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Digital Transformation in Emergency Healthcare: A Multidisciplinary Framework Integrating Patient Care, Health Informatics, Nursing, Pharmacy, Health Administration, Medical Transcription, and Clinical Documentation Quality

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Abstract

Health systems delivering emergency care globally are undergoing and have anticipated rapid digital transformation, with numerous tools such as electronic health records, AI-assisted triage, ambient clinical documentation software, telemedicine, and data-interoperability initiatives at the core. As emergency care is provided by an interdependent group of providers that includes clinicians, nurses, pharmacists, administrators, health informaticians, and clinical documentation specialists, the digital transformation of emergency care cannot be addressed with a single-disciplinary viewpoint. This narrative review of the recent (2020–2026) peer-reviewed literature presents an integrated, multidisciplinary framework for the digital transformation of emergency departments across seven interlocking domain areas that have reported substantial efforts and found benefits: patient care, health informatics, nursing, pharmacy, health administration, medical transcription, and clinical documentation quality. Using a narrative review, recurring themes have been reported in 7 interrelated domain areas: adoption acceleration in the wake of COVID-19, improved nurse documentation time using ambient AI scribes, continued interoperability challenges, varying digital competency among nursing and administrative leaders, and continued questions surrounding the accuracy, equity, and safety of AI-assisted triage and clinical decision support. Results have been summarized in tables of themes across disciplines, and figures demonstrating trends in publications, documentation-time outcome data, AI-triage performance data, and the framework. The narrative recommends additional work around governance structures, workforce development, and future research areas required to actualize the potential of digital transformation in emergency departments in order to improve patient safety, efficiency, and equity.

Keywords: digital transformation; emergency department; health informatics; nursing informatics; pharmacy practice; health administration.

1. Introduction

An operating environment for both practice and training: emergency and acute departments as settings for digital innovation By their very nature, emergency departments (EDs) reside at the crossroads of high patient volumes, urgency, and data complexity. Therefore they act not only as natural testing grounds, but also stress tests for innovative technologies in digital health. Three factors have propelled rapid digital acceleration in acute and emergency services over the past six years: The COVID-19 pandemic forced rapid remote monitoring; The tools for machine learning and natural language processing (NLP) which can support documentation and triage have recently gained traction; clinicians continue to cite EHR overload and the risk to workplace resilience due to burn-out (Keesara et al.,2020).The author's claim from a Call to action from ED Digital Health was that COVID-19 forced rapid progress in remote-working practices, thereby demonstrating how digital technologies can change emergency medicine – both for good and bad and allowing clinicians more opportunities to influence the systems that shape their own profession (Chan & Grant., 2024).

Digital advancement within ED departments rarely happens in isolation from individual departments. A triage algorithm, like one shown in the article, relies on data engineered by people who work in Health Informatics. Similarly, medication management notifications rely on integrated Pharmacy Department, discharge information requires consideration of theNursing department workflow, and automated notes generated via Ambient AI need the approval of institution wide documentation quality standards. Despite these dependencies in many texts regarding emergency department digital transformation the separate discipline of Health Informatics often doesn't work alongside nursing studies, and health administration studies frequently don't refer to research about the quality of clinical documentation. (Agarwal et al.,2020 ; Kraus et al., 2021).

The purpose of this article is to overcome this limitation by comparing findings on the digital transformation of the emergency care department over the period from 2020-2026 for 7 key areas that include; the clinical journey and workflows; health information management; nursing practices; Pharmacy; Health administration and leadership; Medical transcription; clinical document quality.

1.2 The aim

This aim of this review is to provide an overview of proven empirical evidence on digital transformation in the 7 mentioned areas within emergency and acute care settings; identify the issues and similarities common among disciplines, thereby to construct an example which connects these domains together using a common data eco-system; We then use this frame work as an inspiration in suggesting what health organizations can do moving forwards in terms of governance, workforce training and future research directions.

2. Methodology

Approach This work is designed as a narrative review, to synthesize heterogeneous, cross- disciplinary evidence, rather than to address one circumscribed clinical question. (Kraus et al., 2021; Schiffelers et al., 2025). Peer- reviewed articles, systematic reviews and reports published from 2020 to 2026 were retrieved using keyword searching with combinations including ' digital transformation,' ' emergency department,' ' health informatics,' ' nursing informatics,' ' pharmacy practice,' ' health administration,' ' ambient artificial intelligence,' ' clinical documentation,' ' medical transcription' in: PubMed/PMC, JMIR publications, Annals of Emergency Medicine, Science Direct, Nature Portfolio journals, as well as relevant professional body publications (e.g. Health Information Management Association of Australia [HIMSS], the Journal of Healthcare Management) .

