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2734 17 Avenue SW,  
Calgary, Alberta, T3E0A7,  
Canada  
+15878858911  
editorial-office@sciformat.ca

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# PARENTAL SUPPORT TECHNOLOGIES IN NICU: DIGITAL INTERVENTION TO REDUCE STRESS AND IMPROVE BONDING

**Gabriela Daniel** (Corresponding Author, Email: gabrieladaniel.12@gmail.com)  
Divine Mercy District Hospital, Limanowa, Poland  
ORCID ID: 0009-0007-5590-8736

**Karolina Halat**  
Ludwik Rydygier Hospital in Krakow, Kraków, Poland  
ORCID ID: 0009-0001-2242-5814

**Antoni Hajdas**  
Ludwik Rydygier Hospital in Krakow, Kraków, Poland  
ORCID ID: 0009-0005-1836-6312

**Natalia Kaczmarczyk**  
The University Hospital (SU) in Krakow, Kraków, Poland  
ORCID ID: 0009-0000-4386-4333

**Justyna Chudy**  
Beskidzkie Centrum Onkologii, Municipal Hospital of John Paul II in Bielsko-Biala, Bielsko-Biala, Poland  
ORCID ID: 0009-0006-8824-7260

**Łukasz Ćmok**  
Beskidzkie Centrum Onkologii, Municipal Hospital of John Paul II in Bielsko-Biala, Bielsko-Biala, Poland  
ORCID ID: 0009-0009-3414-4743

**Julia Dobrowolska**  
St. Barbara Provincial Specialist Hospital No. 5, Sosnowiec, Poland  
ORCID ID: 0009-0007-9647-2174

**Jakub Robert Skalski**  
Gabriel Narutowicz Municipal Specialist Hospital, Kraków, Poland  
ORCID ID: 0009-0006-5954-096X

**Iga Kałka**  
Stefan Żeromski Specialist Hospital, Kraków, Poland  
ORCID ID: 0009-0008-1527-4983

**Julia Szmuc**  
Stefan Żeromski Specialist Hospital, Kraków, Poland  
ORCID ID: 0009-0005-4403-3044

## ABSTRACT

Parents of infants admitted to Neonatal Intensive Care Units (NICUs) frequently experience elevated levels of stress, anxiety, and depressive symptoms, which may negatively affect early bonding and caregiving confidence. Digital interventions have emerged as accessible and scalable tools to address these challenges.

This narrative review synthesizes current evidence on five categories of digital parental support: mHealth applications, telehealth and video communication systems, digital psychological interventions, virtual peer support platforms and IA based solutions.

The findings suggest that mHealth interventions can improve parental self-efficacy and reduce stress, while telehealth solutions enhance communication with healthcare providers and increase perceived involvement. Digital psychological interventions, including CBT, ACT, and mindfulness-based approaches, support emotional regulation and reduce depressive symptoms. Peer support platforms contribute to social connectedness, empowerment, and shared experiential learning. AI based solutions, including chatbots and predictive monitoring tools may enhance communication, education and engagement in neonatal care.

Despite these promising outcomes, the evidence remains heterogeneous in terms of study design, intervention characteristics, and outcome measures. Future research should focus on long-term effectiveness, standardized evaluation, and equitable access, as well as the integration of multiple digital modalities. A combination of quantitative and qualitative approaches may support the development of user-centered, evidence-based systems that enhance parental well-being and strengthen parent–infant bonding in NICU settings.

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## KEYWORDS

NICU, Digital Health, AI in Medicine, Bonding

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## CITATION

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### 1. Methodology

This study was conducted as a structured narrative review of digital interventions supporting parents of infants hospitalized in Neonatal Intensive Care Units (NICUs). A literature search was performed mainly in PubMed, but also in Scopus, Web of Science, and Google Scholar using keywords related to NICU care, digital health (mHealth, eHealth, telehealth, AI), and parental psychosocial outcomes (stress, anxiety, bonding, attachment).

