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Qualitative Exploration of Neonatal Transport: A Review of Logistical Challenges

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Abstract

Neonatal mortality is a vital indicator of healthcare system effectiveness. In 2019, provincial Neonatal Mortality Rates (NMRs) in Iran ranged from 3.1 (2.6–3.7) to 10.0 (9.2–10.8) per 1,000 live births, illustrating significant regional disparities. Despite these concerning figures, the transfer of critically ill neonates to obtain necessary medical interventions has received insufficient attention, revealing a critical gap in healthcare services. This study aimed to gather stakeholder perspectives on neonatal transfer in Tehran, elucidate the obstacles encountered in neonatal transport logistics, and outline the operational framework underlying these transfers. A qualitative descriptive design was employed, involving semi-structured interviews across five prominent hospitals in Tehran Province (N = 5, n = 5). Participants (N = 6, n = 37) included key stakeholders—such as neonatologists, NICU staff, emergency personnel, and parents—who shared first-hand experiences in the transfer of critically ill infants. A pilot-tested questionnaire guided discussions on various aspects of the transport process, including coordination, infrastructure, team readiness, and equipment availability. As the first study in Iran to comprehensively map the logistical and operational challenges associated with neonatal transport, the findings reveal multiple transfer modes—private vehicles, ambulances, and air transport—and the unique barriers each presents. These challenges fall into five main categories: Infrastructure, Systemic Issues, Communication, Team awareness, and Equipment. Taken together, they underscore systemic inefficiencies that compromise timely and safe transfers for neonates in critical condition.

Keywords: Neonatal transfer process, Neonatal transfer challenges, Inter-hospital transfer of critically ill neonates, Thematic qualitative study.

1 | Introduction

During the neonatal period, individuals are particularly fragile and at the highest risk of death [1]. The clinical condition of these neonates is largely influenced by the availability, accessibility, and effectiveness of healthcare infrastructure, such as hospitals, clinics, and trained medical personnel. Poor neonatal outcomes often highlight systemic issues such as underfunding, inadequate resources, or inequitable distribution of

healthcare services. With this in mind, the Neonatal Mortality Rate (NMR) serves as a key indicator for evaluating health systems within countries [2], [3].

The most recent data for the NMR in the Islamic Republic of Iran, as of 2022, is 8 deaths per 1,000 live births. To provide context, the NMR in the European Union for the same year is reported to be 3.3 deaths per 1,000 live births, which is approximately 59% lower than Iran's rate [4], [5]. Besides, According to Sepanlou et al. [6] the NMR in Iran varies significantly across provinces, ranging from 3.1 (2.6–3.7) to 10.0 (9.2–10.8) per 1,000 live births.

This significant disparity highlights the differences in healthcare quality, access, and infrastructure among various regions, underscoring the need for targeted interventions to improve neonatal care and reduce preventable deaths in Iran. Furthermore, the transfer of critically ill newborns within and between healthcare facilities to access essential medical care has been largely overlooked. This oversight reveals a significant gap in the healthcare system—one that must be addressed to enhance neonatal survival and overall health outcomes. The only study regarding the current state of neonatal transport in Iran was conducted by Hossein et al. [7], which proposed the most suitable flow in neonatal transport services based on the country's health system characteristics and infrastructure. However, as it seems, there has been no study outlining the operational challenges of different transport modes in Iran.

As for other developing countries, several studies have examined the challenges faced by Low- and Middle-Income Countries (LMICs) in neonatal transport system. These studies highlight the systemic issues and resource limitations that hinder effective healthcare delivery in LMICs [8], [9].

For instance, Ashokcoomar and Bhagwan [10] investigated the preparedness of Advanced Life Support (ALS) paramedics in South Africa, revealing critical gaps and systemic challenges. Similarly, Harahap et al. [11] conducted a narrative review focusing on the barriers and technological solutions related to maternal and neonatal referral systems in developing countries. Okorie et al. [12] evaluated the availability of neonatal transport services in practice, uncovering significant gaps in Southern Nigeria. Their study noted that many healthcare facilities lack a standardized Neonatal Transport Network, face poor inter-institutional communication, and grapple with a shortage of adequately trained staff to transfer critically ill newborns. In Dar es Salaam, Tanzania, neonatal transport remains a major challenge, largely due to insufficient pre-transfer care and inadequate monitoring during transportation [13].

These issues illustrate the widespread difficulties in neonatal transport systems across different regions, calling for urgent interventions to address these gaps and improve outcomes for critically ill newborns. The primary objective of this study is to provide a comprehensive overview of the challenges associated with neonatal transport and to explore the relationships between the various modes of transport within the country. Through this multifaceted analysis, the study aims to generate critical insights that can guide policy reforms and enhance the delivery of neonatal care at a national level. Ultimately, this research seeks to address existing gaps in neonatal transport systems, paving the way for more effective and equitable healthcare solutions for critically ill newborns.

