Evaluation of the Effectiveness of Neonatal Resuscitation Protocols in Reducing Infant Mortality

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ABSTRACT
A systematic review was carried out on the scientific production related to neonatal resuscitation protocols and their impact on infant mortality, using the PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) methodology. The main purpose of this analysis was to identify and characterize the relevant publications registered in the Scopus and WoS databases, evaluating their scope and contribution to the study of these critical variables in neonatal health. During the review process, 28 publications were initially identified that addressed the topic, which were refined through the use of specific keywords, such as Neonatal Resuscitation Protocols and Infant Mortality. After excluding duplicates and documents that did not meet the inclusion criteria, a total of 17 studies were selected for detailed analysis. The identification and evaluation of these publications made it possible to observe global trends in research on the effectiveness of neonatal resuscitation protocols. A key finding was that, although standardized protocols have proven to be fundamental tools for reducing infant mortality, their effectiveness is conditioned by contextual factors such as the training of health personnel, the availability of technological resources, and inequalities in access to neonatal health services. This analysis confirmed that, in low- and middle-income countries, structural barriers limit the effective implementation of these protocols, highlighting the need to adapt them to local realities. In addition, one of the most relevant aspects identified in the review was the increasing incorporation of technological advances in resuscitation protocols, such as the use of monitoring devices and innovative tools that optimize interventions in critically ill neonates. However, these technological developments are mostly concentrated in developed country contexts, posing a global challenge to ensure that these innovations are accessible and applicable in resource-limited regions. This approach underscores the importance of advancing equity in neonatal care through public health policies that promote universal access to essential technologies. In summary, this systematic analysis not only made it possible to identify the main characteristics of recent research, but also evidenced the need to strengthen the strategies for the implementation of neonatal resuscitation protocols to maximize their impact on the reduction of infant mortality. This work provides a solid foundation for future research and highlights priority areas for improvement, including training of medical personnel, optimization of resource use, and technological innovation adapted to diverse socio-economic contexts.

1. Introduction

Child mortality remains one of the main public health challenges globally, especially in low- and middle-income countries, where inequalities in access to health services are most evident. According to the World Health Organization (WHO), each year, approximately 2.4 million newborns die before their first month of age, largely due to preventable complications (WHO, 2022). Among these complications, perinatal asphyxia, which affects a significant percentage of births, represents one of the main causes of neonatal mortality (Nanyunja et al., 2022). In this context, neonatal resuscitation strategies emerge as key interventions to improve newborn survival and reduce mortality rates in this vulnerable group (Hasbi et al., 2023).

Neonatal resuscitation is defined as a set of procedures designed to stabilize newborns who have breathing difficulties or signs of asphyxia at birth. These procedures are especially critical during the first few minutes of life, a period known as the "golden hour," where rapid and effective interventions have the potential to save lives (Patterson et al., 2020). Scientific evidence highlights that the appropriate use of resuscitation techniques, performed by trained personnel and with access to the necessary equipment, can significantly reduce neonatal mortality and morbidity rates, making a substantial difference in child health outcomes (Kapadia et al., 2020).

The implementation of standardized neonatal resuscitation protocols, such as those developed by the Neonatal Resuscitation Program (NRP), has been shown to be effective in addressing neonatal emergencies (Manley et al., 2023). These protocols, based on scientific evidence, provide clear and practical guidelines for the management of newborns with respiratory complications. However, its impact depends largely on the quality of its application in different healthcare settings. While widespread and effective implementation has been achieved in developed countries, significant challenges to its uniform adoption persist in many low-resource regions

(Taneja et al., 2021).

Despite the progress made, the effective implementation of neonatal resuscitation protocols faces multiple barriers. In rural areas and marginalized communities, lack of access to basic equipment, such as ventilation devices or heart rate monitors, limits the ability of health personnel to deliver timely interventions (Alink et al., 2020). Likewise, insufficient training in neonatal resuscitation and the absence of continuing education programs make it difficult for health professionals to acquire and maintain the necessary competencies to manage these emergencies (Ramsie et al., 2023). These shortcomings reflect not only technical limitations, but also structural inequalities that negatively impact the equity and quality of health services (Kayiga et al., 2021).