Studies published between 2010 and 2025 were included if they evaluated technology-based interventions targeting parental support and reported psychosocial outcomes. Titles, abstracts, and full texts were screened, and eligible studies were analyzed using thematic synthesis. Interventions were categorized according to technological modality and reported impact.

### 2. Introduction

The hospitalization of a newborn in a Neonatal Intensive Care Unit (NICU) represents not only a medical challenge but also a significant social and psychological disruption for families. Preterm birth and neonatal complications often alter the expected transition to parenthood, leading to increased stress, anxiety, and emotional instability. At the same time, the highly technological NICU environment may unintentionally limit parental involvement and reduce opportunities for early bonding.

From a social science perspective, early parent–infant interaction plays a critical role in shaping long-term developmental and relational outcomes. Parental distress during this period has been associated with impaired bonding, reduced self-efficacy, and increased risk of long-term mental health difficulties. Supporting parents in NICU settings is therefore not only a clinical priority but also a broader societal concern.

Recent advances in digital health technologies have created new opportunities to address these challenges. Tools such as mobile applications, telehealth platforms, and digitally delivered psychological interventions extend beyond clinical monitoring, functioning as mechanisms of social support, communication, and empowerment.

The COVID-19 pandemic further accelerated the adoption of remote solutions, highlighting both their feasibility and importance. However, despite increasing implementation, evidence regarding their effectiveness remains fragmented. In addition, the integration of digital technologies raises important social and ethical questions, including issues of access, privacy, and the changing nature of care relationships.

This review aims to synthesize and critically evaluate current research on digital interventions supporting parents in NICU settings, with a focus on stress reduction and parent–infant bonding.

### 3. Theoretical Background

The evaluation of digital parental support technologies in NICUs can be informed by established psychological and social theories. Attachment theory highlights the importance of early caregiver–infant interaction for healthy emotional development. In NICU settings, medical complexity and physical separation may disrupt these processes, particularly when parental distress is high.

The transactional model of stress and coping provides an additional framework, suggesting that stress arises when perceived demands exceed available coping resources. Digital interventions that improve access to information and enhance coping skills may therefore reduce psychological burden.

From a systems perspective, family-centered care emphasizes collaboration, shared decision-making, and parental involvement. Digital technologies may support these principles by improving communication and increasing parental agency.

Together, these frameworks enable a multidimensional understanding of digital interventions, encompassing not only stress reduction but also bonding, empowerment, and transformation of care relationships.

### 4. Categories of Digital Parental Support Technologies

#### mHealth

Mobile health (mHealth) interventions have emerged as a promising strategy to support parents of infants hospitalized in Neonatal Intensive Care Units (NICUs). These digital solutions, typically delivered via smartphone applications or web-based platforms, aim to reduce parental stress, enhance self-efficacy, and facilitate bonding with the infant. Research indicates that parents of preterm or medically fragile newborns frequently experience high levels of stress, anxiety, and uncertainty, which can negatively impact early attachment and caregiving competence. mHealth interventions offer a flexible, accessible, and scalable approach to address these challenges.

A systematic review and meta-analysis by He et al. (2024) demonstrated that mHealth interventions can significantly reduce negative emotional outcomes among parents of preterm infants, including stress, anxiety, and depressive symptoms, highlighting their potential utility in NICU settings (He et al., 2024 ). Similarly, Chua and Shorey (2022) found that mobile application-based perinatal programs improved parenting self-efficacy, knowledge, and perceived social support, suggesting broader psychosocial benefits of mHealth beyond direct stress reduction (Chua & Shorey, 2022 ). These findings are consistent with pilot studies evaluating mHealth tools specifically designed for NICU parents; for example, Lee et al. (2025) reported that a post-NICU discharge mobile application enhanced parental confidence and showed positive trends in parent–infant bonding (Lee et al., 2025 ).

