated with damage.
2	Errors in accuracy and calculation in the administration of medications.	Although calculation errors can be eliminated with the use of protocols based on standard drug concentrations, accuracy error rates depend on several variables that affect neonatal intensive care units and hospital pharmacy services.
3	Delay in the preparation and administration of the drug, wrong injection rate.	Medication errors (EMs) are likely to pose a threat to the safety of medicines in children. Several potentially unsafe practices and conditions with opportunities to cause errors were identified, but with low agreement among the evaluators. These practices and conditions should be investigated to determine the goals for safety improvements and the reorganization of nursing work processes.
4	Dose calculation errors in administration (tenfold higher dose).	Medication errors are common in NICUs. Fortunately, actual damage to the newborn is rare. Interventions to reduce errors, particularly in the context of a risk management programme, are effective. Continuous monitoring of errors makes it easier to change practices.
5	Calculation errors that affect management, although they occur mainly in the prescription.	The results of these reported errors provide an understanding of the nature of these errors. Checking the correct medication and calculations can minimize errors.
6	Non-homogenization of the drug, administration errors, expired expiration date.	Educational intervention has contributed to a significant reduction in administration error rates, but other measures are needed to further improve medication safety.
7	Wrong administration and dosage, medication not administered by the nurse.	The most frequent medication error was the wrong dosage in the prescription. The nurse's failure to administer the medication was due to the quality of the prescription, lack of time and/or date of the request. General medication errors happened more commonly in premature newborns. The study reinforces the need to sensitize health professionals to reduce medication errors in NICUs.

8	Errors in the dosage and administration of critical medications such as fentanyl, morphine, and vasoactive drugs.	Manual incident reporting is insufficient to comprehensively identify errors. Automatic error detection is feasible and has better performance, with greater sensitivity and accuracy than the current systems used. By systematically detecting and intercepting these errors, it is intended to change neonatal patient safety.
9	Errors in dose, time of administration, infusion pump settings, and route of administration.	Interventions are needed to decrease medication-related adverse events. Increase staff awareness of medication safety issues and focus on medication administration processes.
10	Errors in the administration of antibiotics, dose, speed and wrong route.	Knowing one's own reality is essential to establish preventive measures and good practices.
11	Incorrect administration rate, incorrect drug preparation, and incorrect dose.	The study concluded that errors in drug administration are still common in neonates in neonatal intensive care units. Factors associated with errors were intravenous administration, absence of medication protocols, younger gestational age, condition of non-ventilated neonates, greater number of medications prescribed, and greater nursing experience. Thus, the urgent need to implement effective and sustainable interventions, focused on these factors, to reduce the occurrence of errors and promote greater safety in the administration of medications to this vulnerable population is highlighted.
12	Inadequate nursing staff, medicines with similar appearance, very similar medicine packaging, illegible or unclear medical prescriptions, interruptions while administering medications. Frequent changes in prescriptions by doctors, lack of sufficient training on new medications, limited knowledge of nurses about medications.	The underreporting of medication administration errors is still a worrying reality, with less than a third of nurses reporting errors. Among the main factors that contribute to the occurrence of these errors are the flaws in the packaging of the medications, such as similarity between names and presentations, and the insufficiency of nursing staff in the units. The decision to report errors is influenced by factors such as the nurse's education level, the effort required to complete the reports, and the way hospital management responds to incidents. To promote patient safety and increase the notification rate, it is essential that hospitals encourage a safety culture based on addressing system failures, free from individual punishments, reinforcing the importance of continuous learning from mistakes.

Source: Authors, 2025.

4 DISCUSSION

The process of preparing and administering drugs is among the attributions of the nursing team (Da Cunha et al.). Errors related to these steps can negatively impact and generate consequences and damage to the health of the patient and family members, which

can lead to decreased therapeutic efficacy, generate disabilities, increase the length of hospital stay and recovery or, in more severe cases, lead to death (Batista, Moura, 2021).

In view of the vulnerability of neonates compared to adults, these patients are more prone to medication errors, either due to changes in body size, weight-based dosages, the administration of solutions in different concentrations, the inability to verbalize and communicate with professionals, or their own physiological development, with differentiated metabolism and excretion (De Basagoiti, A. et al., 2021).

