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The Role of Integrated Health Informatics in Streamlining Patient Flow from Emergency Department to Admission: A Review of Administrative and Clinical Synergies

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Abstract

Background: Emergency Department (ED) overcrowding and hospital-wide patient flow blockages represent a critical challenge for healthcare systems globally, impacting patient safety, staff well-being, and organizational efficiency. The journey from ED triage to inpatient admission is a complex, multi-stakeholder process prone to delays and communication failures. **Aim:** This narrative review synthesizes contemporary literature (2010-2024) to examine how integrated health informatics—spanning Electronic Health Records (EHRs), patient tracking systems, and interoperable platforms—facilitates administrative and clinical synergies to streamline patient flow from the ED to admission. **Methods:** A systematic search was conducted across PubMed, CINAHL, Scopus, and ProQuest databases, identifying peer-reviewed articles, systematic reviews, and seminal reports. **Results:** Findings reveal that interoperable health informatics enhances real-time visibility, improves interprofessional communication, and supports data-driven decision-making. Successful implementation is shown to reduce ED length of stay (LOS), left-without-being-seen (LWBS) rates, and ambulance diversion. Crucially, it transforms roles, particularly for nursing and unit secretaries, shifting them towards proactive flow coordination. However, significant barriers persist, including interoperability limitations, workflow misalignment, and training deficits. **Conclusion:** Integrated health informatics is indispensable for modern patient flow management, creating synergistic "command centers" that bridge clinical and administrative functions. Future success hinges on human-centered design, robust change management, and viewing informatics not as a mere tool but as the foundational architecture for a resilient, patient-centered healthcare system.

Keywords: patient flow; health informatics; emergency department; care coordination; health services administration

Introduction

Emergency Department (ED) overcrowding and the subsequent bottleneck in patient flow to inpatient units constitute a pervasive and deleterious crisis in healthcare systems worldwide (Morley et al., 2018). This phenomenon, often described as “access block” or “boarding,” occurs when patients who have been admitted to the hospital remain in the ED due to a lack of available inpatient beds (Carter et al., 2014). The consequences are severe: prolonged ED stays are strongly associated with increased patient mortality, adverse events, diminished patient satisfaction, and extreme clinician burnout (Boyle et al., 2016; Di Somma et al., 2015). Operationally, it leads to ambulance diversion, cancelled surgeries, and financial penalties under value-based care models (Pines et al., 2011). Addressing this multifaceted problem requires moving beyond siloed interventions in the ED or individual wards; it demands a system-wide, integrated approach to understanding and managing the patient’s journey from initial presentation to definitive care.

This journey from ED to admission is a complex, multi-stakeholder process involving intricate coordination between clinical disciplines (emergency physicians, nurses, hospitalists, specialists) and administrative functions (bed management, registration, transport). Historically, this coordination has relied on inefficient, analog methods: phone calls, paper charts, whiteboards, and

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fragmented paging systems, leading to information latency, miscommunication, and reactive management (Moore et al., 2020). The advent of digital health technologies promised a revolution. Integrated health informatics—encompassing comprehensive Electronic Health Records (EHRs), real-time location and patient tracking systems, and interoperable data platforms—has emerged as the central nervous system for modern healthcare delivery. These technologies offer the potential to create a unified, transparent view of patient status, resource availability, and system capacity.

This narrative review aims to synthesize contemporary literature (2010-2024) to critically examine the role of integrated health informatics in streamlining patient flow from the ED to hospital admission, with a specific focus on the administrative and clinical synergies it enables. We will explore how tools like EHRs and patient tracking systems are utilized by nursing teams and ED managers to reduce wait times and bed block (Emergency & Crisis Management). Furthermore, we will investigate the evolving, technology-mediated role of unit secretaries and administrative personnel (Medical Secretary) within this digital workflow. Finally, we will assess the overall impact of these integrated informatics strategies on macro-level hospital efficiency and performance (Health Management). By weaving together these five fields—Health Informatics, Emergency & Crisis Management, Health Management, Nursing, and Medical Secretary—this review argues that effective patient flow is not merely a logistical challenge but a critical test of an organization's ability to harness information technology to foster interdisciplinary collaboration and system-wide resilience.