Beyond these outcomes, mHealth platforms often include features such as daily checklists for infant care, symptom trackers, push notifications with health tips, and guided educational modules. These features not only increase parental engagement but also provide structured routines that reduce uncertainty and empower caregivers in navigating complex NICU processes. Some applications incorporate interactive components, such as quizzes or gamified content, to reinforce knowledge and enhance motivation. Research suggests that such design elements improve adherence and engagement, particularly for parents who may experience fatigue or cognitive overload during stressful NICU stays (Sunshine et al., 2023 ).

Moreover, mHealth interventions can facilitate communication with healthcare providers by enabling parents to submit questions or updates about their infant’s condition asynchronously. This mechanism promotes continuity of care and reduces the anxiety associated with delayed responses from clinical staff. For

instance, apps allowing parents to log feeding times, diaper changes, or sleep patterns can generate data that staff review, creating a feedback loop that enhances perceived involvement and parental agency.

Social and cultural factors also influence the effectiveness of mHealth interventions. Language options, culturally tailored content, and the ability to connect with local support networks increase the relevance and accessibility of these tools. Additionally, accessibility features—such as voice input, large fonts, and simplified navigation—can support parents with varying levels of digital literacy or physical limitations. Despite these advantages, heterogeneity in study designs, intervention features, and outcome measures limits direct comparison across studies. Future research should focus on standardized evaluation of mHealth interventions, consideration of ethical issues such as digital equity and privacy, and exploration of long-term effects on parent–infant bonding.

### **Telehealth**

In addition to mobile applications, telehealth and video communication systems represent a key group of digital interventions aimed at supporting parents during their infant’s hospitalization in NICUs. These technologies focus on real-time or asynchronous audiovisual contact between parents, infants, and healthcare teams, with the potential to regulate parental emotions, improve perceptions of involvement, and strengthen engagement with care processes.

A recent implementation of telepresence technology, providing real-time video and audio communication between families at home and their infant in the NICU, demonstrated measurable improvements in parental mental health. After two weeks of virtual visits, parents exhibited a significant reduction in depressive symptoms, and most reported that telepresence did not increase stress; moreover, nearly all parents expressed increased motivation to visit in person after seeing their child on camera (Saito et al., 2024). The visual connection allows parents to witness their infant’s behaviors, monitor medical devices, and receive immediate reassurance from clinical staff, bridging the emotional gap caused by physical separation.

Empirical studies from a tertiary NICU implementing a video visitation program (FamilyLink) found that remote video viewing was associated with parents’ increased perceived involvement in their infant’s care and sustained intention to provide breast milk at discharge, suggesting that video access may positively affect caregiving engagement and maternal role perception (Weber et al., 2021). Telehealth also enables participation in virtual rounds, giving parents insight into medical decisions and fostering shared decision-making. Such participation aligns with family-centered care principles, supporting parents’ active engagement and ability to contribute meaningfully to their infant’s care.

Broader reviews of telehealth in neonatal care support these findings, concluding that real-time audiovisual communication—whether bedside camera access, video conferencing for rounds, or scheduled telehealth consultations—can decrease emotional burden and increase confidence in caregiving, particularly when parents are physically separated from their infant (Wagenaar et al., 2024). These systems also allow healthcare teams to provide targeted education, for example, demonstrating feeding techniques or skin-to-skin care virtually, which parents can practice immediately, reinforcing learning and competence.

Telehealth interventions also face challenges, including technical limitations (e.g., unstable internet connections) and usability barriers. Ensuring privacy and confidentiality is essential, particularly when sensitive medical information is shared via video platforms (Holm et al., 2019; Wagenaar et al., 2024). Qualitative research on tele-homecare highlights that parental training and orientation to telehealth platforms are critical for maximizing benefits (Holm et al., 2019). Overall, telehealth and video communication systems show promise as supportive tools for parents in NICUs by enhancing engagement, reducing psychological distress, and complementing traditional family-centered care models.