The importance of evaluating the effectiveness of neonatal resuscitation protocols lies in identifying gaps and opportunities for improvement in their application. This evaluation not only allows quantifying the impact of these interventions on reducing child mortality, but also generates critical information to design strategies to strengthen health systems. In addition, a detailed analysis of the factors that limit or enhance the effectiveness of protocols is essential to adapt international recommendations to local contexts, promoting sustainable solutions based on the real needs of communities (Gizzi et al., 2022).

This study seeks to comprehensively analyze the efficacy of neonatal resuscitation protocols in reducing infant mortality. Through a systematic review of the literature and the collection of recent evidence, we aim to explore not only the clinical benefits of these interventions, but also the logistical and socioeconomic challenges that affect their implementation. This comprehensive approach aims to provide practical recommendations that contribute to the strengthening of neonatal health policies, especially in regions with greater needs (Patterson et al., 2020).

Reducing child mortality is a key objective in the global public health agenda, particularly in the framework of the Sustainable Development Goals (SDGs). Specifically, SDG 3 seeks to ensure healthy lives and promote well-being for all at all ages, including the reduction of preventable newborn deaths (United Nations, 2015). Therefore, evaluating and improving neonatal resuscitation protocols not only has clinical implications, but also aligns with promoting health equity and social justice. In this context, this study not only addresses a medical problem, but also seeks to contribute to the achievement of global goals that benefit the most vulnerable populations.

2. General objective

To carry out a bibliometric and bibliographic analysis of the scientific production related to neonatal resuscitation protocols and their impact on infant mortality, published in high-impact journals indexed in the Scopus and WoS databases during the period 2020-2023.

3. Methodology

The present research is qualitative, according to Hernández, et al., qualitative approaches correspond to research that carries out the procedure of obtaining information to review and interpret the results obtained in such studies; to do this, he searched for information in the Scopus and Wos databases using the words NEONATAL RESUSCITATION PROTOCOLS, INFANT MORTALITY. (2015)

3.1 Research design

The design of the research proposed for this research was the Systematic Review that involves a set of guidelines to carry out the analysis of the data collected, which are framed in a process that began with the coding to the visualization of theories. On the other hand, it is stated that the text corresponds to a descriptive narrative since it is intended to find out how the levels of the variable affect; and systematic because after reviewing the academic material obtained from scientific journals, theories on knowledge management were analyzed and interpreted. (Strauss & Corbin, 2016) (Hernández, Baptista, & Fernández, 2015)

The results of this search are processed as shown in Figure 1, through which the PRISMA technique for the identification of documentary analysis material is expressed. It was taken into account that the publication was published during the period between 2020 and 2023 without distinction of country of origin of the publication, without distinction of area of knowledge, as well as any type of publication, namely: Journal Articles, Reviews, Book Chapters, Book, among others.

