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Digital-Enhanced Interdisciplinary Care in Neonatal Intensive Care Units (NICUs): A Perspective

Zohreh Farzadi [1], Negar Alipour [2], Tayebeh Cheraghian [3*]

[1] Florence-Nightingale Hospital, Kaiserswerther Diakonie, Düsseldorf, North Rhine–Westphalia, Germany
[2] Student Research Committee, School of Nursing and Midwifery, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[3] Cardiovascular Research Center, Shahid Rahimi Hospital, Lorestan University of Medical Sciences, Khorramabad, Iran

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ABSTRACT

The Neonatal Intensive Care Unit (NICU) is one of the most technologically advanced and interdependent environments in modern healthcare. Delivering high-quality care to premature or critically ill newborns requires uninterrupted coordination among physicians, nurses, respiratory therapists, pharmacists, developmental specialists, psychologists, social workers, and the family. However, traditional siloed models of practice often hinder communication, delay clinical decision-making, and reduce opportunities for meaningful parental involvement. Over the past decade, interdisciplinary approaches built on shared goals, structured communication, and collaborative teamwork have been associated with stronger safety cultures, enhanced staff cohesion, and improvements in selected clinical outcomes. Simultaneously, the rapid growth of digital health technologies has reshaped expectations within NICU teams. Tools such as tele-neonatology networks, integrated physiological monitoring platforms, digital dashboards, parent-facing communication portals, and emerging artificial intelligence (AI)-based decision-support systems are redefining information flow and team coordination in care. However, introducing these technologies requires more than simply deploying devices. This calls for a thoughtful redesign of communication pathways, alignment of clinical workflows, targeted interprofessional training, and adaptive governance structures that preserve human connections and reinforce family centered care. This perspective synthesizes current evidence and conceptual insights to examine how digitally enabled interdisciplinary care can be effectively implemented in the NICU. We describe key domains, including technological integration, team communication, competency development, and organizational leadership, that support successful and sustainable adoption. We conclude with practical recommendations for aligning human, technological, and system-level components to strengthen the safety culture, operational efficiency, and family experience in neonatal care. Rather than presenting new empirical data, this article offers a conceptual roadmap for transforming digital innovation into meaningful interdisciplinary collaboration.

Keywords: Neonatal intensive care; Interdisciplinary care; Tele neonatology; Digital health; Simulation-based education; Family-centered care

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[*] *Corresponding* author: Tayebeh Cheraghian. Cardiovascular Research Center, Shahid Rahimi Hospital, Lorestan University of Medical Sciences, Khorramabad, Iran. email: cheraghiantayebe@gmail.com

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Introduction

The Neonatal Intensive Care Unit (NICU) is one of the most technologically advanced and logistically demanding settings in modern healthcare. Providing care for premature or critically ill newborns requires seamless coordination among neonatologists, highly trained nurses, respiratory therapists, pharmacists, feeding and developmental specialists, psychologists, social workers, and, critically, engaged parents and caregivers. However, traditional models in which each discipline "operates in its own silo" can disrupt communication, slow clinical decision-making, and limit opportunities for meaningful family participation. These gaps may weaken the safety culture, prolong hospitalization, and negatively affect developmental outcomes. Recent evidence, for instance, demonstrates that interprofessional and family centered meetings in the NICU enhance communication and reduce parental stress and the risk of medical errors [1].

In contrast, interdisciplinary care paradigms—defined by shared goals, coordinated workflows, continuous dialogue, and mutual accountability—have been linked to stronger safety climates and improvements in selected clinical outcomes in NICU settings. A recent chapter, for example, noted that high-reliability interprofessional collaboration in neonatology enhances both process efficiency and the delivery of family centered care [2]. Such collaborative structures are essential because the condition of critically ill newborns can change from minute to minute, requiring multiple disciplines to synchronize their expertise in real time to optimize respiratory management, nutrition, developmental support, and discharge planning for the patient.

Amid the rapid digital transformation of contemporary healthcare, NICU teams are navigating evolving expectations and new modes of interaction. Digital health tools increasingly shape the capture, sharing, interpretation, and operationalization of clinical information across disciplines. Emerging applications in neonatology include prenatal digital platforms, integrated monitoring systems, telemedicine networks, parent-facing portals and mobile applications. For instance, a recent retrospective cohort study reported that engagement with digital health during prenatal care was associated with a longer gestational age and a reduced likelihood of NICU admission [3]. Likewise, digital health competencies among NICU nurses—particularly skills related to system integration and e-health literacy— are measurable and modifiable contributors to technology-enabled clinical performance [4].

