Harnessing technology in pediatric nursing: balancing innovation, equity and sustainability

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Introduction

Modern technology is revolutionising pediatric healthcare, enhancing clinical decision-making, improving patient outcomes, and streamlining care delivery. From artificial intelligence (AI)-driven diagnostics to biosensors for continuous health monitoring, to virtual reality to reduce pain and anxiety in children, technological innovations are transforming the future of pediatric care, making it more precise, efficient, and patient-centred. However, the challenge lies in ensuring that these advancements are integrated responsibly, ethically, and equitably. This editorial acknowledges the exponential growth of modern technology in pediatric healthcare, highlighting both its successes and existing evidence gaps. It also emphasizes the need to counterbalance research waste from unadopted interventions while ensuring equitable, sustainable, and child-focused technology solutions.

Transforming pediatric healthcare through modern technology

Advancements in modern technology are enhancing both patient outcomes at the point of care while supporting a more responsive healthcare system tailored to children's unique needs. Machine Learning (ML) algorithms underpinning AI tools allow clinicians to predict critical events, such as appendicitis and sepsis in critically ill neonates. They can also detect conditions such as hydrocephalus and brain tumours by analysing abnormalities in pediatric brain magnetic resonance imaging (Huang et al., 2022; Lam et al., 2023; McAdams et al., 2022). Even wearable sensor devices such as smartwatches, enable continuous health monitoring of multiple physiological parameters and are reducing invasive testing as seen in continuous glucose monitoring (CGM) for children with diabetes (Hyun et al., 2024; Karges et al., 2023; Plummer et al., 2024). Virtual Reality (VR) a technological intervention is increasingly being adopted in healthcare settings to reduce pain and anxiety during procedures, such as intravenous cannulation and burns dressings. VR has also demonstrated success in providing immersive distraction-based therapies for both acute and chronic pain (Chan et al., 2019; Logan et al., 2021; Storey et al., 2025).

Pediatric care also benefits from modern technology in remote patient monitoring and tele-medicine, which improves access to and quality of care for children with chronic conditions (Shah & Badawy, 2021). Parents caring for children with medical complexity at home can be supported to monitor their child's symptoms and offered treatment guidance through AI-powered chatbots and virtual assistants (Kerth et al., 2024). Mobile health applications similarly provide children an opportunity to self-report symptoms, incorporating validated health outcome measures for real-time tracking and intervention (Jibb et al., 2020; Plummer et al., 2024; Ullman et al., 2024).

Despite technological advancements, ethical considerations, including patient autonomy, data privacy and equitable access to digital health tools, remain critical. Addressing disparities in digital health access is essential to ensure technology serves all children, rather than deepening existing inequities. access to emerging health technologies, particularly for marginalised populations, is essential for ensuring equitable healthcare outcomes for all children.

Implementation challenges of modern technology

Nurses, as the largest users of health information technology, are presented with both opportunities and challenges with the integration of modern technology into pediatric healthcare (Australian College of Nursing, 2017). Digitalisation has improved patient safety by integrating early warning and clinical decision support systems into Electronic Medical Records (EMRs), reducing medication errors, standardising treatment protocols, and alerting clinicians to patient deterioration (Wulff et al., 2018). Digitalisation of health records has also enhanced clinician efficiency by automating documentation processes and implementing standardised templates, which streamline workflows and allow clinicians to focus more on patient care rather than administrative tasks (Jenssen et al., 2022).

While the shift from paper-based records to EMRs enhances patient safety and efficiency, it also introduces issues in interoperability, data security, and maintaining human connection in paediatric healthcare. Many paediatric EMRs lack full interoperability, the capacity to seamlessly exchange information, creating inefficiencies that hinder data exchange between hospital departments and across healthcare settings (Australian Digital Health Agency, 2023;

Dufendach et al., 2024). This fragmentation disrupts coordinated care, particularly for children with complex medical needs, delays critical clinical decision-making, and increases the administrative burden on an already overstretched workforce (Pope et al., 2023).

The rapid proliferation of digital clinical decision tools, though designed to improve efficiency, is often poorly integrated into EMRs, leading to workflow disruptions, clinician cognitive overload, and alert fatigue (Higgins et al., 2018; Pope, Keyser, et al., 2024). Poorly integrated decision-support systems can overwhelm healthcare professionals with excessive alerts, contributing to alert fatigue and burnout (Pope, Keyser, et al., 2024). The growing reliance on AI-driven decision-support systems over clinical expertise has sparked frustration among healthcare workers, with American nurses staging protests to voice concerns about the erosion of professional judgment in patient care (Walker, 2024). Nurses continue to advocate for meaningful involvement into the design and evaluation of digital technologies.

Children and young people are increasingly engaging with digital health tools such as EMR and patient portals, raising concerns about data privacy and confidentiality. Adolescents, in particular, express apprehension about who has access to their sensitive health information, especially in cases where parents or caregivers might view personal health details (Pope, Jones, et al., 2024). While these technologies enhance engagement and accessibility, children and families fear the unintended consequences of information overload, which may increase anxiety in high-stress hospital settings (Thai et al., 2023). Striking a balance between transparency and privacy is essential to ensure young patients have control over their information while maintaining trust in digital healthcare systems.