This research prioritized articles published 2020 onwards (with a particular emphasis on recent 2023-26 publications when readily available to support updates on rapidly moving subfields such as ambient AI scribes and LLM- assisted triage in clinical care). (Chan and Grant, 2024; Stults et al., 2025)

Studies were screen for applicability to emergency and acute- care settings or for relevance for workforce and informatics phenomena applicable to emergency team environments. Information was the metricized

by discipline, then integrated into an overall framework supported by common constructs observed in the reviewed literature (sociotechnical adoption principles, documentation burden markers, interoperable architecture models, and leadership competency paradigms).(Iyanna et al., 2022; Stoumpos et al., 2023).As a narrative synthesis, rather than systematic review with meta- analysis, results will not reported as pooled effect size; this synthesis highlights representative, well- documented publications for each theme as in other recent narrative and umbrella reviews. 3. An All- Sectorial Framework for the Transformation of Acute Care Through Digital Initiatives The proposed framework (Figure 3) places a unifying data infrastructure across the clinical care spectrum- represented by EHR, secure sharing agreements and instant information processing at the nexus of six related disciplines: care and delivery in the workflow; health information technology; nurse practice and technology; pharmacy practice, and medication risk management; administration in leadership; and scribal and clinical record keeping standards all held within an overriding structure of ethical codes, oversight and workforce preparedness and skill set .(Schiffelers et al., 2025).

We deliberately make our framework non- hierarchical because evidence indicates clearly that poor standards in each field - from the insufficient digital skillset of a nurse's line manager to unconnected pharmacy databases- undermines effective practices in all areas, irrespective of the quality of a particular medical advancement. (Agarwal et al., 2020; Brommeyer et al., 2024).



Figure 1. Multidisciplinary digital transformation framework for emergency healthcare, showing the integrated data ecosystem at the center of six clinical and operational domains, surrounded by governance and workforce-readiness considerations.

4. Domain-Specific Evidence Synthesis

4.1 Patient Care and Clinical Workflow

Digital tools are changing the way patients journey through the ED, from check-in through to discharge (Stoumpos et al., 2023). In the United Kingdom's National Health Service, reporting documented in the Journal of m Health indicated the extremely rapid build-out of virtual wards-creating nearly 14 virtual-ward beds per day on average between March and August 2023-outfitted with remote monitoring devices enabling patients to send vital data directly to clinicians, which improves patient monitoring and care coordination without the need for hospitalization, particularly effective in the context of patients with heart and lung disease (Keesara et al., 2020).

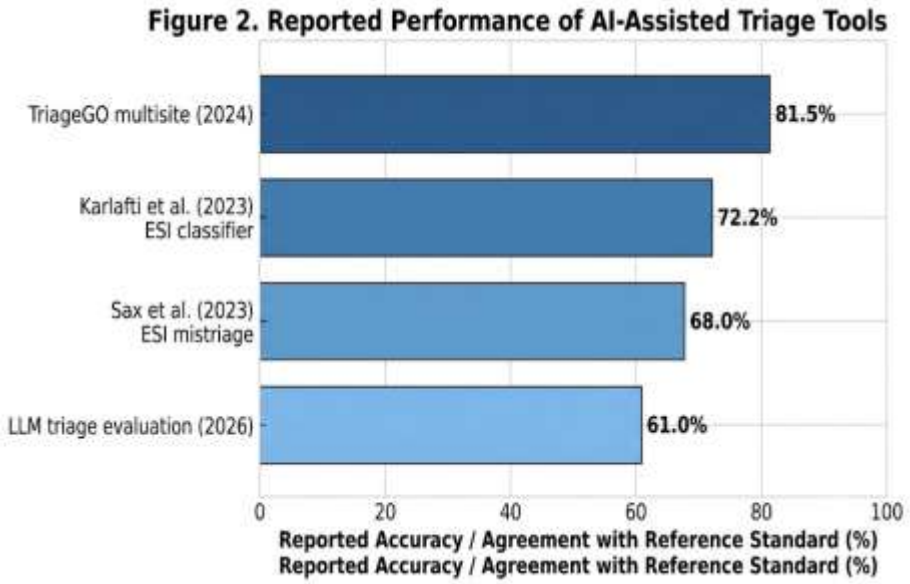
In addition to virtual wards, hospitals have launched patient-facing check-in and wait-time apps; such a n application aims to reduce patient anxiety related to long waits, while reducing staff burden by directing information straight to the patient record (Stoumpos et al., 2023). Digitally transforming patient-facing workflow applies to patient education and discharge instructions as well. A systematic review of randomized controlled trials focusing on digital patient educational interventions in the ED (including video