2 | Materials and Methods

This study aimed to explore the challenges related to the neonatal transport process, with a particular focus on the perspectives of key stakeholders involved in the care of critically ill neonates. The following sections describe the study design, the sampling strategy, data collection methods, and ethics statement in greater detail.

2.1 | Study Design

This qualitative descriptive study utilized thematic analysis to gain a comprehensive understanding of stakeholders' perspectives on the challenges associated with the neonatal transfer process. Conducted across five hospitals in Tehran, Iran's capital, the research targeted individuals with direct, hands-on experience in

neonatal and infant transport. Participants were strategically selected from leading Medical Sciences Universities in Iran, ensuring a diverse range of expertise from various disciplines within the healthcare sector. Through in-depth analysis of their insights, the study sought to uncover critical obstacles, identify systemic inefficiencies, and offer a nuanced understanding of the complexities inherent in neonatal transfers.

2.2 | Study Population and Sampling Strategy

To establish the study sample, researchers sought to include all key groups and stakeholders with direct experience in neonatal transport programs. Participants included neonatologists, NICU head nurses, NICU nurses, NICU staff, personnel from central health authorities, and the families of neonates. In total, 37 individuals with in-depth knowledge of the processes, challenges, and requirements of infant transport were included in the study.

The authors analyzed the qualitative data by thoroughly reviewing the transcripts to identify patterns and insights. The data were then systematically organized into themes and sub-themes through content analysis and cross-participant comparisons. Key themes, recurring phrases, and common practices formed the backbone of the data structure. To ensure the reliability and validity of the findings, preliminary results were shared with several participants for feedback and verification, enhancing the study's credibility. This approach allowed for a comprehensive, nuanced understanding of the challenges and dynamics of neonatal transport.

2.3 | Data Collection

Data were collected through in-depth semi-structured interviews, guided by a pre-designed interview framework. Semi-structured interviews are particularly advantageous as they provide a balance between structured questioning and flexibility, enabling participants to share their experiences in detail while maintaining the study's focus.

To ensure the interview guide's effectiveness, a pilot study was conducted to assess the coherence, clarity, and relevance of the questions. Based on the feedback received, the questionnaire was refined, resulting in a final version organized around five main topics. Each interview lasted between 60 and 90 minutes, allowing for comprehensive discussions. The interview schedule consisted of the following questions:

- I. What are your thoughts on the inter-hospital transfer process for critically ill neonates?
- II. What are the key components of essential newborn care during the transfer process?
- III. What are the barriers and obstacles to achieving ideal transfer conditions in Iran?
- IV. What are the most prominent reasons for referral?
- V. Based on your experience, what changes or interventions would you recommend to improve neonatal transport systems?

These interviews yielded rich, highly relevant data, capturing diverse perspectives on neonatal transport challenges. Data collection continued until thematic saturation was reached, ensuring no new themes emerged from additional interviews. As shown in *Table 1*, the final sample comprised six neonatologists, four central health authorities, five NICU head nurses, ten NICU nurses, four Emergency Medical Technicians (EMTs), and eight mothers whose children had been transferred to a destination hospital. The diversity of this participant pool offered a holistic view of the neonatal transport process, spanning both healthcare professionals' expertise and families' lived experiences. Saturation indicated that the gathered data were comprehensive and representative of the key issues in neonatal transport.

Table 1. Transport team interviewed.

Interviewees	%
Neonatologists	16
Central health authorities	10
NICU head nurses	13
NICU registered nurses	27
Parents	21
EMTs	10

2.4 | Ethics Statement

The study received approval from the institutional ethics review board at the Tarbiat Modares University. The survey addressed various aspects of neonatal transport, including team composition, equipment, staffing, and procedures.

3 | Result

The neonatal transfer process in Iran exhibits considerable variation across provinces, with each region adhering to unique protocols shaped by its healthcare infrastructure, resource availability, and hospital policies.

Typically, as shown in *Fig. 1*, the process involves dispatching an ambulance from the referring hospital to transport the neonate to the receiving hospital. Once the transfer is complete, the ambulance returns empty to the referring hospital to prepare for subsequent missions.

Through interviews in Tehran, the study identified five key themes representing the main barriers and obstacles in the neonatal transfer process (*Table 2*). These challenges were detected in three primary modes of transport in Tehran province: air transport, private vehicles, and ambulances. Although each mode is crucial for neonatal transport, each faces its own distinct set of hurdles. Below is a detailed exploration of these modes and their associated challenges.