### **Digital Psychological Interventions**

As highlighted above, parents in NICUs may encounter anxiety, depressive symptoms, and feelings of overwhelm due to their infant’s critical condition, which can compromise early attachment and ability to care for an infant. Digitally delivered psychological interventions—based on Cognitive Behavioral Therapy (CBT), Acceptance and Commitment Therapy (ACT), mindfulness, and relaxation techniques—are increasingly explored as scalable support strategies.

A recent randomized cluster trial protocol evaluates a digital ACT-based intervention combined with parent education for caregivers of preterm infants, aiming to mitigate psychological strain, persistent concerns, and depressive symptoms compared to education alone or standard care (Ginsberg et al., 2024). Qualitative research informing this intervention indicates that parents prefer accessible, mobile-friendly digital tools offering structured emotional support rather than traditional printed materials (Ginsberg et al., 2025).

Mindfulness and relaxation modules, delivered via app or web platforms, include guided meditations, deep-breathing exercises, and cognitive reframing prompts, supporting parents in regulating acute stress responses.

Systematic evidence further suggests that mindfulness- and relaxation-based approaches may reduce anxiety and depressive symptoms in NICU parents, although methodological heterogeneity limits firm conclusions (Ginsberg et al., 2023). Digital psychological interventions can also include psychoeducation about grief, trauma, and coping strategies, enhancing understanding of the NICU experience and reducing feelings of helplessness. Some programs incorporate self-monitoring tools, allowing parents to track mood, stress levels, and sleep quality, enabling personalized feedback and adaptive recommendations.

The scalability of digital psychological interventions is particularly relevant for NICUs with limited on-site mental health support. Remote modules allow consistent delivery without requiring additional clinical staff, which is essential in resource-constrained settings. Furthermore, these interventions can be integrated with mHealth or telehealth platforms, offering a multimodal approach to parental support. However, high-quality controlled trials remain limited, highlighting the need for further evaluation of their long-term effects on parental well-being and parent–infant bonding.

### **Peer Platforms**

Virtual peer support platforms, including moderated online communities, parent-to-parent mentoring programs, and structured discussion forums, have emerged as an important digital resource for families of infants hospitalized in NICUs. These platforms provide parents with opportunities to share experiences, ask questions, and receive emotional validation from individuals who have faced similar challenges. Evidence suggests that participation in peer support programs can contribute to reduced perceived stress, increased parental confidence, and enhanced coping with the NICU experience, although effect sizes vary across studies (Wegman et al., 2024).

Effective peer programs often involve experienced parents trained to provide guidance, practical advice, and emotional support, helping to normalize experiences and reduce feelings of isolation (Pascual et al., 2024). Online delivery is particularly valuable when in-person presence is limited due to geographic, medical, or pandemic-related constraints, offering a flexible and accessible method of engagement. Mentorship programs often match parents based on infant gestational age, NICU experience, or cultural background, increasing relevance and trust.

Hall et al. (2015) emphasize that structured mentoring, facilitated discussion groups, and moderated forums can create safe spaces for knowledge exchange and peer learning, complementing formal clinical support. These platforms can address both practical caregiving skills (e.g., breastfeeding, sleep schedules) and emotional coping, including dealing with guilt, fear, or post-traumatic stress. Some platforms include synchronous video sessions, while others allow asynchronous messaging, giving parents control over participation according to their schedules and emotional readiness.

Despite these advantages, challenges remain. Ensuring content accuracy, appropriate moderation, and equitable digital access is critical to prevent misinformation and maintain trust. Additionally, some parents may feel hesitant to participate or share sensitive experiences in online settings, highlighting the need for optional anonymity and clear community guidelines. Ethical considerations, including privacy, data protection, and safeguarding of vulnerable families, must also be addressed (Roberts et al., 2021).

