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A Systematic Review of Digital Health Tools for Interdisciplinary Collaboration Across Clinical and Support Services: Bridging the Silos in Modern Healthcare

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Abstract

Background: Contemporary care delivery demands seamless collaboration across a wide array of professions, including nurses, anesthetists, laboratory personnel, and operational specialists. Traditional workflows and communications across silos have typically been barriers to this coordination, usually resulting in inefficiencies that might also pose risks to patient safety.

Aim: This review synthesizes the literature on digital health tools from 2015 to 2025 to determine how they have facilitated interdisciplinary collaboration among these key stakeholders.

Methods: It reviewed different technologies, such as EHRs, Health Information Exchanges, CDSSs, telehealth platforms, secure messaging applications, and ERP systems.

Results: Integrated digital platforms greatly enhance the efficiency of communication, facilitate smooth patient care pathways, and extend operational decision-making. EHRs with interdisciplinary portals and HIEs provided a shared mental model for clinical teams, while telehealth and secure messaging facilitated real-time consultation. ERP systems integrated with clinical data were imperative for support services to align operational capacity with the demand for patient care. Several serious challenges remain, such as interoperability issues, very high implementation costs, alert fatigue, and resistance to cultural change.

Conclusion: Digital tools can be powerful enablers of collaboration, but their success is dependent on strategic, human-centered implementation in terms of workflow integration, data standardization, and fostering a shared culture of interdisciplinary care.

Keywords: digital health; interdisciplinary collaboration; nursing; anesthesia; laboratory services; health information technology; EHR; telehealth; operations; healthcare systems

Introduction

The paradigm of modern healthcare has irrevocably shifted from a model of isolated professional practice to one of integrated, interdisciplinary care. It recognizes that optimal patient outcomes are indeed achieved through the synergistic effort of a diverse team, each member contributing his unique expertise to care (Slater et al., 2023). This extends beyond the traditional physician-nurse dyad to highly specialized clinical roles such as anesthesia providers and crucial support functions, including planning and development specialists, operations technicians, and laboratory services professionals (Sinsky, 2024). The effective coordination of this complex ecosystem is paramount in ensuring patient safety, efficiency of care, and prudent management of resources.

Despite this recognized need, healthcare systems worldwide continue to face deep challenges in achieving seamless collaboration. Deeply ingrained professional silos, disparate communication protocols, and fragmented information systems often create barriers that lead to communication breakdowns, delays in procedures, medication errors, and suboptimal resource use (Sharkiya, 2023). For example, if laboratory results are late in reaching the anesthesia team, it may delay a scheduled surgery, with cascading operational inefficiencies throughout the perioperative pathway (Schouten et al., 2023). Similarly, a lack of real-time communication between nursing staff and operations technicians regarding equipment availability can impede patient care delivery directly.

In response to these challenges, digital health technologies have emerged as the transformative force with the potential to bridge these collaborative gaps. Digital health, defined as the use of information and communication technologies in managing health and well-being, is a broad array of tools, including but not limited to EHRs, telehealth platforms, clinical decision support systems, secure messaging applications, and ERP systems (Appleton et al., 2023). Among many promises, such tools will create a unified information environment, foster real-time communication, and provide data-driven insight to support collective decision-making.

While many have considered the impact of digital health on one single clinical domain or a bilateral professional relationship, no comprehensive synthesis has been done on the complex collaboration among nursing, anesthesia, planning and development, operations, and laboratory services. The current review aims to fill this gap by systematically analyzing the peer-reviewed literature for the last decade (2015-2025) in order to answer the following questions:

1. What particular digital health tools are being used to assist the interdisciplinary collaboration process that may include nurses, anesthesia providers, planning and development specialists, operation technicians, and laboratory services?
2. What is the perceived and measured impact of these tools on collaborative processes, clinical outcomes, and operational efficiency?
3. What are the main facilitators and barriers to the successful implementation and adoption of these tools within and across these professional groups?

Methodology

This is a systematic narrative review of the literature. A comprehensive search strategy was conducted for relevant peer-reviewed articles published between 2015 and 2025. Electronic databases considered for this purpose included PubMed, CINAHL, Scopus, and Web of Science. The search strategy used a combination of keywords and MeSH terms relating to the following: ("digital health" OR "EHR" OR "telehealth" OR "health information technology" OR "mHealth" OR "clinical decision support") AND ("interdisciplinary collaboration" OR "interprofessional collaboration" OR "teamwork" OR "communication") AND ("nursing" OR "anesthesia" OR "perioperative care" OR "laboratory services" OR "pathology" OR "healthcare operations" OR "planning"). The reference lists from identified articles were also hand searched for additional relevant publications.