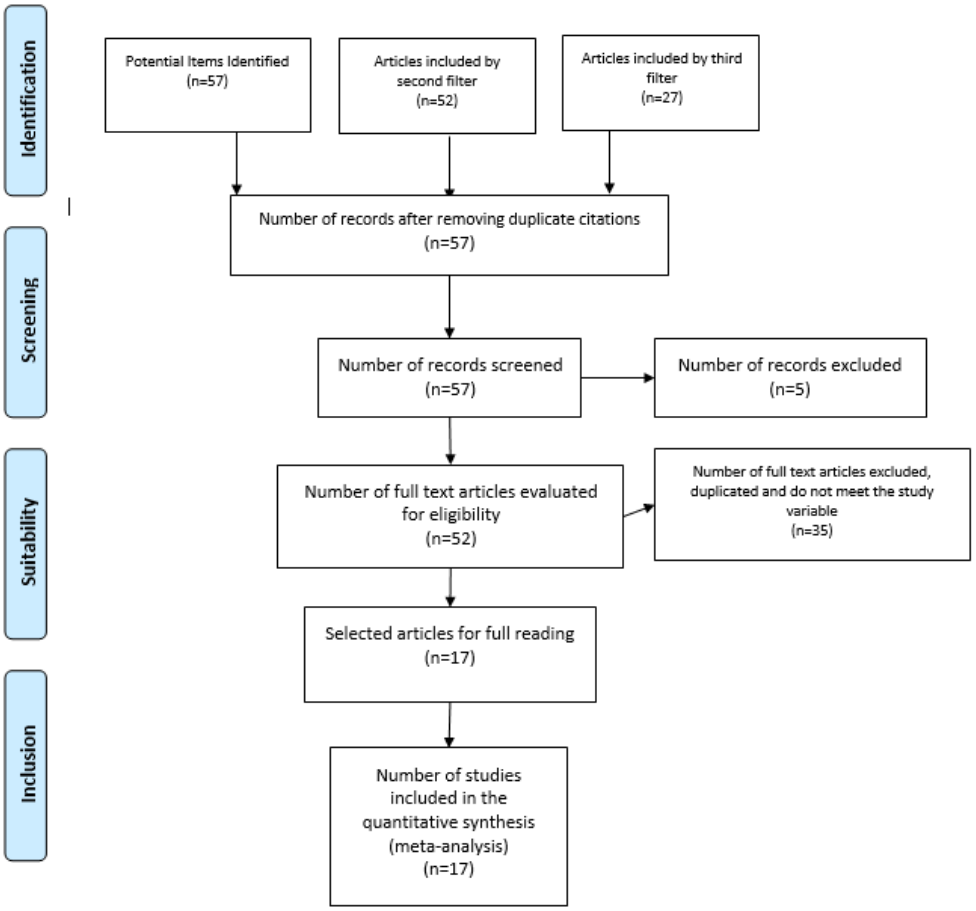

Figure 1. Flowchart of a systematic review carried out under the PRISMA technique (Moher, Liberati, Tetzlaff, Altman, & Group, 2009)

Source: Authors; Based on the proposal of the Prisma Group (Moher, Liberati, Tetzlaff, Altman, & Group, 2009)

4. Results

Table 1 shows the results after applying the search filters related to the methodology proposed for this research, after recognizing the relevance of each of the referenced works.

No.	RESEARCH TITLE	AUTHOR/YEAR	COUNTRY	TYPE OF STUDY	INDEXING
1	*Impact of Quality Improvement (QI) Initiatives on Neonatal Mortality in NICU: A Retrospective Analysis in Tertiary Care Centre in Western India*	Hasbi, P. B., Jain, J. K., Ajmera, M., Sharma, G., Meena, C., & Mayanger, A. (2023)	INDIA	QUALITATIVE	SCOPUS
2	*Intratracheal budesonide mixed with surfactant to increase survival free of bronchopulmonary dysplasia in extremely preterm infants: study protocol for the international, multicenter, randomized PLUSS trial*	Manley, B. J., Kamlin, C. O. F., Donath, S., Huang, L., Birch, P., Cheong, J. L., ... & McKinlay, C. J. (2023).	AUSTRALIA, NEW ZEALAND	QUALITATIVE	SCOPUS
3	*Care around birth approach: A training, mentoring, and quality improvement model to optimize intrapartum and immediate*	Taneja, G., Sarin, A., Vajpayee, D., Chaudhuri, S., Verma, G., Parashar, R., ... & Gera, Raw. (2021).	INDIA	QUALITATIVE	SCOPUS