discharge instructions, follow-up text messages, and web-based interactive learning tools) that searched the literature from 2012-2024 indicated that digital interventions can improve patient and caregiver information recall and affect discharge behavior, though what characterizes effective interventions, or the ways in which "success" is measured, vary greatly. At the system level, healthcare executives are beginning to treat digital transformation as a strategy for enhancing operational efficiencies. In its 2024 analysis, Healthcare Executive classified AI-enabled clinician communication, predictive analytics, and telehealth alongside work-force strategy and value-based care as key strategies for boosting emergency and acute-care efficiency. However, digitalization of the patient experience has not always been overwhelmingly positive. A survey in Italy on the digitalization of ED triage found that respondents were willingness to use completely digital or hybrid triage processes depending on the specifics of the scenario presented, highlighting that patient acceptance of digital transformation is conditional, not absolute (Schiffelers et al., 2025).

4.2Health Informatics and Interoperability.

Interoperability of infrastructure underlies all other domains in this framework. A large-scale implementation report on the German National Emergency Department Data Registry highlighted both the potential and frustrations of interoperability at a national level: collecting data between 2017 and 2024 from 58 federated EDs, a federated data access authorization system provided access to over 7.9 million patient records; 75% of all requests were authorized in less than 15 days, and request volumes grew rapidly to 15,000 per day in 2024 with an 86% completion rate. The authors view ongoing, governed access to electronic health records as the foundation for digital medical transformation, while acknowledging that ongoing data- sharing projects will need to balance the interests of data holders and the needs of researchers/clinicians for immediate data access. (Schiffelers et al., 2025; Stoumpos et al., 2023). Built on top of an interoperable data infrastructure, AI has emerged as a valuable tool for ED operations (Zhang et al., 2021).

A 2024 review on the impact of AI on ED operations identified predictive ED patient volume models (e.g., Hu et al., 2023) and prediction of hospital admission from the ED based on triage note data including demographics, vital signs, ESI level, and lab results (Patel et al., 2022) as key applications. The review also emphasized AI/machine learning/natural language processing-based triage tools which predict the urgency category of individual patients (Zhang et al., 2021) and concluded that a 2024 meta-analysis of these tools by Kaboudi and colleagues found that AI triage support tools demonstrate an acceptable degree of accuracy overall. More targeted research has continued to validate these findings and examine areas of variability (Kaboudi et al., 2024). A machine learning classifier trained to predict the ESI level yielded an F1-score of 72.2% despite a skewed training dataset in one study by Karlafti and colleagues (2023), while a multisite implementation of the clinical decision-support tool Triage GO preserved nurse autonomy, offered brief explanations of machine learning-generated recommendations and allowed local adjustment of risk thresholds (Kvitka & Myrhorodska, 2024) to tailor triage distribution toward specific objectives, potentially improving equity. In one 2025 retrospective study evaluating 7 LLMs against physicians for ESI level designation at a Greek hospital ED (June 2024-July 2025, n=39,375), the LLMs show promising but inconsistent abilities, some over- or under- triaging patients and none showing strong agreement with physician judgments (Cohen's kappa > .80) (Sax et al., 2023; Kaboudi et al., 2024).



Reported Accuracy / Agreement with Reference Standard (%)

Figure 2. Reported performance of AI-assisted triage tools across recent emergency department studies. Values reflect the primary accuracy or agreement metric reported in each source; metrics and reference standards differ across studies and are not directly comparable.

A 2025 scoping review in ScienceDirect similarly concludes that AI-driven triage tools carry meaningful benefits for speed and consistency, but that challenges around explainability, clinician trust, and equity persist and warrant continued evaluation before broad deployment.