However, integrating digital technologies into an interdisciplinary NICU care model involves more than just installing devices or launching parent portals. Effective implementation requires redesigning communication pathways, mapping collaborative workflows, providing intentional training for diverse professionals (and families), adopting adaptive governance structures, and cultivating a culture that supports continuous learning and shared decision-making across disciplines. Realizing the benefits of digital enhancement also depends on addressing several interconnected dimensions: information architecture (how data move across monitors, electronic medical records, decision-support systems, and clinical teams), human–technology interaction (how clinicians and families experience and engage with these tools), interprofessional dynamics (how digital tools mediate or augment collaborative behavior), and organizational policy (how leadership ensures trust, accountability, and resilience).

The NICU's uniquely demanding environment intensifies these challenges. Clinicians must respond to rapid physiological instability, interpret high-volume data streams (including vital signs, ventilator settings, nutritional metrics, imaging, and laboratory results), support shifting developmental trajectories, and address complex family needs and ethical considerations. Introducing digital tools into this already dynamic setting, while preserving interdisciplinary synergy, raises critical questions. How can telemedicine networks strengthen collaboration among neonatologists, respiratory therapists, and developmental specialists? In what ways might AI-enabled decision-support systems be embedded into real-time workflows without eroding professional autonomy or family's trust? What training models are needed to build digital competence across diverse disciplines, and how can such training be integrated into existing interprofessional education frameworks? Recent work on AI in the NICU underscores that although predictive models and intelligent decision-support systems hold significant promise, real-world adoption remains in its early stages and is marked by challenges related to trust, data quality, explainability, and alignment with workflow demands [5].

In this perspective article, we synthesize emerging empirical evidence and reflect on practical strategies for operationalizing "digitally enhanced interdisciplinary practice" in the NICU setting.

Our goal is to propose a framework that encompasses (a) digital tools and platforms that support interdisciplinary neonatal care, (b) team and

workflow redesign that aligns with collaborative clinical objectives, (c) training and competency development for clinicians and families, and (d) organizational and governance structures, including leadership, safety culture, data stewardship, and continuous improvement, required for sustainable implementation. We also draw on illustrative case examples and identify key enablers and barriers, such as technology adoption, interoperability, team acceptance, data overload, family engagement and appropriate evaluation metrics. Achieving progress in this domain will require not only technological innovation but also deliberate human-system integration; team cognition, workflow design, and digital artifacts must align to realize the full potential of interdisciplinary care.

Through this synthesis, we aim to offer neonatal clinicians, informaticians, organizational leaders, and families a practical roadmap for translating digital health innovations into a more coherent and collaborative NICU practice. By strengthening safety, efficiency, developmental outcomes, and family experience, digitally enabled interdisciplinary care can advance quality and equity in one of the most complex areas of modern medicine. To guide this perspective, we developed a framework illustrating how digital tools, interdisciplinary workflows, team competencies, and organizational enablers interact to support digitally enhanced interdisciplinary NICU care (Figure 1].

Rationale for integrating digital technologies into interdisciplinary NICU care

Multiple converging trends underscore the growing need to embed digital solutions in interdisciplinary NICU frameworks. Teleneonatology services extend specialist expertise across geographic regions, supporting hospitals with limited neonatal resources and reducing unnecessary transfers [6, 7]. At the same time, NICUs produce enormous volumes of physiological data and device-generated alerts; teams with strong digital competencies are better equipped to synthesize these data streams and translate them into timely, coordinated clinical decisions (4, 8]. Families increasingly expect real-time updates, opportunities for remote engagement, and the ability to participate in clinical discussions. Digital platforms enable virtual presence, structured education, and participation in rounds, thereby enhancing family centered care [3,7]. Furthermore, modern interprofessional education increasingly recognizes the need for digital competencies, ensuring that clinicians can function effectively within technology-rich, collaborative workflows [9].