Methodology

This narrative review employed a systematic search strategy to identify relevant literature published between 2010 and 2024. Databases searched included PubMed/MEDLINE, CINAHL, Scopus, and ProQuest Central. A combination of Medical Subject Headings (MeSH) and keywords was used, including: ["patient flow" OR "patient throughput" OR "emergency department crowding" OR "access block"] AND ["health informatics" OR "electronic health records" OR "clinical information systems" OR "dashboard" OR "interoperability"] AND ["bed management" OR "admission" OR "discharge"] AND ["nursing" OR "care coordination" OR "medical secretary" OR "administrative staff"]. The search was limited to English-language, peer-reviewed articles, systematic reviews, and seminal reports from healthcare organizations (e.g., The Joint Commission, Agency for Healthcare Research and Quality). Grey literature was selectively included for foundational context on operational models.

Inclusion criteria focused on studies or articles that explicitly discussed the application of health information technology to improve the intra-hospital patient journey, particularly the ED-to-inpatient transition. Studies focusing solely on ED triage technology or inpatient discharge planning without connection to the admission process were excluded. Given the integrative and practical nature of the topic, a narrative synthesis approach was chosen over a meta-analysis to allow for the incorporation of diverse study designs (qualitative, quantitative, mixed-methods, and case studies) and to develop a coherent thematic analysis of the interdisciplinary synergies and challenges (Wong et al., 2013).

The Digital Ecosystem for Patient Flow

The digital infrastructure supporting patient flow is composed of several interconnected technologies, each playing a distinct yet complementary role. Understanding these components is essential to analyzing their synergistic application (Table 1).

The Electronic Health Record (EHR) as the Foundational Repository

The modern EHR is far more than a digital version of a paper chart; it is the central transactional and documentation system for patient care. For patient flow, key EHR functionalities are critical. Computerized Provider Order Entry (CPOE) allows for immediate transmission of admission orders, eliminating delays from lost paper slips and clarifying physician intent (Abbassi et al., 2022). Integrated clinical decision support (CDS) can prompt physicians to consider admission criteria or alternative pathways at the point of decision-making. The EHR's role in bed management is pivotal; most contemporary hospital bed management systems are either modules within or tightly interfaced with the EHR, allowing real-time visibility of bed status (clean, dirty, occupied) and patient placement criteria (e.g., telemetry, isolation) (Nguyen et al., 2022). This digital bedboard becomes the single source of truth for bed capacity, though its accuracy is only as good as the data entered by staff.

Patient Tracking and Operational Dashboards

If the EHR is the repository, patient tracking systems and operational dashboards are the visualization and command tools. ED-specific tracking boards have evolved into enterprise-wide systems that provide a minute-by-minute, visual status of every patient in the ED and often the hospital (Shenvi et al., 2023). These systems track key milestones: time of arrival, triage level, provider assignment, order entry, results pending, and admission request time. Advanced systems use color-coding and alerts to flag delays. Operational dashboards aggregate this data further, presenting key performance indicators (KPIs) like ED length of stay (LOS), number of boarders, time to admission decision, and bed turnover time to managers in a digestible format (Forstater et al., 2019). This real-time situational awareness is crucial for ED charge nurses and flow coordinators to make proactive adjustments, such as reassigning staff or expediting diagnostics.

Interoperable Platforms and Health Information Exchange (HIE)

The true power of informatics is unlocked through interoperability—the seamless, secure exchange of data between systems. In the context of patient flow, interoperability between the ED EHR and the inpatient EHR (if different), laboratory information systems, radiology PACS, and bed management systems is non-negotiable (Vest & Gamm, 2010). Health Information Exchange (HIE) at a regional level can provide ED staff with crucial data on recent visits, medications, and advance directives from other facilities, preventing redundant testing and accelerating decision-making for complex patients (Shapiro et al., 2013). The lack of true interoperability creates data silos, forcing staff to engage in "swivel-chair integration," manually re-entering data or consulting multiple screens, which reintroduces delay and error into the process (Graber et al., 2017).

Table 1: Core Health Informatics Technologies and Their Impact on Patient Flow

Technology	Primary Function	Key Stakeholders	Impact on ED-to-Admission Flow
Electronic Health Record (EHR)	Centralized patient data repository; CPOE; documentation.	Physicians, Nurses, Coders.	Enables instant admission order entry; provides clinical data for placement; digital bed board management.
Patient Tracking System	Real-time visual status of patient journey & milestones.	ED Charge Nurses, Flow Coordinators, Bed Managers.	Enhances situational awareness; flags bottlenecks; allows proactive resource allocation.
Operational Dashboard	Aggregates KPIs for managerial oversight (LOS, boarders, etc.).	ED Director, Nurse Managers, Hospital Administrators.	Supports data-driven decisions & resource planning; monitors system performance.
Interoperable Platforms/HIE	Securely exchanges data between disparate systems.	All clinical staff, Health Information Management.	Reduces redundant testing; provides comprehensive patient history; accelerates clinical decision-making.