4.3 Nursing Practice and Informatics

The ED nurses, are potentially the front-line clinicians who can be directly affected by ED digital transformation, inasmuch as they often staff ED's front lines (triage, etc.), as well as being early adopters of new technology into clinical workflows (Iyanna et al., 2022). The original and quite unique qualitative interview based study of 8 ED Norwegian Nurses (2024) employed an 8D sociotechnical approach following Braun & Clark's 6 steps in thematic analysis, identified three themes for its ED nurses in: impacts on patient care safety, communication impacts with in ED environments, and the impacts for acute nursing care - suggesting for the nurses themselves digitalization felt every bit safety and team work focused as it did efficiency enhancing. (Schiffelers et al., 2025).

A 2022 qualitative analysis of a systemic literature review in JMIR Nursing analysed literature between Jan 2020 – Oct 2021 for its effects of the transformation of the covid 'digital' era on nursing workforces, utilizing a comprehensive 8D framework to inform this, highlighting how 'nursing informatics skill requirements increased dramatically' with almost '35%" studies identified including the word 'informatics skill' – although it pointed to persistent gaps in describing nurses' 'need for digitally trained nurses'.

The 2022 systematic scoping review in JMIR Nursing, which narrowed specifically to Telemedicine, similarly concludes that the building of competence within digitally prepared and telehealth prepared nursing works needs to provide an integrated set of technology competency management and soft / interpersonal communication skill skills and not simply technical skill building (Stoumpos et al., 2023; Brommeyer et al., 2024).

Bibliometrics demonstrates the scale of the digital scale of the transformation in nursing; an integrative bibliometric analysis up to 2024 that followed prisma standards analysed 409 research works relating to digitally transformed nursing informatics, where publications went up from 30 in 2019 to 54 in 2020 and 54 in 2023 – it calls for a massive global digital, or, 'surge', and it clearly comes after 2015, accelerates in 2020-23' with major contribution from the USA, China, South Korea and Taiwan (Kraus et al., 2021; Brommeyer et al., 2024).

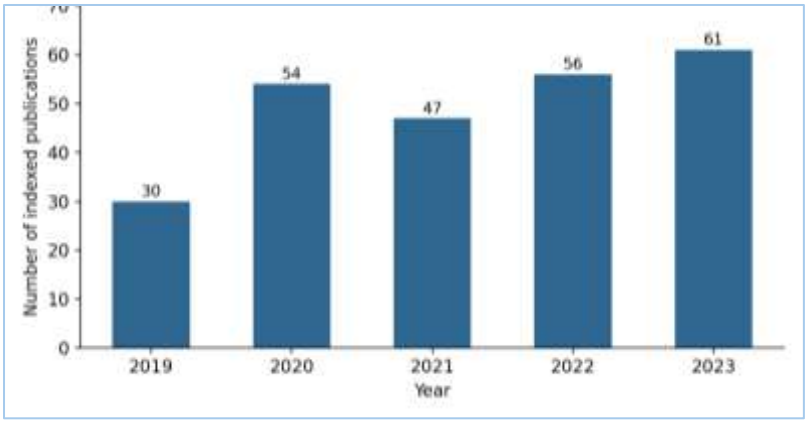


Figure 3. Growth in nursing-informatics digital technology publications, 2019–2023, based on an integrative bibliometric analysis of 409 studies indexed across PubMed, CINAHL, MEDLINE, Embase, Web of Science, and Scopus.

Cross-national survey data extends this account into the post-acute period of the pandemic. An international survey of 1423 nurses (in Australia, Finland, New Zealand, Switzerland, the UK, and the US; performed 2022–23 on 1128 discrete technologies) showed "usability" scores clustered around the SUS benchmark for "acceptable" and showed significant country variation (attributed to differences in infrastructure maturity and working environment). A systematic umbrella review of the adoption of digital nursing technology in practice search through January 2025 similarly affirmed the role of individual and team rather than solely performance factors in the technology adoption process(Iyanna et al., 2022; Schiffelers et al., 2025).

Leadership-level nursing informatics competence represents another related and increasingly studied issue: a 2024–2025 qualitative examination of 42 nurse managers at a large Saudi hospital, all of whom possessed at least a bachelor's degree and a minimum of 5–10 years' managerial experience, revealed that just under 62% had received no formal digital leadership training despite a shifting set of responsibilities dictated by digital transformation. (Brommeyer et al., 2024).