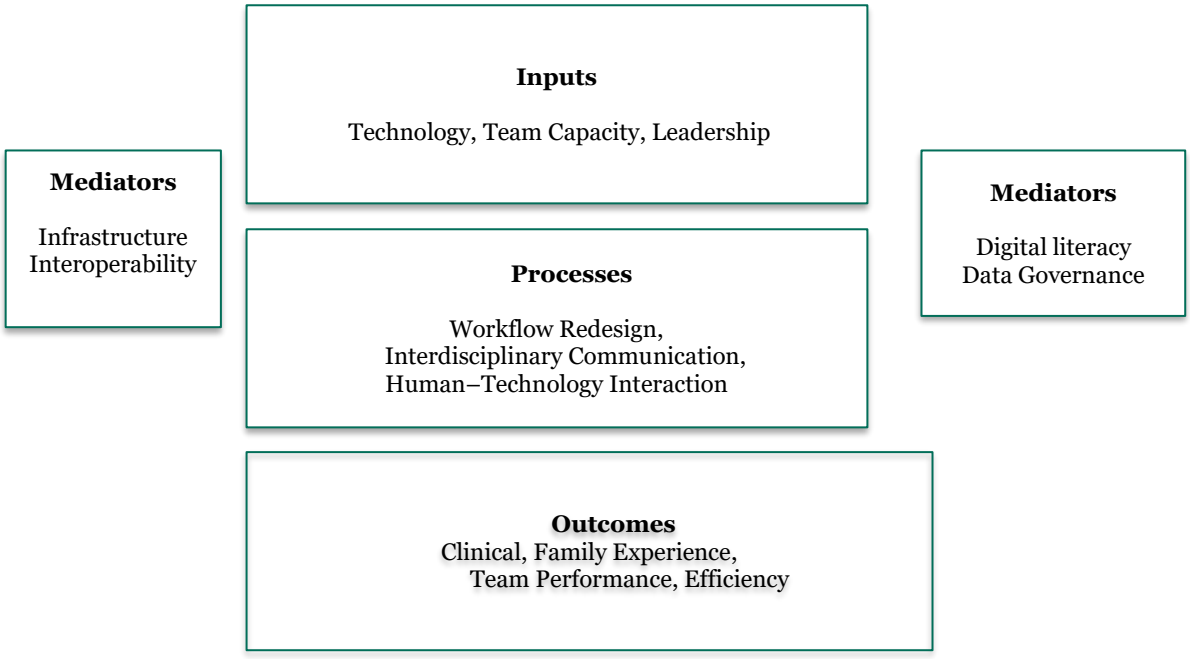

Figure 1. Framework digitalization and interdisciplinary care in the NICU

Evidence syntheses and representative studies

Telemedicine solutions are increasingly being integrated across the neonatal–perinatal continuum, with documented benefits ranging from improved access to prenatal consultations to reduced logistical barriers in follow-up care [6].

A 2024 scoping review reported that interventions using real-time video, secure messaging platforms, and mobile applications may enhance parental well-being, self-efficacy, and discharge readiness, particularly when parents are directly involved in the design and evaluation of these interventions [7]. Additionally, a hybrid implementation pilot in the Netherlands demonstrated that a national TeleNeo program was both feasible and informative, offering actionable guidance for scaling tele-neonatology across regional NICUs [10].

Recent bibliometric analyses have revealed exponential growth in research on telemedicine and digital health applications for newborns, establishing these areas as rapidly advancing scientific frontiers [8]. This trend reflects the growing global recognition of the value of tele-neonatology in expanding access and supporting high-quality neonatal care. Emerging empirical evidence also links nursing e-health literacy with real-world technology-mediated practice patterns in NICUs, including alert management, digital documentation, and data interpretation [4].

These findings reinforce the idea that digital competence is not merely an individual skill but a collective team capacity essential for ensuring safe and efficient neonatal care.

A large body of work on simulation-based interprofessional education in neonatology demonstrates improvements in communication, teamwork, and both technical and non-technical skills [9]. Systematic evidence continues to support the benefits of family centered interventions, including improvements in breastfeeding, parental preparedness, and selected neonatal outcomes [3, 11].