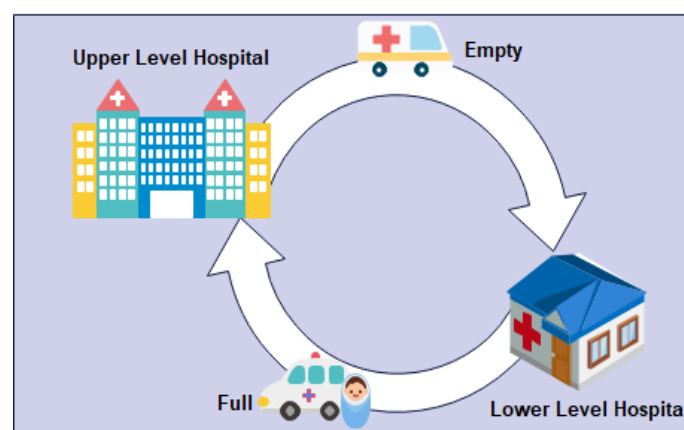


Fig. 1. Neonatal transfer in Iran concerning ambulance dispatch.

Air transport: Air transport is often preferred for time-sensitive care over long distances. However, it poses challenges related to the availability of specialized aircraft and equipment. Many hospitals do not have dedicated neonatal transport units, and even when such units exist, the aircraft may lack modern technology required to stabilize critically ill neonates in flight. Adverse weather and air traffic regulations can also delay or cancel flights. High costs further limit air transport, reinforcing inequities in access to care. Issues like

low lighting, high noise levels, and the absence of trained personnel for in-flight neonatal care exacerbate these problems.

Private vehicle: In less urbanized areas, or when other options are not feasible, private vehicles are frequently used for neonatal transport. However, there is limited awareness among families about the risks of unassisted transfer. Private vehicles generally lack the medical equipment and trained staff necessary to manage critically ill neonates, placing infants in potential danger during transport. In the absence of proper monitoring systems or respiratory support, an infant's condition can deteriorate, especially if complications arise. Additionally, the lack of standardized protocols for neonatal transport in private vehicles and the absence of medical personnel can lead to delayed or insufficient interventions.

Ambulance: Ambulances are among the most common methods of neonatal transport, particularly for emergencies or city transfers. Yet many ambulances are not equipped with advanced technology like incubators, ventilators, or specialized neonatal monitoring devices.

Furthermore, there are not enough ambulances staffed by trained neonatal personnel. Congested city traffic, lengthy travel times, and suboptimal road conditions can also delay hospital arrival, negatively impacting critical treatment outcomes.

Table 2. Operational challenges in neonatal transfer process.

Challenges Themes	Subtheme(s)	Air	Ambulance	Private
Communication: Lack of clear communication can lead to misunderstandings and increased risks during transport	Lack of communication	*	*	*
Team awareness: Insufficient team readiness can result in delays and inadequate responses to emergencies	Low skill level of the transport team	*	*	*
Structural issues: Inefficient transport systems can hinder timely access to specialized neonatal care	Lack of definition for hospital levels	*	*	*
	No centralized unit for neonatal transfers (transfer triage)	*	*	*
Equipment: Inadequate or malfunctioning equipment poses a significant risk to the infant's health during transport	Insufficient monitoring equipment	*	*	*
Infrastructure: Poor logistics which complicate transport operations and affect the overall efficiency of the process	Inadequate roads		*	*
	Stressful factors	*	*	*

The five main themes—communication, team awareness, structural, equipment, and infrastructure—highlight how each challenge affects the efficiency, safety, and coordination of neonatal transfers from a logistical standpoint.

Communication: From a logistics perspective, ineffective communication creates scheduling delays, misunderstandings about patient condition, and insufficient handover of critical information. This gap is seen across all transport modes (private, ambulance, air). When sending facilities are unclear on the receiving hospital's capacity or when a designated physician is not assigned, it can delay crucial decisions about transport times, necessary resources, and staff allocation. Overall, communication breakdowns delay decision-making, create scheduling conflicts, and increase the risk of critical information being lost in transit.

Team awareness: Logistically, a well-prepared team is key for prompt stabilization and safe transfer. Lack of expertise or training can lead to inefficiencies in triage, handling of specialized equipment, and response to in-transit complications. For instance, if drivers are not trained to appreciate the fragility of neonates (e.g., avoiding excessive vibration, maintaining temperature), the quality of care during transport deteriorates. This challenge spans all modes of transport but is particularly problematic for private vehicles, where specialized neonatal transport training is less common or inconsistent.

Structural issues: From a structural logistical standpoint, an inefficient referral network results in duplications and delays. For example, if there is no centralized coordination unit to orchestrate neonatal transfers, the process becomes ad-hoc—leading to scheduling conflicts, unclear or redundant referral steps, and extended waiting times. Without well-defined hospital tiers or standardized protocols, it is challenging to decide which facility is most appropriate or available. This leads to potential overburdening of tertiary centres and underutilization of other suitable facilities. Such systemic issues affect all modes of transport and compound the burden of logistical planning, thereby weakening the overall transfer chain. Family dissatisfaction often stems from lengthy waiting periods or confusion over billing and referrals. This can complicate administrative processes and cause delays in departure.