4.4 Pharmacy services and medication safety

Pharmacy practice has morphed from largely dispensing-centered to a digitally integrated, team-based clinical function. A 2025–26 review in the J of Multidisciplinary Healthcare argued electronic prescribing, interoperable records, and AI-driven decision systems enable increased pharmacist visibility within the healthcare team and earlier intervention on potential medication problems, despite a 2021 global International Pharmaceutical Federation (FIP) survey which identified a severe shortage of informatics or inter professional collaborative education in ~35% of pharmacy schools. Reviews of digital pharmacy platforms consistently linked e-prescribing, automated dispensing, tele-pharmacy, and CDS to fewer medication errors and greater efficiency; a 2024 review in the International J of Community Medicine and Public Health detailed how genomics data, analysis, and CDS could integrate into pharmacy practice to provide precision medicine, permitting pharmacists armed with wearable monitoring data to provide tailored treatment and remote patient monitoring; CDS itself, "a means of bringing together... Patient specific information, existing clinical knowledge and evidence at the point of care," has evolved as a concept from stand-alone reference material into built-in functionality within e-prescribing and dispensing applications (Agarwal et al., 2020; Stoumpos et al., 2023).

While evaluations of e-prescribing showed benefits in some settings, heterogeneity limit direct comparison and a 2024 clinician survey demonstrated variability in how well clinical decision-making assistance within e-prescription applications could be realized in different practice environments; the development of online services in conjunction with clinical practice broadened pharmacy's digital scope into commerce. Common threads through the literature: adoption is limited less by technology availability, than by workforce training

gaps, interoperability issues between pharmacy management systems and hospital EHRs, and a shift to recognizing pharmacists as clinical decision-makers, not merely dispensers. (Agarwal et al., 2020)

4.5 Health Administration and Digital Leadership

Effective digital transformation requires administrative and executive leaders who can convert technological investment into operational and clinical gains. One study (described in 2023 as a qualitative-study protocol in JMIR Research Protocols), reported that between the first and second iterations, the Australian Health Informatician Competency Framework-a professional standard developed by Health Informatics Society Australia-increased from 5 to 11 leadership and management competencies, and that the relevant Master Health Service Management Competency Framework underwent a 2022 revision that incorporated six new leadership competencies focused on digital management-demonstrating that professional bodies are developing credentialing standards adapted to digital transformation (Agarwal et al., 2020; Kraus et al., 2021). Likewise, a companion qualitative investigation targeting health service managers-which conducted focus groups between February and August 2023-revealed that digital health implementation's full benefits depend on a mix of individual, leadership, organizational, professional, and system-level digital competencies. (Brommeyer et al., 2024&(Kraus et al., 2021)

No established consensus competencies for health service managers were identified in the evidence, even though some competency lists were found to relate to health informaticians, clinical informaticians, project managers, information-resource managers, and information system support.

Strategic transformation involving digital, health-system executives A recent qualitative investigation of more than 4 dozen interviews with CEOs and chief information officers at United States health-systems from October 2022 to April 2023 identified 13 core strategy, governance, and executive-team coordination components of digital transformation for leadership, but found the need for further refinement to guide leadership across digital-transformation life stages by examining current leadership knowledge and competency gaps to guide decision-makers in implementing effective healthcare-transformation strategies.

Additionally, some academic curricula must more fully emphasize clinic AL informatics content within health-service management programs so they more adequately prepare future leaders for the increased emphasis on data that is transforming the healthcare landscape; that perspective was framed for a 2023 JHA article. Case-Based Operational Research For a 2023 PLOS Digital Medicine–reported study involving the case study method as one approach, health service administrative organizations' leaders' operational roles and actions to achieve digital health are addressed by illustrating effective approaches for using an organizational implementation matrix or the balanced scorecard framework to direct digital health transformation within an academic hospital department (a rheumatology practice and related clinic); that use accelerated organizational adjustment and improved in-real-time operational metrics across several organizational perspectives to ensure digital investment aligns with organizational-strategic goals. (Flaig et al., 2020; Kraus et al., 2021).

Individual, Group, Organizational, System & Societal, and Global Perspectives . Individual/Group Leadership/Management Individual Health Informatics Leadership Research. (Flaig et al., 2020).