The inclusion criteria were: (a) primary research (qualitative, quantitative, or mixed-methods) and/or a systematic review; (b) a study concerning the application of a digital health tool; (c) explicitly addressing the impacts on collaboration between at least two of the following professional groups: nursing, anesthesia, planning/development, operations, laboratory; and (d) published in English during 2015-2025. Exclusion criteria included studies focusing solely on physician-nurse collaboration when not involving the other specified roles in the collaboration, and/or studies not published in the English language. Data from the included studies were extracted and charted per category of digital tool, professional groups involved, key findings on collaboration, and outcomes reported.

Digital Health Tools for Clinical-Clinical Collaboration: Nursing and Anesthesia

It is here, in the high-stakes perioperative environment, that the collaboration of nursing and anesthesia is most critical, where information transfer needs to be fast and accurate. Digital tools have become central to orchestrating this complex dance.

Electronic Health Records (EHRs) and Perioperative Modules

The EHR is a foundational digital infrastructure for modern healthcare. When combined with specialized perioperative modules, it becomes a shared workspace for nurses and anesthetists. Researchers confirm that the integration of the EHR significantly enhances the completeness and accessibility of preoperative patient assessments (Mershon et al., 2021). For instance, nursing assessments of a patient's allergies, baseline vital signs, and psychosocial concerns are, within seconds, presented to the anesthesia team, who can use the information in their anesthetic planning. Inversely, the anesthesia plan, which includes estimated case duration and specific equipment requirements, is readily accessible to the circulating nurse, enabling superior preparation of the room (Gatiti et al., 2021).

Yet, merely having an EHR in place is not enough. In this case, design and interoperability are critical features of these systems. Carayon & Perry (2021) point out that improperly designed EHRs with different tabs, and even more critically, non-intuitive

navigation, can form "information silos within the silo," where clinicians have to invest more time navigating the system than interacting with each other. The best systems include interdisciplinary dashboards showing a synthesized view of key information from the nursing and anesthesia perspectives, thus creating one shared mental model of the patient's journey through the perioperative period of care (Rudin et al., 2014).

Clinical Decision Support Systems and Alert Fatigue

CDSS embedded within the EHR can proactively facilitate collaboration by flagging potential risks. For example, when a patient has a recent laboratory result (e.g., low potassium) or is taking medications known to increase anesthetic risk, a rule-based CDSS can automatically alert both the preoperative nurse and the anesthetist of this information (Sutton et al., 2020). Events like this create a shared alert that fuels collaborative discussion and intervention before the patient arrives in the operating room.

One important challenge involves alert fatigue. Clinicians, when CDSS generates a high volume of low-value alerts, gradually become desensitized and may override critical warnings (Rush et al., 2016; Oliveira et al., 2018). In the literature, developing "smart" or "tiered" alerts that are context-sensitive and prioritize high-severity warnings has been recognized as integral to the continued effectiveness of CDSS as a collaborative tool. Additionally, in ensuring that the alert parameters have clinical relevance and will be taken up, engagement of end-users from nursing and anesthesia is critical in their design and fine-tuning (Asiri et al., 2025; Baysari et al., 2025).

Secure Messaging and Telehealth Platforms

Apart from the EHR, communication-specific tools have become very important. Secure messaging apps, for example, platforms like TigerConnect or Vocera, permit fast, targeted communication. A nurse in the PACU can directly message the attending anesthetist regarding a patient's emerging pain or nausea and thus assure a quick response without the delays of phone tag or overhead paging (Webb et al., 2016). These tools support "closed-loop" communication, where a message has been both received and acknowledged.

Telehealth applications have opened up more collaboration opportunities. Consultations in preoperative anesthesia conducted through telehealth ensure better access for patients in remote locations and also create easier opportunities to involve the primary nurse in the discussion for a cohesive care plan from the very start (Appleton et al., 2023). Video conferencing facilitates ad-hoc consultations of the intraoperative anesthesia team with specialized nursing units, such as the ICU, in complex cases, enabling collaborative management in critically ill patients (Kalvelage et al., 2021).

Digital Health Tools for Clinical-Support Collaboration: Bridging Patient Care with Operational Logistics

Seamless delivery of patient care is linked inextricably to the efficiency of support services. Digital tools play a crucial role in connecting the clinical world with the logistical and diagnostic engines of the hospital (Table 1 & Figure 1).