Clinical and Administrative Roles Transformed

The implementation of integrated informatics does not automate patient flow; rather, it retools and empowers the human actors within the system, creating new synergies between clinical and administrative roles.

From Task-Based Care to Flow Coordination

The nursing role is profoundly impacted by flow-focused informatics. The ED nurse, armed with a patient tracking board, transitions from a purely task-oriented role to that of a flow orchestrator. They can monitor the progress of all assigned patients simultaneously, anticipate needs (e.g., seeing that bloodwork is complete and can prompt the physician for review), and coordinate ancillary services (Reznek et al., 2017). For inpatient nurses receiving the patient, interoperable systems mean the admission documentation, medication reconciliation, and care plan are often visible before the patient arrives, allowing for better preparation (Collins et al., 2011). The emergence of dedicated "flow nurse" or "capacity coordinator" roles, often filled by experienced nurses, exemplifies this shift. These roles use dashboards and bed management systems to actively match pending admissions with available beds across the hospital, negotiating with unit charge nurses and facilitating direct transfers from the ED, bypassing traditional, slower bed management pathways (Morais Oliveira et al., 2018). Figure 1 depicts how integrated health informatics reshapes and aligns clinical and administrative roles during the ED-to-admission process.

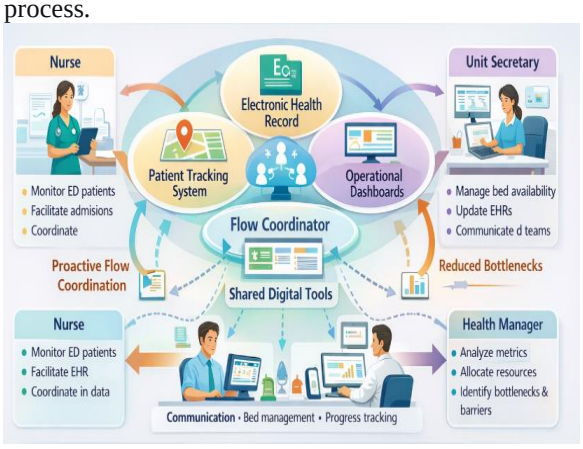

Figure 1. Clinical–Administrative Synergies Enabled by Health Informatics in ED-to-Admission Workflow

Emergency & Crisis Management in Enabling Proactive Command

For ED managers and medical directors, integrated informatics transforms management from reactive firefighting to proactive command and control. Real-time dashboards provide an objective, data-rich picture of departmental and hospital status, moving management beyond anecdote (Gross et al., 2023). This allows for dynamic surge response: if the dashboard shows a rising number of boarders and a spike in ambulance arrivals, the manager can trigger surge protocols—opening overflow areas, calling in backup staff, or collaborating with the house

supervisor to expedite discharges elsewhere (Kelen et al., 2015). Furthermore, predictive analytics, a growing application of informatics, uses historical data to forecast ED volumes and admission rates, allowing for strategic staffing and resource allocation hours in advance (Sun et al., 2012). This predictive capability represents a pinnacle of crisis management, shifting the focus from reaction to preparedness.

The Medical Secretary/Unit Coordinator

Perhaps the most understudied yet critical transformation is that of the unit secretary, now often termed a unit coordinator or administrative clinical partner. Their role has evolved from one of transcription and phone answering to being the digital hub of unit operations. They are primary operators of the bed management module, responsible for its accuracy—promptly marking beds as dirty, clean, or occupied (Wisner et al., 2019). They manage electronic patient placement requests, communicate digitally with transport and environmental services, and ensure all digital prerequisites for admission are complete. This requires a new skill set: digital literacy, understanding of clinical priorities (e.g., STAT vs. routine admissions), and the ability to navigate multiple software systems under pressure (Musty, 2023). Their accurate data entry is the linchpin for the entire digital flow system; a bed not marked clean in the system is a bed that remains unavailable, directly contributing to ED boarding.