Overall, virtual peer support platforms serve as a complementary tool to traditional interventions, fostering social connectedness, empowerment, and shared learning, while providing scalable, flexible support for NICU parents who might otherwise feel isolated or overwhelmed. By integrating structured mentorship, moderated discussions, and accessible online resources, these platforms can enhance both psychosocial well-being and parent–infant bonding, especially when combined with other digital interventions such as mHealth or telehealth.

### **AI based solutions**

Emerging artificial intelligence (AI)-based technologies hold substantial promise in redefining how parental support is delivered in Neonatal Intensive Care Unit (NICU) settings. Beyond traditional digital health tools such as mHealth applications and telehealth platforms, AI introduces adaptive, data-driven mechanisms capable of personalizing information delivery, enhancing communication, and augmenting clinical decision support — all of which may mitigate parental distress and improve engagement (Choudhury & Urena, 2022; Coşkun et al., 2024).

One of the most direct applications of AI for NICU parents is the integration of generative AI chatbots into counseling and education. A recent observational study comparing AI-integrated counseling with standard clinician-led communication demonstrated significantly higher parental satisfaction scores in the AI group,

suggesting that AI can supplement human interaction by offering clearer, more comprehensive, and readily accessible explanations tailored to individual concerns (Joshi et al., 2025). Fathers in the AI-augmented counseling arm reported enhanced understanding and satisfaction without compromising the clinician's central role, indicating that AI may function as a valuable adjunct rather than a replacement for human communication.

AI-assisted information provision has also been evaluated in structured analyses of large language model outputs, where AI systems provided responses about premature infant care largely consistent with current clinical guidelines and comprehensible to lay audiences (Molu, 2023). These findings point to the potential utility of AI as an on-demand informational resource for parents navigating complex care environments. However, studies note limitations in depth for certain care domains and the need for enhancements in individualized guidance.

Beyond communication and information delivery, AI systems are being explored for clinical monitoring that may indirectly benefit parents by improving infant care quality and transparency. AI algorithms for continuous physiological and pain monitoring in NICU patients have been viewed positively by both healthcare professionals and parents, who recognize the potential for enhanced detection of clinical states and improved caregiver confidence (Racine et al., 2024).

The application of AI in NICUs extends into clinical decision support systems, where machine learning models are used for early detection of conditions such as sepsis, respiratory compromise, and adverse events long before traditional methods are able to detect them. Although these measures primarily impact infant outcomes rather than parental psychosocial support directly, improved early warning systems may reduce parental anxiety by shortening uncertainty and streamlining care decisions (Sullivan et al., 2024).

Despite these promising developments, several overarching challenges remain. Researchers highlight the importance of ecological validity, accountability, and human factors in the design of AI systems, stressing that AI readiness must be evaluated in real-world clinical workflows and in close collaboration with clinicians and families (Choudhury & Urena, 2022). Issues such as explainability, data privacy, ethical safeguards, and the avoidance of overreliance on algorithmic output are critical for responsible integration.

In summary, AI-based solutions in the NICU are beginning to expand the scope of parental support from informational assistance and satisfaction enhancement to more nuanced clinical integration. These technologies show potential to personalize guidance, improve clarity, and support shared understanding between families and healthcare teams. However, ongoing research is necessary to validate long-term benefits, ensure equitable accessibility across diverse populations, and integrate AI safely within family-centered care models (Choudhury & Urena, 2022; Coşkun et al., 2024; Joshi et al., 2025; Molu, 2023; Racine et al., 2024; Sullivan et al., 2024).

## **5. Comparative Analysis of Outcomes**

Digital interventions supporting parents in Neonatal Intensive Care Units (NICUs) vary widely in design, function, and psychosocial outcomes. Each modality offers unique benefits while addressing different aspects of parental stress, coping, and engagement. Understanding the comparative strengths of these approaches can guide the development of comprehensive support strategies in NICU settings.