Integration with Laboratory Services: Real-Time Data, Automated Notifications

Timeliness and accuracy of laboratory data are crucial for the numerous clinical decisions made by nurses and anesthetists. Digital interfaces between LIS and the EHR have been a cornerstone of this collaboration. The most significant development over the past decade has been from passive viewing to active, intelligent notification.

A good example includes critical value alerts. When a life-threatening laboratory result, such as a critically high potassium level, is verified, the LIS can automatically trigger an alert in the EHR that is pushed directly to the responsible nurse's and/or physician's secure mobile device, with read-receipt functionality (Flott et al., 2021). In this way, urgent results are acted on without delay, a huge improvement on the more laborious traditional approach, where a lab technician had to call down to the unit in the hope of finding the right person.

Also, "result pending" notifications and tracking in the EHR enable nurses to view the status of a drawn sample, thereby reducing time spent calling the lab for updates, enabling better management of their workflow. For the anesthesia team in the OR, real-time access to integrated POCT devices with the anesthesia record offers immediate data on blood gas or coagulation, thus allowing fluid management or ventilation strategies to be adjusted in real time.

Integrating with Planning, Development, and Operations

The integration of clinical staff and non-clinical operational roles in service represents one of the most dramatically changed areas in modern healthcare, driven in large measure by the incorporation of digital tools. This synergy is crucial; the efficiency of patient care depends directly on how well logistical and strategic support systems function. Planning and development specialists, for example, require access to robust, aggregated data to project with certainty the demand for services, make prudent investments of capital, and design new clinical spaces appropriately. Operations technicians have the critical role of ensuring availability, maintenance, and flow of the essential equipment and materials, a function that disrupts clinical activities the very moment it is in disarray.

Central to this operational-clinical integration are modern Enterprise Resource Planning systems. When these platforms are seamlessly interfaced with the EHR clinical scheduling systems,

they provide a whole-of-operational-capacity picture in real time. The surgical schedule thereby changes from a simple, clinical timeline into a rich data feed that proactively informs the operations team about the specific anesthesia machines, specialized surgical sets, and implants required for each procedure. Deployment of technologies like RFID tags on equipment and automated inventory management systems enables moving from reactive to proactive management. These tools can automatically signal operations technicians when a device is reaching its due date for maintenance or supplies of a critical item are running low on a specific unit, thereby averting the scenario where a nurse finds a broken infusion pump or an anesthetist finds a missing vital drug at the point of care.

Beyond daily logistics, digital tools empower strategic, forward-looking collaboration through advanced data analytics. Planning and development specialists utilize business intelligence (BI) platforms that aggregate and synthesize data from the EHR, ERP, and scheduling systems. This enables sophisticated analysis in long-term trends within surgical volume, case-mix complexity, and resource utilization. Equipped with these data-driven insights, these specialists can engage with the clinical leaders of nursing and anesthesia in genuinely collaborative planning. For instance, they can use predictive analytics together to model the operational and financial impact of introducing a new surgical service, thereby creating evidence-based forecasts of future staffing needs, the need for capital equipment, and physical space modification. This is a collaborative data-informed approach that effectively moves the planning function from its historical, reactive stance into a strategic, evidence-based discipline. This ensures that institutional growth will be sustainable and aligned with the evolution in patient care needs.

Table 1: Impact of Digital Tools on Interdisciplinary Collaboration

Digital Tool Category	Specific Example	Professional Groups Most Impacted	Impact on Collaborative Process	Key Challenges
Electronic Health Record (EHR)	Integrated Perioperative Module	Nursing, Anesthesia	Creates a single source of truth; improves information accessibility for shared decision-making.	Poor usability; workflow disruption; data overload. (Carayon & Perry, 2021; Mershon et al., 2021)
Clinical Decision Support (CDSS)	Drug-Lab Interaction Alerts	Nursing, Anesthesia, Laboratory	Proactively flags risks, prompting interdisciplinary review.	Alert fatigue: low specificity, poor integration with workflow. (Baysari et al., 2025; Sutton et al., 2020)
Secure Messaging	HIPAA-compliant mobile apps	All Groups (esp. Nursing & Anesthesia)	Enables asynchronous, closed-loop communication; reduces delays.	Blur work-life boundaries, message overload, and potential for miscommunication. (Webb et al., 2016)
Lab Information System (LIS)	Critical Value Alerting	Laboratory, Nursing, Anesthesia	Ensures urgent diagnostic data reaches the right clinician instantly.	Integration complexity, ensuring alert acknowledgment, and false positives. (Flott et al., 2021; Thakur et al., 2023)
Enterprise Resource Planning (ERP)	Integrated Staff/Asset Scheduler	Operations, Planning, Nursing, Anesthesia	Aligns operational resources (staff, equipment) with clinical demand.	High cost of implementation; resistance to sharing operational data; requires high data quality. (Wang et al., 2023; Kwon et al., 2022)
Telehealth Platforms	Preoperative Consultation	Anesthesia, Nursing, Planning (for resource modeling)	Facilitates remote team planning and patient inclusion.	Reimbursement issues, technological barriers for some patients, and state licensure restrictions. (Appleton et al., 2023; Kalvelage et al., 2021)