Young people who are experts in technology use have a particularly nuanced vision of ethical use (McCradden et al., 2020). They describe how awareness of how even accurate, proper use of computational systems can make a person “feel like a number,” which has the potential to de-humanize the experience of medicine and nursing. Young people and adults alike emphasise the importance of ensuring the patient-clinician connection must not only be preserved but prioritized in particular situations, ensuring that automation supports, rather than replaces, meaningful interactions (Moy et al., 2024; Thai et al., 2023).

Meaningful collaboration among healthcare providers, technology developers, and policymakers is essential to establish industry-wide interoperability standards. By integrating user-centred co-design approaches, incorporating both young patients' concerns about data security and clinicians' needs for streamlined workflows, modern technology can serve as a facilitator rather than an obstacle to effective pediatric care (Pope et al., 2023). A well-designed digital ecosystem must enhance, rather than hinder, both patient engagement and provider efficiency, ultimately improving health outcomes for children and reducing strain on healthcare professionals.

Bridging the technology gap through codesign and Implementation Science

Digital health innovations demand significant financial investment, yet many fail to reach end-users, contributing to research waste. High development costs and poor clinical integration often confine these advancements to research settings. For example, a systematic review of e-health tools for pediatric pain management found that over $300,000 American dollars was spent on development and testing, with no access beyond the research phase (Higgins et al., 2018). Failure to partner with end-users and incorporate their perspectives early in the design process have equally resulted in clinically impractical tools, further limiting their real-world implementation (Chambers, 2018; Elish, 2018). In an increasingly costly healthcare system, failure to translate research into practice raises ethical concerns, as it undermines the responsible use of funding, participant contributions, and clinician engagement, ultimately delaying potential benefits for patients (Braithwaite et al., 2020; Chalmers & Glasziou, 2009). Ensuring that technological innovations are designed for real-world implementation is both a financial and ethical imperative and requires pragmatic research approaches.

A key contributor to research waste is the misalignment between research priorities and end-user needs (Becker-Barroso, 2022). Priority-setting studies have identified research needs from the perspectives of children (Modanloo et al., 2023), nurses (Mörelius et al., 2020) and specific fields such as pediatric anaesthesia (Sommerfield et al., 2023) and oncology (Aldiss et al., 2023). Capturing children's voices is essential, and the recently published Child-Centred Research Checklist provides an internationally supported framework for ethical collaboration with young participants (Foster et al., 2025).

To ensure successful integration of technology into pediatric clinical practice settings, a collaborative co-design child and family centred care approach is required where strategies and methods used are specifically designed to be engaging, meaningful, child friendly, age-appropriate, and equitable for children of various ages, gender, degree of illness and ethnicity (Chang et al., 2023). Some successful examples of child, family and health care provider co-design studies include computer games for treating anxiety in children with long-term physical conditions, self-monitoring apps for young people, an emotional health and substance use app, and development of an augmented reality intervention for children with developmental coordination disorders (Thabrew et al., 2018; Welsby et al., 2024).

Implementation science plays a critical role in bridging the gap between research and practice and supports the co-design process. By simultaneously evaluating clinical effectiveness and implementation outcomes, this approach ensures that digital health interventions are not only evidence-based but also feasible, scalable, and sustainable within real-world healthcare systems (Roberts et al., 2023).

Equity and sustainability of modern technology for healthcare

Our societal and health structures make technological innovation available to some more than others. Historically, participation in clinical research has been more readily available for children and families able to access metropolitan centres in high income countries (Cunninghame et al., 2024). Similarly, participants with other barriers, such as language (e.g., culturally and linguistically diverse) and challenged communication (e.g., medically complex, severe disability) have often been excluded from study participation, potentially limiting the generalizability of findings. These inequities are now recognised by the global and national frameworks for ethical conduct of research and funding bodies, however resources (e.g., translators) to support the safe inclusion of children with diverse needs are rarely provided (Chancel, 2022). Technologies to transform health experiences need to be made available to all children especially the most vulnerable and marginalised children (De & Pradhan, 2023; Faulkenberry et al., 2022).

The challenge of equity in modern technology extends well beyond geographical boundaries and poses an equity problem globally due to ethical concerns about their environmental impact. The environmental and sustainability impacts have been receiving more attention every year, and even incorporated into institutional and network-wide commitments (NHS England, 2022). The conundrum exits for pediatric nurses that integrating modern technology into pediatric healthcare may ultimately impact the well-being of the children they care for. The rapid expansion of AI infrastructure is accelerating climate change through high energy, mineral, and water consumption; disproportionately affecting global minority countries (Crawford, 2024; Hajiesmaili et al., 2024; Samuel & Lucassen, 2023). Despite the push for ‘responsible AI,’ current frameworks for AI translation largely overlook environmental consequences (Crawford, 2024). To ensure truly equitable and ethical innovation, sustainability must be embedded in the evaluation of healthcare technologies, balancing clinical benefits with long-term global impact.

Call for action

As modern technologies continue to evolve, the future of pediatric health care looks increasingly digital, personalised, and accessible. However, without careful planning, technology risks widening disparities and creating unintended consequences. Modern technology research must prioritise clinical practicality by ensuring co-design and real-world testing. It is critical to evaluate whether short-term term advancements justify long-term environmental and ethical costs. To create truly sustainable and equitable healthcare solutions, researchers, policymakers, and clinicians must integrate ethical, environmental, and implementation considerations into every stage of development. Without this commitment, technological progress risks widening disparities and compromising the very future it seeks to improve.

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