### **mHealth Applications**

mHealth apps are designed to provide accessible, on-demand resources for parents. They commonly deliver educational content about neonatal care, self-monitoring tools for tracking mood or stress, and guidance on coping strategies. These apps have been shown to reduce parental stress, anxiety, and depressive symptoms while improving self-efficacy and confidence in caregiving tasks. One of the key advantages is their asynchronous nature, allowing parents to access support at any time, which is especially useful during off-hours or when in-person visits are limited.

However, the effectiveness of mHealth apps depends on usability, interface design, and parents' digital literacy. High engagement often correlates with intuitive navigation, personalized feedback, and interactive elements such as reminders, quizzes, or progress tracking. Conversely, complex or poorly designed apps may discourage consistent use, limiting their psychosocial benefits. Emerging trends also explore integrating mHealth platforms with wearable devices to monitor physiological stress indicators, potentially enabling real-time, adaptive support.

### **Telehealth and Video Communication Systems**

Telehealth and real-time video platforms aim to replicate aspects of in-person NICU interaction. These systems provide parents with live visual and auditory access to their infants, fostering a sense of presence and involvement even when physical access is restricted. In addition to enhancing bonding, telehealth allows parents to communicate directly with medical staff, ask questions, and receive guidance on caregiving tasks, which can alleviate anxiety and uncertainty.

Evidence suggests that telepresence interventions improve parental confidence in caregiving and may reduce stress associated with limited NICU access. Additionally, these platforms can facilitate multidisciplinary rounds, enable remote participation in educational sessions, and support family-centered care models. Limitations include reliance on stable internet connectivity, potential privacy concerns, and the need for staff training to ensure effective implementation. When combined with other digital interventions, telehealth can serve as a critical bridge between the NICU and home-based support systems.

### **Digital Psychological Interventions**

Digital psychological interventions, including Cognitive Behavioral Therapy (CBT), Acceptance and Commitment Therapy (ACT), and mindfulness-based programs, are designed to target emotional regulation and coping directly. These structured interventions provide guided exercises, psychoeducation, and interactive modules to reduce depressive symptoms, trauma-related stress, and maladaptive coping strategies.

Adherence and engagement are critical for effectiveness, as parents must actively participate in exercises and practice learned techniques. Research indicates that combining digital psychological programs with personalized feedback or professional coaching can significantly enhance outcomes. Moreover, these interventions may help parents develop long-term resilience and stress management skills, extending benefits beyond the NICU stay. The scalability of digital psychological programs also makes them a promising solution for institutions with limited mental health staffing.

### **Virtual Peer Support Platforms**

Virtual peer support systems connect parents with others experiencing similar NICU journeys. These platforms provide social validation, emotional support, and shared experiential guidance. Parents often report feeling understood and less isolated when participating in peer networks. While peer platforms may have less direct impact on clinical measures such as stress hormone levels or anxiety scales, they enhance perceived social support, empowerment, and normalization of parental experiences.

Peer support can take many forms, including moderated discussion forums, group video calls, and one-on-one mentorship programs. Effective peer platforms combine structured guidance with flexibility, allowing parents to seek support at times that suit their schedule. Integrating peer support with professional interventions can amplify benefits, as parents receive both experiential reassurance and evidence-based guidance.

Overall, mHealth applications and digital psychological programs primarily support individual coping, offering structured resources and evidence-based interventions. Telehealth strengthens parent-provider interaction, enhancing bonding and parental confidence in caregiving tasks. Peer platforms build social connectedness and provide validation that may not be captured through clinical measures alone.






The complementary nature of these interventions suggests that a multimodal digital approach may be most effective. By combining asynchronous mHealth support, real-time telepresence, structured psychological programs, and peer networks, healthcare providers can address the diverse psychosocial needs of parents in NICU settings. Such integration may not only alleviate emotional distress but also promote empowerment, relationship with the infant, and overall family resilience.