The successful deployment of digital tools for interdisciplinary collaboration is a complex socio-technical process in which human, organizational, and technical factors are inextricably linked. It is not guaranteed by the technology itself but depends on a strategic approach that actively fosters facilitators while mitigating significant barriers.
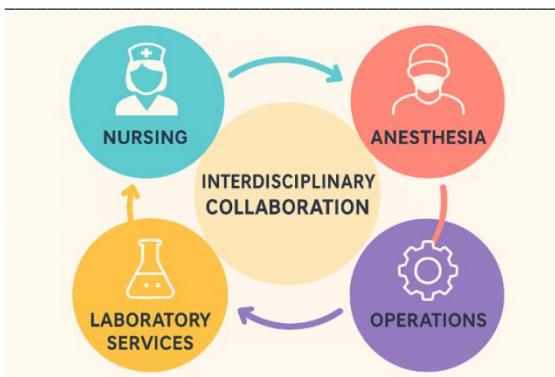
Figure 1: Conceptual Framework of the Interdisciplinary Collaboration

Key Facilitators for Effective Integration

Several critical facilitators consistently arise that enable the successful integration of collaborative digital health tools. Notably, interdisciplinary co-design involves the engagement of end-users from all professional groups impacted-from the nurses and anesthetists to laboratory technicians and operations staff-from initial planning through to implementation and ongoing optimization. Such a participatory approach makes sure the tool will be fitted to real-world workflows, and the particular pain points for each user group are met, thus enhancing ownership and increasing the likelihood of adoption. This is complemented by the essential role of strong clinical champions who are respected leaders in each professional domain. These individuals can speak credibly about the change, demonstrate its practical added value, and provide peer-level support, which is of great importance to achieve wide acceptance. Thirdly, comprehensive training and support should be role-specific and focused on how the tool enhances collaboration, rather than just the technical functions of the tool itself. This is equally important for sustaining use and sorting out unforeseen challenges during and after the go-live period. Lastly, at a technical level, interoperability and data standardization form the foundational facilitator. Tools that can exchange data seamlessly with other systems using common standards such as HL7 and FHIR reduce burdensome manual data re-entry, minimize errors, and create a more cohesive and productive information environment, the very bedrock of effective collaboration.

Significant Barriers to Adoption and Use

Despite potential benefits, numerous formidable barriers can impede effective adoption of the digital collaboration toolset. One persistent technical challenge is interoperability failure, where systems from different vendors function as "walled gardens," unable to communicate. This fragmentation forces clinicians and staff to develop manual workarounds that bridge information gaps, directly undermining the goal of seamless collaboration and leading to frustration and inefficiency (Haendel et al.,

2021; Beshbishy, 2024). Closely related is the problem of workflow misalignment and increased cognitive load. When digital tools are imposed without a deep understanding of clinical and operational workflows, they create redundant tasks, increase documentation time, and add to the already high cognitive load of healthcare professionals, which inevitably leads to resistance and the creation of unofficial workarounds, so-called shadow processes that compromise system integrity and patient safety (Asgari et al., 2024).

Financial and resource constraints also present a major hurdle, as the substantial initial costs for the purchase and implementation of sophisticated platforms, together with ongoing expenses for maintenance and upgrades, can be prohibitive for many institutions, thereby exacerbating a digital divide and creating inequities in the quality of collaborative care (Apathy et al., 2021). Perhaps the most intractable barrier is professional and cultural resistance. Deep-seated cultural norms entrenched professional hierarchies, and general reluctance to alter long-established practices may be more formidable than any technical issue. A senior surgeon or anesthetist accustomed to giving orders verbally resists using a Computerized Physician Order Entry (CPOE) system; such resistance throws nursing workflows off kilter and negates the collaborative benefits of a unified digital record (Musheke & Phiri, 2021). Overcoming these human factors requires a dedicated, long-term strategy focused on change management and cultural transformation.