Digital leadership is key A March 2025 study examining leadership style at digital-intensivity level organizations with public-sector primary-health-entity functions determined that leadership actions can create, but will affect organizational and individual digital outcomes indirectly through impacting organizational and leadership characteristics, such as leadership agile (Flaig et al., 2020; Kraus et al., 2021).

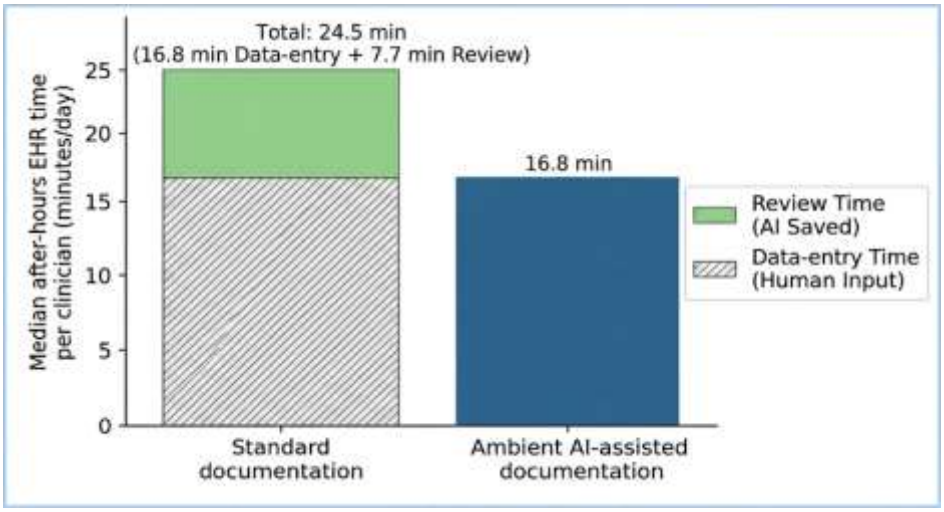


Figure 4. Illustrative comparison of after-hours documentation time associated with standard versus ambient AI-assisted clinical documentation in the emergency department, based on patterns reported in recent ED-based ambient-scribe evaluations.

A separate quality-improvement pilot in an academic ED (Mayo Clinic, Rochester, Minn., with an approximate volume of 85,000 visits annually) assessed 710 total patient visits (284 human-scribed, 426 AI-scribed, December 2024 to January 2025) the difference between ambient AI (Abridge AI) and human scribes. The notes were evaluated by 2 physician blinded to note origin, who used the validated nine-item Physician Documentation Quality Instrument (PDQI-9) tool to evaluate the quality of the generated documentation. Results found that while PDQI-9 quality scores were comparable for adult cases generated from human and AI notes, for pediatric cases documentation quality for AI-generated notes were lower compared with human-scribed notes (adjusted risk ratio approx 1.89), implying documentation-quality parity is not uniform across diverse patient populations. (Balloch et al., 2024; Stults et al., 2025). Concurrent studies outside the context of the emergency department add to the more nuanced but often favorable evidence: A 2024 quality improvement study by Balloch and colleagues published in Future Healthcare Journal suggests the use of an ambient AI documentation tool would lead to improved quality of clinical documentation during actual use of electronic health records (Balloch et al., 2024). A 2025 study led by Stults and colleagues, published in JAMA Network Open, evaluated an ambient AI documentation system in use among various clinicians and identified improvements in documentation-related workflows. A closely related 2025 study published in the Journal of the American Medical Informatics Association assessed ambient AI scribes, clinician perspectives of use, and the role in physician burnout. The authors conclude that, while results generally indicate positive impressions from clinicians with varied backgrounds and perspectives, their experiences were not uniform (Stults et al., 2025). And a 2025 rapid review published in JMIR AI analyzed the available evidence on ambient listening and generative AI scribes in real-world practice: documentation time savings continue to be reported, but down-stream impacts such as accuracy of notes, edits, and the quality of clinician-patient conversations require additional evidence in rigor to evaluate (Balloch et al., 2024; Stults et al., 2025).

Collectively, these findings seem to point toward a transition in the field of medical transcription-from something to be primarily automated by humans to a model featuring human-AI collaboration-where the primary interaction is the human use of the computer's document output and subsequent clinical editing and review. Recent studies examining the way humans actually edit AI-generated notes (and analyzing nuances of their communication to AI- scribing tools), the logic behind their edits, and their language used for hedging, make it clear that ongoing human vigilance in the documentation process represents substantial and non-perfunctory interaction. (Balloch et al., 2024; Stults et al., 2025).