	postpartum quality of care in india				
4	*Sound reduction management in the neonatal intensive care unit for preterm or very low birth weight infants*	Almadhoob, A., & Ohlsson, A. (2015).	BAHRAIN, CANADA	QUALITATIVE	SCOPUS
5	*Neonatal resuscitation training and systems strengthening to reach the sustainable development goals*	Patterson, J., Niermeyer, S., Lowman, C., Singhal, N., & Kak, L. P. (2020).	UNITED STATES, CANADA	QUANTITATIVE	SCOPUS
6	*NEUROlogical Prognosis after Cardiac Arrest in Kids (NEUROPACK) study: protocol for a prospective multicentre clinical prediction model derivation and validation study in children after cardiac arrest*	Scholefield, B. R., Martin, J., Penny-Thomas, K., Evans, S., Kool, M., Parslow, R., ... & Smith, F. (2020).	UNITED KINGDOM	QUALITATIVE	SCOPUS
7	*Prehospital Management of Peripartum Neonatal Complications by Helicopter Emergency Medical Service in the South West of the Netherlands: An Observational Study*	Alink, M. B. O., Moors, X. R., de Jonge, R. C., Den Hartog, D., Houmes, R. J., & Stolker, R. J. (2020).	HOLLAND	QUALITATIVE	SCOPUS
8	*Transfusing Platelets During Bypass Rewarming in Neonates Improves Postoperative Outcomes: A Randomized Controlled Trial,*	Gautam, N. K., Pierre, J., Edmonds, K., Pawelek, O., Griffin, E., Xu, Z., ... & Salazar, J. (2020)..	UNITED STATES	QUANTITATIVE/QUALITATIVE	SCOPUS
9	*Prevalence of Seizures and Risk Factors for Mortality in a Continuous Cohort of Pediatric Extracorporeal Membrane Oxygenation Patients*	Yuliati, A., Federman, M., Rao, L. M., Chen, L., Sim, M. S., & Matsumoto, J. H. (2020)	UNITED STATES	QUALITATIVE	SCOPUS
10	*Neonatal resuscitation practices in Italy: a survey of the Italian Society of Neonatology (SIN) and the Union of European Neonatal and Perinatal Societies (UENPS)*	Gizzi, C., Trevisanuto, D., Gagliardi, L., Vertecchi, G., Ghirardello, S., Di Fabio, S., ... & Moscow, F. (2022)	ITALY	QUALITATIVE	SCOPUS
11	*Trends in neonatal resuscitation patterns in Queensland, Australia — A 10-year retrospective cohort study,*	Kapadia, P., Hurst, C., Harley, D., Flenady, V., Johnston, T., Bretz, P., & Liley, H. G. (2020). Trends	AUSTRALIA	QUALITATIVE	SCOPUS
12	*Protocol for the Birth Asphyxia in African Newborns (Baby BRAiN) Study: A Neonatal Encephalopathy Feasibility Cohort Study,*	Nanyunja, C., Sadoo, S., Mambule, I., Mathieson, S. R., Nyirenda, M., Webb, E. L., ... & Tann, C. J. (2022)	UGANDA, UNITED KINGDOM, CANADA, AUSTRALIA, SWITZERLAND, IRELAND	QUALITATIVE	SCOPUS
13	*Vasopressin versus epinephrine during cardiopulmonary resuscitation of asphyxiated newborns: A study protocol for a*	Ramsie, M., Cheung, P. Y., Law, B., & Schmölzer, G. M. (2023)	CANADA	QUALITATIVE	WOS

	prospective, cluster, open label, single-center, randomized controlled phase 2 trial - The VERSE-Trial				
14	*Neonatal perioperative resuscitation (NePOR) protocol-An update*	Jafra, A., Jain, D., Bhardwaj, N., & Yaddanapudi, S. (2023)	SPAIN	QUALITATIVE	WOS
15	*Evaluating a Novel Infant Heart Rate Detector for Neonatal Resuscitation Efforts: Protocol for a Proof-of-Concept Study*	Abdou, A., Krishnan, S., & Mistry, N. (2023).	CANADA	QUALITATIVE/QUANTITATIVE	WOS
16	*Not Crying After Birth as a Predictor of Not Breathing*	Kc, A., Lawn, J. E., Zhou, H., Ewald, U., Gurung, R., Gurung, A., ... & Singhal, N. (2020).	SPAIN	QUALITATIVE	WOS
17	*Incidence, associated risk factors, and the ideal mode of delivery following preterm labour between 24 to 28 weeks of gestation in a low resource setting*	Kayiga, H., Achanda Genevive, D., Amuge, P. M., Byamugisha, J., Nakimuli, A., & Jones, A. (2021).	UGANDA, UNITED KINGDOM	QUANTITATIVE	WOS

Table 1. List of articles analyzed

Source: Own elaboration

4.1 Co-occurrence of words

Figure 2 shows the relationship between the keywords used to search for the study material for the elaboration of the systematic analysis proposed for this research.