Research carried out in 2020 states that most medication errors in intensive care units were grouped into the category of errors that affected the patient, but did not cause harm (Zanella Lazaretto, Oliveira dos Santos, Fernandes Millão, 2020). Among the types of errors, the most prevalent were related to the inadequate dose and amount of the drug. In a similar study, it was found that the most frequent medication errors were incorrect dosing and failure to administer the medication to the patient; Regarding the quality of the prescription, the lack of time and/or date of prescription was the most common failure. In addition, medication errors occurred more frequently in premature newborns (Eslami et al., 2019).

These errors, in most cases, are related to the writing of the medical prescription, either due to illegibility, use of acronyms and abbreviations, absence of dosage or identification of the patient and/or date. Nursing, which is linked to the manipulation of medications, plays a fundamental role in this context, since the nurses reported having experienced some medication error, mostly related to the incorrect dose (Dick-Smith, F. et al.). This study reveals important insights into the medication administration practices of nurses in intensive care units, reinforcing that understanding where errors occur and the factors that contribute to their occurrence can help in the development of interventions to improve medication safety.

A study conducted in 2021 highlights that medication errors in neonates can be prevented through multiple interventions aimed at improving the processes of prescribing, preparing, and administering medications, with attention to the dosage in samples prepared for administration in NICUs (Vieira et al., 2021). However, knowledge about the prevalence and characteristics of these errors in pediatric and neonatal patients is still limited. Incorrect administration of antimicrobials can compromise their therapeutic efficacy, highlighting the importance of adequate administration to reduce the risk of underdose or overdose. In this sense, there is a need for greater incorporation of pediatric-specific decision support tools, as well as the implementation of error prevention measures (Liu et al., 2023).

In another study, it was observed that medication errors can prolong hospital stay and are a relevant cause of morbidity and mortality. Many of these errors were related to the

wrong administration or dosing of medications, being administered by the wrong route or at inappropriate time intervals, especially in neonates with longer hospital stays (Bharathi. et al., 2020).

Continuous monitoring and evaluation of interventions in clinical practice is key to measuring effectiveness and ensuring child safety. In a study, Marufu et al. (2022) used a technological approach to investigate failures in the preparation and administration of drugs, applying tests before and after educational interventions. During the observation, errors related to the reconstitution and homogenization of drugs, respect for the half-life, expiration date of drugs, and incompatibilities were identified (VON HOBE et al., 2024)

Neonatal intensive care units, recognized as high-risk environments, show many weaknesses related to the safe administration of medications. Errors in medical prescription, combined with the prescriber's lack of experience and work overload, are factors that make knowledge of the inputs and the critical performance of the nurse even more essential, focused on the safety of the newborn (Shawhana et al., 2022).

Another study reinforces that medication errors are an emerging problem in different hospital settings, especially in neonatology (Mondal et al., 2022). It is observed that, for this population, the drug dose is adjusted according to weight, but changes in the programming of the infusion pump in ml/h, especially with vasoactive drugs and opioids such as fentanyl, can cause serious damage (Ruskin, Ruskin, O'Connor, 2020).

In this scenario, failures represent potential risks to the integrity of the newborn, requiring safe and vigilant practices on the part of the team. A study points out that, although many errors are intercepted by nursing, the administration of medications remains a complex process, subject to serious harm to the patient and significant economic burden. The prevalence of underreporting of errors makes it difficult to analyze the scenario and implement improvements in the health system. (Ramos, 2024).

5 FINAL CONSIDERATIONS

In view of the results presented and the analysis of the literature, it is evident that medication errors in neonatal intensive care units constitute a multifactorial problem, related both to the structural and organizational weaknesses of the services and to the specificities of the neonatal population. The vulnerability of neonates, added to the complexities inherent in the preparation, prescription, and administration of medications, reinforces the need for continuous and systematic interventions that involve professional training, use of safe technologies, strengthening of interprofessional communication, and promotion of a safety culture free of punishment.

Thus, it is essential that health institutions implement effective prevention and monitoring strategies, aimed at minimizing risks and ensuring the drug safety of newborns, consolidating safer and more humanized care practices.

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