5. Results

Drawing together our results across the seven domains illuminates specific domain outcomes and cross-cutting themes. Table 1 details examples of digital tools, described outcomes, and source of information for each of the seven domains. Table 2, highlights five cross-cutting themes that apply to more than one domain and explains why a multidisciplinary approach rather than a domain-unique plan for coordinated digital transformation in emergency care is required.

Table 1. Summary of Digital Transformation Evidence by Domain (2020–2026)

Domain	Representative digital tools/interventions	Key reported outcomes	Representative sources
Patient care & clinical workflow	Virtual wards; patient check-in/wait-time apps; digital discharge education	Reduced avoidable admissions for cardiorespiratory patients; improved information retention post-discharge; patient acceptance is scenario-dependent	(Stoumpos et al., 2023; Schiffelers et al., 2025)
Health informatics & interoperability	Federated data registries; AI/ML admission and volume prediction; AI-assisted ESI triage	7.9M+ records accessible via federated authorization; triage classifiers reaching ~72% F1; LLMs show inconsistent triage agreement (kappa <0.80)	(Kraus et al., 2021)
Nursing practice & informatics	Bedside digital tools; telehealth/telenursing; nurse-manager digital leadership	Publications on nursing informatics rose from 30 (2019) to 61 (2023); ~62% of nurse managers report no formal digital-leadership training	(Brommeyer et al.,2024)
Pharmacy & medication safety	E-prescribing; automated dispensing; telepharmacy; AI-supported CDS	Only ~35% of pharmacy programs offer substantial informatics/interprofessional training (FIP, 2021); CDS increasingly embedded in dispensing workflow	(Agarwal et al.,) 2020
Health administration & leadership	Digital-competency credentialing; balanced-scorecard strategic planning; CEO/CIO governance	Competency frameworks expanded (5→11 leadership competencies in one national framework, 2022); persistent CEO/CIO leadership-skill gaps identified	(Brommeyer et al., 2024; Flaig et al., 2020)

Medical transcription & documentation quality	Ambient AI scribes; PDQI-9 quality scoring; hybrid human–AI note review	AI scribes reduced after-hours documentation time in EDs; PDQI-9 scores comparable to human scribes for adults, modestly lower for pediatric notes	(Balloch et al., 2024; Stults et al., 2025)

Table 2. Cross-Cutting Themes Identified Across Domains

Cross-cutting theme	Domains most affected	Description
Interoperability & data governance	All domains	Reconciling data-holder control with timely clinical/research access; fragmented pharmacy–EHR integration
Workforce digital-competency gaps	Nursing, pharmacy, administration	Nurse managers, pharmacy graduates, and some hospital executives report limited formal digital-leadership or informatics training
AI performance variability & equity	Health informatics, patient care	Triage AI/LLM performance varies by patient subgroup (e.g., pediatric vs. adult) and across models; risk of over/under-triage
Documentation burden vs. oversight burden	Medical transcription, patient care	AI scribes reduce transcription time but shift effort toward clinician review/editing of AI-drafted notes
Leadership & governance readiness	Health administration, nursing	Credentialing frameworks are evolving faster than many institutions' internal leadership-development programs

The growth of nursing-informatics publications, variations in after-hours documentation time for ambient AI scribe usage, and the disparity in reported AI-assisted triage performance across studies. Figure 3 displays the proposed conceptual model. The findings combined suggest a developing and inequitable transition toward digital systems within emergency medicine. Health administration and nursing literature focus on competency and governance rather than patient outcomes and measure it using documentation quality tools, while health informatics focuses more broadly on EMR data, such as from audit logs.

.6Discussion

We draw the following three conclusions from the available evidence. First, the digital transition within emergency healthcare is tangible and measurable, but at varying levels of maturity across disciplines. AI-assisted documentation with ambient scribes and AI-assisted triage both have relatively substantial evidence of impact at the ED level from the literature (using EHR audit logs and documentation-quality measures like PDQI-9) (Balloch et al., 2024; Stults et al., 2025)and the body of literature on health administration and nursing-leadership concentrates on competence rather than patient outcomes. Availability of standard measurement tools like EMR audit logs in health informatics research and updated health administration and nursing-leadership competency models contribute to disparity in the field (Brommeyer et al., 2024; Schiffelers et al., 2025).