Equipment: Inadequate or malfunctioning equipment impairs the ability to monitor and stabilize neonates en route. Logistically, this challenge links to procurement, maintenance, and training. Proper planning and budgeting for specialized neonatal equipment (e.g., incubators, ventilators) is crucial. Even when equipment is available, limited user competence can hinder its correct application, leading to underutilization or misuse. Such deficits are seen across private, ambulance, and air transport but can be particularly pronounced in private vehicles, which typically lack formal medical instrumentation or standardized maintenance schedules.

Infrastructure: Infrastructure challenges directly affect travel time and reliability. Poor road conditions impede rapid or safe ground transport and can cause further deterioration of a neonate's condition. In the case of air transport, reliable landing facilities and access to remote regions can also be limiting factors. Vehicle breakdowns not only delay arrival but also risk depleting in-transit supplies (oxygen, heat, power). Such issues require robust preventative maintenance schedules, well-established contingency plans (e.g., backup vehicles or flight plans), and effective route planning to mitigate risks to infants.

From a logistical point of view, these themes—communication, team awareness, structural, equipment, and infrastructure—are interlinked and collectively shape the efficiency and safety of neonatal transfers. Addressing them requires:

- I. Clear communication channels and protocols to ensure rapid, accurate information-sharing.
- II. Adequate training for all involved, from medical teams to drivers and support staff.
- III. Streamlined systems with well-defined hospital tiers, a central coordination unit, and standard operating procedures.
- IV. Sufficient, well-maintained equipment and competent users for continuous monitoring and care.
- V. Robust infrastructure planning to reduce transit delays and safeguard critical neonatal transport.

By focusing on these logistical components—particularly in building a centralized, well-coordinated referral system—health facilities can strengthen neonatal transfer services across private, ambulance, and air transportation, ultimately improving outcomes for vulnerable neonates.

4 | Discussion

The referral of critically ill neonates to tertiary hospitals is frequently unavoidable, as many newborns require specialized medical or surgical interventions [14-17]. To examine this process more thoroughly, we conducted a qualitative evaluation involving a diverse range of stakeholders in neonatal transport. Six key stakeholder groups took part, with 37 individuals participating in in-depth discussions. Our findings indicate that neonatal transfers in Iran are often disorganized and inconsistent, echoing earlier research highlighting the lack of standardized protocols for transferring critically ill neonates in low-income or resource-constrained environments [10], [17], [18].

A particularly noteworthy outcome of this study is the substantial variability in neonatal transfer processes across Iranian provinces. Given the limited existing research on neonatal transport in Iran, the urgency of developing and applying consistent, evidence-based guidelines becomes evident to enhance the efficiency, safety, and equity of neonatal transport systems.

To further contextualize the challenges within Iran's neonatal transport system, we identified to contextualize the challenges in Iran's neonatal transport system, we categorized barriers under five main themes: 1) infrastructure, 2) structural issues, 3) communication, 4) team awareness and 5) equipment. These themes overlap with those identified in other developing nations [10-13]. The recurring themes across these studies—such as inadequate infrastructure, limited access to specialized equipment, and fragmented communication systems—underscore the shared struggles of LMICs in addressing neonatal transport challenges and highlight the need for collaborative, context-specific solutions to improve outcomes.

Further research should prioritize strategies to address the challenges identified here. Notably, Key Performance Indicators (KPIs) are essential for systematically monitoring the neonatal transfer process. These KPIs might include transfer time, patient outcomes, resource usage, and stakeholder satisfaction—variables that together provide a quantitative foundation for gauging process efficacy.

Moreover, conducting a comprehensive study to determine the relative weight of each challenge is crucial. Understanding which challenges have the greatest impact on neonatal outcomes will help in allocating resources and designing targeted interventions more effectively.

5 | Conclusion

To the best of our knowledge, this is the first study conducted from a stakeholder perspective to identify obstacles in the inter-organizational handover practices of critically ill neonates. By examining neonatal transfer processes in Iran, this research provides valuable insights into the logistical, systemic, and operational challenges that shape neonatal transport, particularly in resource-constrained settings. Our findings emphasize the urgent need to address these constraints, which are deeply influenced by the contextual realities of developing countries.

Through this study, we identified five key themes that significantly impact neonatal transport: 1) infrastructure, 2) structural issues, 3) communication, 4) team awareness and 5) equipment. These themes highlight the logistical inefficiencies that hinder timely and safe neonatal transfers, including poor communication channels, lack of centralized coordination, inadequate transport infrastructure, insufficiently trained teams, and unreliable medical equipment. Such barriers not only contribute to delays but also compromise the overall quality of neonatal care.

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