### **AI-Based Solutions**

AI-driven interventions, such as generative chatbots and predictive monitoring tools, offer personalized support for parents by providing tailored guidance, real-time updates, and educational resources. These tools can enhance communication with healthcare teams, increase parental understanding and confidence, and complement existing digital interventions like mHealth and telehealth. Ethical considerations, usability, and data privacy remain important for successful implementation, and AI should support rather than replace direct clinical interaction.

To summarize and compare the main categories of digital interventions for parents in NICU settings, **Table 1** presents their key benefits and limitations. This visual overview highlights how each modality addresses different aspects of parental stress, coping, and engagement.

**Table 1.** Digital interventions in NICU settings

Intervention	Key Benefits	Limitations / Challenges
 <b>mHealth Apps</b>	<ul style="list-style-type: none"> <li>Reduces stress and anxiety</li> <li>Improves caregiving confidence</li> <li>Accessible anytime</li> </ul>	<ul style="list-style-type: none"> <li>Depends on usability and digital literacy</li> <li>Complex apps may discourage use</li> </ul>
 <b>Telehealth &amp; Video Communication</b>	<ul style="list-style-type: none"> <li>Enhances parent–infant bonding</li> <li>Supports remote participation</li> </ul>	<ul style="list-style-type: none"> <li>Needs stable internet</li> <li>Privacy and training issues</li> </ul>
 <b>Digital Psychological Interventions</b> (CBT, ACT, Mindfulness)	<ul style="list-style-type: none"> <li>Emotional regulation and coping</li> <li>Builds long-term resilience</li> </ul>	<ul style="list-style-type: none"> <li>Requires active engagement</li> <li>Limited long-term data</li> </ul>
 <b>Virtual Peer Support Platforms</b>	<ul style="list-style-type: none"> <li>Provides social support</li> <li>Reduces feelings of isolation</li> </ul>	<ul style="list-style-type: none"> <li>Hard to measure clinically</li> <li>Requires moderation</li> </ul>
 <b>AI-Based Solutions</b>	<ul style="list-style-type: none"> <li>Personalized guidance</li> <li>Real-time updates</li> </ul>	<ul style="list-style-type: none"> <li>Needs quality data</li> <li>Risk of algorithm bias</li> </ul>

## 6. Social and Ethical Implication

The integration of digital technologies into Neonatal Intensive Care Units (NICUs) extends beyond clinical effectiveness, raising important social and ethical considerations. One key issue is digital inequality, as access to mHealth applications, telehealth systems, and online support platforms may vary depending on socioeconomic status, digital literacy, and technological infrastructure. This disparity can exacerbate existing inequalities in parental support and healthcare outcomes (Roberts, et al. 2021).

Another critical concern relates to data privacy and security, particularly in systems involving video streaming, mobile applications, and remote monitoring. Parents may experience discomfort regarding constant observation or uncertainty about how sensitive data are stored and shared (Wagenaar, et al. 2024). Ensuring transparency, informed consent, and secure data management is therefore essential.

From a psychosocial perspective, while digital tools can enhance access to information and support, there is a risk of over-reliance on technology, potentially reducing direct interpersonal interactions with healthcare providers or replacing human emotional support (Ginsberg, Alsweiler, Ross, et al. 2025).

Additionally, the quality and accuracy of information—particularly in peer support platforms—must be carefully managed to prevent misinformation.

Overall, ethical implementation of digital interventions requires balancing innovation with equity, privacy, and human-centered care, ensuring that technology complements rather than replaces supportive relationships in NICU environments

## 7. Future Directions

Despite growing evidence supporting digital interventions for parents in Neonatal Intensive Care Units (NICUs), there is a clear gap in the literature regarding the long-term effects of these tools on parent–infant bonding. Most research focuses on short-term outcomes, such as reductions in parental stress, anxiety, or depressive symptoms during hospitalization or shortly after discharge. While these findings are promising, they do not allow conclusions about whether digital interventions lead to sustained improvements in attachment, parenting competence, or quality of parent–child interactions over months or years following NICU discharge.