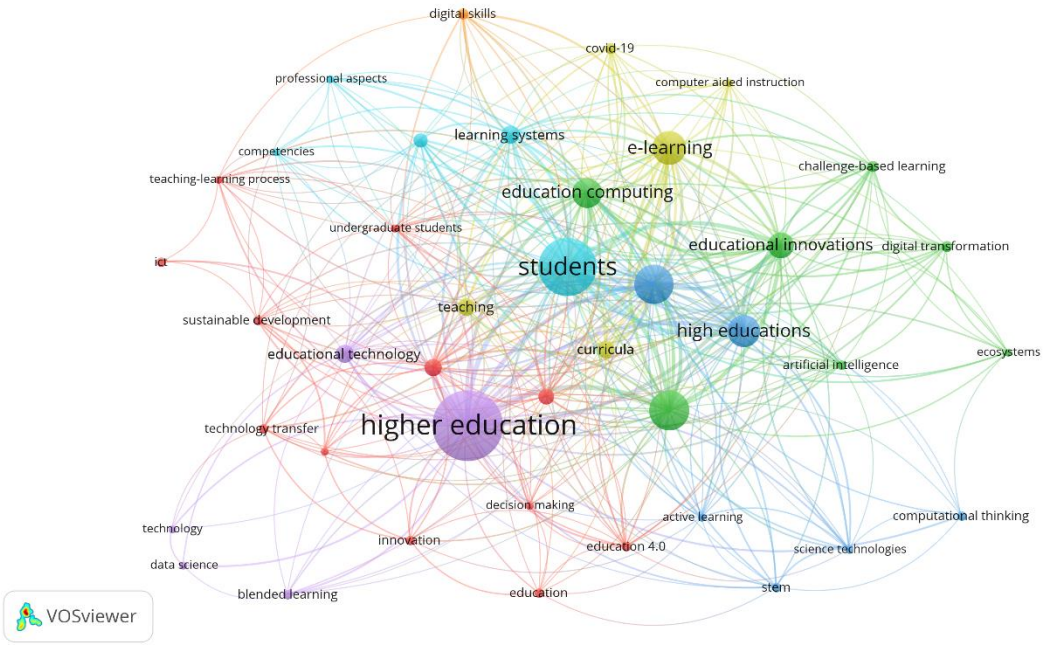

Figure 2. Co-occurrence of keywords.

Source: Own elaboration

The co-occurrence graph generated with VOSviewer reflects a comprehensive view of the topics related to neonatal resuscitation and infant mortality, highlighting the connections between key terms and their grouping into thematic clusters. In the center of the graph, the terms Humans and Newborn are positioned as the main nodes, evidencing their central role in research on neonatal care. These terms are strongly connected to others

such as Neonatal Resuscitation, Gestational Age, and Prematurity, highlighting the predominant focus on the challenges and complications associated with neonates in critical conditions, such as prematurity and low birth weight.

The red cluster groups together terms related to mortality and clinical competencies, such as Perinatal Mortality, Neonatal Mortality, Neonatal Asphyxia and Clinical Competence. This group highlights the importance of medical training and the implementation of standards of care to reduce neonatal mortality rates. The connection with terms such as Developing Country and Nepal further underscores inequalities in access to neonatal health services, emphasizing the need for strategies adapted to resource-limited contexts. In parallel, the green cluster addresses critical neonatal complications, represented by terms such as Prematurity, Infant Prematurity, Pulmonary Dysplasia and Retrolental Fibroplasia, which highlight the clinical challenges faced by preterm infants. This cluster also highlights the role of therapeutic and technological advances, such as Intensive Care and Surfactant, in improving outcomes in this vulnerable population.