Second, there are consistent gaps in workforce competencies in every field examined ranging from pharmacy education (only about 1/3 programs with robust informatics training), nursing management (most nurses responding to surveys without formal leadership training), to hospital leadership (CEO/CIO

interviews showing knowledge deficiencies in governance). Therefore technology deployment lags far behind workforce development across the entirety of the emergency team and not just individuals. This is consistent with sociotechnical models of digital health adoption where people and process elements are as important as technology (Schiffelers et al., 2025).

Third, AI can be a useful tool for clinical management and documentation but both are still imperfect. Clinical triage tools can exist in partnership with the clinician as seen in the intention of Triage GO, and AI-based triage studies explicitly cite differences in agreement rates rather than equality. Similarly, ambient AI scribes shorten time for after-hours documentation but demonstrate limitations within the quality of notes, like mildly poorer PDQI-9 scores from pediatric encounters during one study at an academic ED. These findings suggest a continuation of human monitoring and judicious implementation of services. (Balloch et al., 2024; Stults et al., 2025).

6.1 Implications for the Proposed Framework

The integrated framework demonstrates health-system leaders need to address these cross-domain interdependencies directly. When, for instance, a health-system's emergency department deploys ambient AI scribes (Medical Transcription), health informatics must closely liaise about EHR integration, cybersecurity and audit trail compliance (Kraus et al., 2021; Stults et al., 2025). Health system leaders in Nursing and Medicine simultaneously need to address workflows changes, and track post-implementation note quality through PDQI-9 metrics for different patient subgroups (Balloch et al., 2024).

Lastly, Health Administration needs to ensure governance over data, maintain strategic ROI, and leadership buy-in of digital efforts (Flaig et al., 2020).

In contrast to an integrated systems approach, attempts to digitally transform any single domain without consideration to inter-domain needs risks creating fragmented implementation, the most common barrier in past health system adoption studies (Agarwal et al., 2020; Brommeyer et al., 2024).

7. Recommendations

Five practical recommendations emanate from this evidence:

1. Adopt Cross-culinary Governance of all ED Digital Transformation Efforts. The Steering Committee governing Digital Transformation should comprise representation from Medicine, Nursing, Pharmacy, Health Informatics, Administration and Documentation / Health Information Management Staff as depicted through this paper’s findings and interdependencies.

   2. Invest in Workforce Competencies At All Levels. Digital Training for nurse managers, pharmacy graduates and hospital executives should be given as high priority and considered a primary part of the Technology Procurement process rather than after thought, given the significant deficits.

   3. Measure AI-Assisted Tools at The Subgroup Level. As seen from the Child/Adult ED PDQI-9 discrepancies, and the ED AI Triage algorithm’s varying accuracy to specific patient populations / disorders, overall accuracy scores mask and fail to measure the real impact of a device, system or an algorithm in multiple patient subgroups . Institutions should analyze performance at a subgroup level, pre and post.

   4. Reserve Clinician Final Authority on Use of AI in Triage and Documentation. Consistent with the concept behind tools like the ENA/ED triage tool Triage GO,AI outputs Should be positioned as decision support devices with explanation, recommendations and ambient documents should still required clinician review / editing for finalized notes.

   5. Prioritize Investments in Interoperability That Support Federated, Governed Access. Such as evidenced from the data registry from the German National Emergency Department data registry (NEODOR) using a federated data authorization concept and could serve as a roadmap for health systems, as can be applied to future large datasets and National Registries.

8. Conclusion

Digital transformation in emergency care should never be treated as a single technology initiative but rather as co ordinated and interconnected clinical, health informatics, nursing, pharmacy and administration based endeavor. The evidence from 2020 –2026 indicates meaningful but still incomplete gains have been achieved, (i .e . From the eder data set to the performance of an ambient AI system with reduced after-hours charting) but we are still plagued with workforce Competencies and AI performance variation(s) that is the case for most clinical tool usage and an inappropriate time to depend solely on Automation. As suggested by the framework offered in this review, institutions and leaders must find common ground in shared structure and coordination of digital-transformation and the appropriate utilization of new technology to maximize efficiency , equity and Patient Safety.

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