Longitudinal assessment is particularly important because early parent–infant interactions play a critical role in children’s emotional and social development, as well as parental psychological well-being. The absence of long-term studies limits the ability to develop evidence-based recommendations for integrating digital tools into routine clinical practice.

Future research should adopt longitudinal designs that evaluate both the quality of parent–infant bonding and parental psychosocial outcomes over extended periods after NICU hospitalization. Such studies are

essential to determine whether digital interventions can provide lasting benefits for family relationships and child development.

Second, while mHealth, telehealth, digital psychological programs, and virtual peer support platforms have demonstrated feasibility and acceptability, comparative effectiveness studies are limited. Direct head-to-head trials could clarify which modalities, or combinations thereof, yield the greatest psychosocial benefit.

Third, implementation challenges—including usability, digital literacy, accessibility, and integration into routine NICU workflows—remain underexplored. Addressing these factors is critical to ensure equitable access and meaningful engagement for diverse parent populations.

Fourth, there is a need for standardized outcome measures across studies, particularly regarding bonding, coping, and social support, to facilitate synthesis and meta-analysis.

Finally, emerging technologies such as AI-based support and predictive digital tools require careful evaluation for ethical, privacy, and emotional considerations. Future research should combine rigorous quantitative assessments with qualitative insights from parents and clinicians to develop integrated, evidence-based, and user-centered digital support systems that can be sustainably implemented in NICU settings.

## 8. Discussion

This review highlights the potential of digital technologies to support parents in NICU settings across multiple dimensions. mHealth and psychological interventions primarily enhance individual coping and emotional regulation, while telehealth improves communication and reduces distress associated with separation. Peer support platforms strengthen social connectedness and normalize parental experiences.

However, the available evidence remains heterogeneous, limiting direct comparison across studies. Most research focuses on short-term outcomes, with limited data on long-term effects.

Importantly, digital tools should be viewed as complementary to family-centered care rather than as substitutes for interpersonal support. Integrated, multimodal approaches may offer the most effective strategy for improving parental well-being and early bonding.

## 9. Conclusions

Digital technologies are becoming an increasingly important component of parental support in neonatal care. Current evidence indicates that interventions such as mHealth applications, telehealth platforms, structured digital psychological programs, and virtual peer support systems can effectively reduce parental distress, enhance confidence in caregiving, and support early parent–infant bonding. These interventions offer flexible, accessible, and scalable solutions that complement traditional in-person support, particularly for parents with limited access to the NICU or those facing logistical and emotional barriers.

Despite promising results, further research is necessary to establish the long-term effectiveness of these digital interventions. Most studies focus on short-term outcomes, and there is limited evidence regarding sustained reductions in stress, anxiety, or depressive symptoms after NICU discharge. Standardized evaluation metrics, longitudinal follow-up, and consideration of diverse family contexts are needed to ensure that interventions provide meaningful and lasting benefits.

In addition, attention to accessibility, usability, and ethical considerations remains critical. Factors such as digital literacy, socioeconomic status, language, and cultural relevance may affect engagement and outcomes. Ensuring data privacy, maintaining confidentiality, and integrating interventions within broader family-centered care models are essential to preserve trust and safety for families.

Future developments should focus on comprehensive, user-centered solutions that combine multiple digital approaches. Multimodal platforms integrating educational content, real-time telepresence, structured psychological support, peer networks, and AI-based tools have the potential to address the complex psychosocial needs of parents more holistically. AI solutions, including generative chatbots and predictive monitoring systems, can provide personalized guidance, real-time updates, and decision support, enhancing parental understanding, engagement, and confidence. Collaboration between clinicians, researchers, software developers, and families will be key to designing interventions that are effective, acceptable, and adaptable across diverse neonatal care environments. Ultimately, such integrated approaches could enhance parental well-being, strengthen parent–infant bonding, and contribute to improved developmental outcomes for preterm and critically ill infants.

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