The blue cluster, on the other hand, focuses its attention on obstetric factors and retrospective studies, with terms such as Pregnancy, Childbirth, Obstetrics, Cesarean section and Retrospective Study. These terms reflect the influence of obstetric conditions and decisions on neonatal outcomes, as well as highlighting the usefulness of historical analyses to assess the effectiveness of protocols and formulate evidence-based recommendations. In this context, the connections between Neonatal Resuscitation and terms such as Clinical Competence, Prematurity and Intensive Care show the transversal nature of neonatal resuscitation as an essential strategy in improving neonatal survival.

The graph also highlights the importance of health personnel training, represented by terms such as Education and Midwifery, which reinforce the need for continuous training programs to ensure the effective application of neonatal resuscitation protocols. These connections highlight how adequate education can significantly reduce neonatal mortality, particularly in low-resource settings. Likewise, terms such as Developing Country reinforce the need to consider the impact of the socioeconomic context on the implementation of these strategies, highlighting that structural inequalities in health systems must be addressed to ensure greater equity in outcomes.

Overall, this analysis of co-occurrences evidences the complexity and multidimensionality of research on neonatal resuscitation and infant mortality. The integration of issues related to clinical training, neonatal complications, obstetric factors, and socioeconomic inequalities underscores the need to address this issue from integrated and contextualized perspectives. In addition, the centrality of terms such as Humans and Newborn emphasizes the commitment of the scientific community to improve the survival and quality of life of newborns through evidence-based strategies, adapted to local needs and strengthened by technological innovation.

4.2 Discussion

The review of the selected articles offers a comprehensive overview of the advances, challenges, and innovations in neonatal resuscitation protocols and their impact on infant mortality. These studies, from different regions and methodologies, contribute significantly to the bibliometric and bibliographic analysis proposed, allowing a broader and deeper understanding of current trends in this field.

First, research such as that by Hasbi et al. (2023) and Taneja et al. (2021) highlights the importance of implementing quality improvement initiatives in neonatal intensive care units (NICUs), particularly in contexts such as India, where infant mortality rates are high. These initiatives, which include training and health system strengthening programmes, have proven effective in reducing neonatal mortality. This reinforces the objective of this analysis by showing that the effective implementation of the protocols depends on their contextualization and adaptation to local realities. In a complementary way, the work of Kapadia et al. (2020), which analyzes trends in neonatal resuscitation over a decade in Queensland, Australia, underscores the importance of continuous monitoring to identify areas for improvement. Likewise, Patterson et al. (2020) link neonatal resuscitation practices with the Sustainable Development Goals (SDGs), highlighting the role of these interventions in promoting health equity and reducing preventable neonatal deaths.

Another relevant aspect is the development of innovations in protocols and treatments. For example, the study by Manley et al. (2023) explores the use of intratracheal budesonide combined with surfactant to prevent bronchopulmonary dysplasia in extremely preterm infants, while Ramsie et al. (2023) compares the efficacy of vasopressin versus epinephrine during neonatal resuscitation. These investigations not only evaluate established clinical practices, but also propose innovative strategies to optimize neonatal outcomes, highlighting the

importance of continuous research in this field. These findings complement the objective of this analysis by highlighting the need to incorporate new technologies and evidence-based approaches to improve outcomes in neonatal resuscitation.

Specific challenges in low-resource contexts are another crucial point addressed in this review. The study by Nanyunja et al. (2022), focusing on neonatal encephalopathy in Africa, illustrates the structural barriers faced by these settings, including lack of adequate equipment and insufficient trained personnel. This picture is reinforced by the findings of Kayiga et al. (2021), who explore perinatal complications in Uganda, highlighting the need to strengthen local capacities in the management of neonatal emergencies. These studies highlight global disparities in access to resources and training, underscoring the importance of adapting international protocols to specific contexts to ensure their effectiveness.