Discussion and Synthesis

This review demonstrates that digital health tools are not just adjuncts in interdisciplinary collaboration but also active participants in reshaping the collaborative fabric of healthcare. When well-designed and implemented, they can tear down information silos, open new avenues for communication, and provide a data-driven foundation for shared clinical and operational decision-making. The transition from standalone systems to integrated digital ecosystems has emerged as the most promising pathway forward.

The findings range on a continuum of collaboration: On one end, information collaboration is supported by such tools as EHRs and LIS, which make sure all parties have the same information. In the middle, CDSS and secure messaging facilitate process collaboration that can trigger conversations and coordinated actions. At the most advanced end, integrated ERP and analytics platforms support strategic collaboration, where clinical and operational leaders co-design and manage the care delivery system itself (Wen & Huang, 2022).

But interoperability, usability, and cultural resistance continue to be stubborn challenges that show technology is not the solution in and of itself. The idea of the "socio-technical system" comes to the fore: it should be a simultaneous co-optimization of

both technology and the social system comprising people, processes, and culture (Carayon & Perry, 2021; Haddash, 2025). A perfectly interoperable system will fail if the organizational culture punishes transparency or upholds rigid hierarchies. Similarly, a collaborative culture will be hamstrung by fragmented, clumsy technology. Table 2 summarizes the key barriers and proposed mitigation strategies

Table 2: Summary of key barriers and proposed mitigation strategies

Barrier Category	Specific Challenge	Proposed Mitigation Strategies
Technical	Lack of Interoperability between Systems	Advocate for and purchase systems with open APIs (e.g., FHIR); develop institutional interoperability frameworks. (Holmgren et al., 2023)
	Alert Fatigue from CDSS	Implement intelligent, tiered alerting; regularly review and refine alert rules with an interdisciplinary committee. (Baysari et al., 2025)
Financial/Resource	High Implementation and Maintenance Costs	Develop a strong business case focused on ROI through improved efficiency and safety; consider phased implementation. (Apathy et al., 2021)
	Inadequate Training Resources	Dedicate sufficient budget for role-specific, simulation-based training and just-in-time support staff. (Koehler et al., 2025)
Human/Cultural	Resistance to Change and Workflow Disruption	Engage strong clinical champions; involve end-users in co-design from the outset; communicate "what's in it for me." (Shaw et al., 2025; Slater et al., 2023)
	Professional Silos and Hierarchies	Implement interdisciplinary team training; foster psychological safety; leadership must model collaborative behaviors. (Musheke & Phiri, 2021)
Usability/Design	Poorly Designed UI Increasing Cognitive Load	Adhere to user-centered design principles; conduct usability testing with real users from all professional groups. (Asgari et al., 2024)

Conclusion and Future Directions

This review synthesizes a decade of evidence confirming that digital health tools are indispensable for enabling the complex interdisciplinary collaboration required in modern healthcare. For this particular consortium of nursing, anesthesia, laboratory, planning, and operations professionals, these tools have demonstrably done much more, from the foundational EHR to advanced analytics and IoT: they improve communication, streamline and align processes, and synchronize operational logistics with clinical care. They transform collaboration from reliance on happenstance and heroic individual effort to a more structured, reliable data-informed process. Looking to the future, there are several key areas that require focused attention. First, the field needs to go beyond the metric of adoption and develop standardized, validated measures regarding the impact of digital tools on the quality of interdisciplinary collaboration itself and subsequently on hard clinical and operational outcomes.

Second, the promise of AI and ML is huge. Future systems could predict patient-specific risks and automatically convene the relevant interdisciplinary team or use natural language processing to summarize key interdisciplinary concerns from clinical notes (Ahmed et al., 2023). Third, ethical dimensions regarding data sharing, algorithmic bias, and digital equity must be proactively addressed to ensure these tools reduce, rather than exacerbate, health disparities (Chikhaoui et al., 2022). This journey to seamless collaboration across disciplines is ongoing. The vehicle to get there is through the use of digital health tools, but it needs a skilled and willing crew within all professional domains to master technical, financial, and human challenges. By keeping human-centered design front and center, creating a culture of shared purpose, and investing smartly in interoperable systems, healthcare organizations can use digital tools not to simply connect systems but to truly connect people to bring their collective mission of delivering exceptional patient care to life.

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