Artificial intelligence and digital health innovations are increasingly integrated into neonatal NICUs to enhance clinical care and family centered communication. AI systems can analyze large-scale, complex NICU data, such as continuous vital sign monitoring and electronic health records, to predict risks, such as sepsis and length of stay, helping clinicians make faster and more accurate decisions [5, 12, 13]. Moreover, qualitative studies show that parents generally welcome AI tools (e.g., automated pain assessment) as a means to improve safety and responsiveness; however, they emphasize that these tools should supplement, not replace, human care and interaction [14]. By developing AI-powered platforms and mobile applications, NICUs can deliver tailored, timely information and answers to parents' concerns — supporting digital access and fostering trust—while maintaining transparency, human oversight, and ethical safeguards [15].

Digital tools increasingly serve as mechanisms for operationalizing these principles, enabling meaningful parental engagement, even when families cannot be physically present at the bedside. Foundational research on safety culture in NICUs has shown that a strong teamwork climate is associated with reduced healthcare-associated infections and improved overall safety performance [16]. As digital systems are further integrated into clinical practice, these relational and cultural dynamics remain central to successful implementation and sustained clinical excellence.

Based on the current evidence, several pathways may guide NICUs seeking to integrate digital innovation with interdisciplinary practice such as:

- **Map roles, data flows and escalation pathways**: Clarify how remote and in-person team members participate in rounds, care planning and discharge processes. The TeleNeo framework offers useful exemplars of coordinated, digitally enabled teamwork [7, 10].
- **Integration of e-health competencies into ongoing education programs**: Training should be hands-on and context-specific, focusing on alert interpretation, teleconsult etiquette, and digital communication skills [4, 9]. Embedding authentic digital processes into simulation-based interprofessional training can better prepare teams and reduce workflow fragmentation [9]. Inclusive design principles should be used. Co-designing digital interventions with clinicians and parents ensures alignment with clinical realities and family needs, thereby increasing acceptability, engagement, and sustainability [7, 11].
- **Strengthening policies and governance**: Digital tools must be supported by transparent policies on consent, data protection, remote visual access, accountability structures, and equitable implementation across various resource settings [6, 10].
- **Expand the evaluation metrics**: Assessments should move beyond feasibility to include clinical outcomes, parental experiences, communication quality, safety climate, and cost-effectiveness. Large-scale longitudinal studies are critically needed to inform policy and practice [8, 10].

Challenges and research priorities

Key barriers to digital integration in interdisciplinary NICU care include variable levels of digital literacy among staff, workflow misalignments that introduce additional burdens rather than alleviating them, limited or unreliable technological infrastructure, particularly in under-resourced settings, persistent concerns related to privacy and data security, and a continued lack of robust, long-term evidence on clinical effectiveness and cost-effectiveness [3, 4, 7, 8, 10].

The priority areas for future research span several domains. These include controlled evaluations of tele-interdisciplinary models and their effects on neonatal morbidity, length of stay, and resource utilization; longitudinal studies examining digitally facilitated family integration with attention to parental mental health and infant developmental trajectories; and economic evaluations assessing system-level efficiency and cost-effectiveness.

Equity-focused implementation research is critically needed, particularly in low- and middle-income contexts where digital infrastructure may be limited. Mixed-methods approaches are particularly valuable for capturing the dynamic interplay between technology, team culture, and family experience.

Conclusion

Digital technologies are expanding the scope of interdisciplinary care in the NICU. When intentionally and collaboratively integrated, they allow teams to share expertise across boundaries, strengthen family participation, and support training environments that closely reflect real-world clinical practice. However, technology alone cannot drive meaningful changes. Sustainable improvement requires the deliberate embedding of digital tools into team processes, ongoing investment in digital competencies, genuine co-design with families, and rigorous longitudinal evaluations to understand clinical, experiential, and system-level impacts. When guided by these principles, digitally enhanced interdisciplinary care represents a promising and pragmatic pathway toward safer, more family centered, and resilient neonatal services.

Authorship contribution statement

All authors have reviewed and approved the final version of the manuscript. T Ch conceived and designed the study. Z F conducted the study and collected the data; ZF, N A and T Ch performed the interpretation.

Ethical Consideration

Not appliable

Declaration of Competing Interest

The authors declare no conflicts of interest related to the development, analysis, or presentation of the concepts described in this manuscript. No financial or personal relationships influenced the work reported

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