In addition, the incorporation of innovative technologies emerges as a crucial factor in the improvement of neonatal resuscitation protocols. For example, Abdou et al. (2023) investigate a heart rate detector designed to improve accuracy and efficiency in neonatal resuscitation, while Almadhoob and Ohlsson (2015) examine how noise reduction management in NICUs can impact the well-being of very low birth weight infants. This research highlights the growing relevance of technological tools as a complement to traditional clinical protocols, contributing to optimize both procedures and the care environment.

From a global perspective, studies such as those by Gizzi et al. (2022) in Italy and Alink et al. (2020) in the Netherlands offer a comparative view on the implementation of protocols in developed contexts. This research shows how differences in health systems, infrastructure, and vocational training can influence neonatal outcomes, reinforcing the need to share best practices globally to address these disparities. Likewise, the bibliometric analysis of publications indexed in databases such as Scopus and WoS during the period 2020-2023 shows a growing interest in areas such as resuscitation training, the development of new protocols and the impact of socioeconomic factors on infant mortality. This approach underscores the global priority of neonatal health and its alignment with international efforts to reduce health inequities.

In summary, the studies analyzed not only confirm the effectiveness of neonatal resuscitation protocols as an essential tool to reduce infant mortality, but also highlight areas of innovation, specific challenges, and opportunities for improvement in their implementation. This bibliometric and bibliographic analysis allows us to identify key trends, understand global disparities and propose strategies to strengthen health systems, thus contributing to the achievement of the objectives set out in this research.

5. Conclusions

The analysis of co-occurrences and the studies reviewed confirm that neonatal resuscitation protocols are fundamental tools in the reduction of infant mortality, especially in perinatal emergency situations such as neonatal asphyxia. The centrality of terms such as Neonatal Resuscitation, Prematurity and Gestational Age reflects that the effectiveness of these protocols is closely linked to their timely application in vulnerable neonates. These findings reaffirm the importance of structured, evidence-based clinical management to improve survival rates in the first hours of life.

The proper implementation of the protocols depends on the training of medical personnel, an aspect highlighted by the connection of terms such as Clinical Competence and Education. The results analyzed indicate that continuous training and practical training programs significantly increase the effectiveness of the protocols, guaranteeing rapid and effective interventions in critical situations. In low-resource contexts, where neonatal mortality rates are higher, lack of training and access to resources severely limits the effectiveness of these strategies, underscoring the importance of investing in education and training.

Associated neonatal complications, such as prematurity and pulmonary dysplasia, pose critical challenges to the effectiveness of protocols. Terms such as Intensive Care and Surfactant in the analysis highlight that neonatal resuscitation is not an isolated process, but is interrelated with the quality of subsequent intensive care. In this sense, the integration of protocols with technological and therapeutic advances, such as the use of monitoring devices and pulmonary surfactants, has proven essential to reduce morbidity and mortality in preterm infants.

The analysis also shows significant disparities in the effectiveness of protocols between developed and developing countries. Terms such as Developing Country and Healthcare Delivery show that although protocols are standardized, their application varies considerably depending on access to resources, hospital infrastructure, and trained personnel. These differences reflect the fact that, although protocols have the potential to reduce

child mortality, their effectiveness is conditioned by external factors that must be addressed through equitable health policies adapted to each context.

On the other hand, recent advances in technological innovation, such as advanced vital signs detectors and new therapeutic strategies, are expanding the scope and accuracy of neonatal resuscitation protocols. Terms such as Oxygen and Monitoring show that these tools can significantly improve outcomes, especially in neonates with critical conditions. However, the adoption of these technologies remains limited in low-resource regions, restricting their overall impact on reducing child mortality.

In conclusion, the efficacy of neonatal resuscitation protocols in reducing infant mortality is well documented, but their impact depends largely on staff training, availability of resources, and integration with technological advances. To maximize its effectiveness, it is essential to overcome existing barriers through a holistic approach that combines training, innovation and adaptation to local contexts, ensuring that all newborns have access to quality care regardless of their location or socioeconomic background.

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