Driving System-Wide Efficiency

At the health management level, integrated informatics provides the metrics necessary for strategic performance improvement and resource justification. Data on ED LOS, door-to-provider time, and admission hold times, easily extracted from informatics systems, allow administrators to identify persistent bottlenecks, measure the ROI of flow initiatives, and comply with regulatory reporting (Rathlev et al., 2020). This data supports business cases for investments in additional staffing, physical space, or new technology. Moreover, informatics enables more sophisticated capacity management models, such as system-wide capacity command centers that use predictive models and real-time data to manage patient placement across an entire hospital network (Phattharapornjaroen et al., 2022). This represents the ultimate health management application of informatics: using data to orchestrate the entire healthcare delivery system as a single, efficient organism.

Documented Impacts and Outcomes

The implementation of integrated health informatics strategies for patient flow has yielded measurable improvements across a range of outcome domains, though the magnitude of effect varies based on implementation fidelity and organizational context (Table 2).

Operational and Clinical Outcomes

The most consistently reported benefits are operational. Numerous studies link the implementation of EHR-integrated bed management, tracking boards, and data-driven protocols to reductions in ED Length of Stay (LOS) for both discharged and admitted patients (Booker et al., 2016; Khanna et al., 2016). For example, a study by Tsai et al. (2022) found that an enterprise-wide tracking system coupled with nurse-led bed coordination reduced median ED LOS for admitted patients by 87 minutes. Concomitantly, metrics like Left Without Being Seen (LWBS) rates and ambulance diversion hours often show a significant decline, indicating improved access and capacity (Gross et al., 2023). Clinically, reduced boarding time is associated with lower rates of hospital-acquired conditions for boarded patients and decreased mortality for critical patients requiring ICU admission (Singer et al., 2011; Carter et al., 2014). Furthermore, improved information handoff via interoperable systems has been linked to a reduction in medication errors and improved compliance with core measures for conditions like pneumonia and sepsis (Collins et al., 2011).

Staff Experience and Role Evolution

The impact on staff is dual-faceted. On one hand, technologies that reduce chaos and improve communication can decrease frustration and cognitive burden. Nurses report that tracking boards help prioritize care and reduce time spent hunting for information or providers (Wisner et al., 2019). On the other hand, poorly designed or implemented systems can become a source of "alert fatigue," redundant documentation, and workflow disruption, contributing to burnout (Graber et al., 2017). The evolution of roles, particularly for unit coordinators and flow nurses, can be empowering, offering increased responsibility and a more central role in hospital operations. However, this requires intentional training and support; without it, role ambiguity and stress can increase (Musty, 2023).

Financial and Organizational Outcomes

From a health management perspective, improved flow directly impacts the bottom line. Reducing ED boarding frees up ED treatment spaces, increasing capacity to see new patients and generate revenue (Rathlev et al., 2020). Efficient admission processes improve inpatient bed utilization, allowing for higher occupancy rates without compromising care or causing backup. This can reduce the need for costly contingency staffing or construction of new bed capacity. Furthermore, in value-based payment environments, organizations face penalties for excessive readmissions and are rewarded for efficiency; informatics tools that streamline care transitions and reduce LOS are critical for financial success under these models (Kansagara et al., 2011). Figure 2 illustrates the integrated health informatics ecosystem that enables streamlined patient flow from the Emergency Department (ED) to inpatient admission.

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Table 2: Documented Outcomes of Integrated Health Informatics on Patient Flow

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Outcome Domain	Specific Metrics	Example Finding (Selected References)
Operational	ED Length of Stay (LOS)	Reduction of 60-120 minutes for admitted patients (Khanna et al., 2016; Tsai et al., 2022).
	Left Without Being Seen (LWBS)	Decrease of 3-5% following tracking system implementation (Gross et al., 2023).
	Ambulance Diversion Hours	Significant reduction with real-time capacity dashboards (Gross et al., 2023).
Clinical	Inpatient Mortality	Associated with reduced boarding times for critically ill patients (Singer et al., 2011).
	Medication Errors	Reduction with improved EHR interoperability at care transitions (Collins et al., 2011).
	Hospital-Acquired Conditions	Lower rates for patients with reduced boarding time (Carter et al., 2014).
Staff & Process	Nurse Workflow Efficiency	Improved prioritization and communication (Wisner et al., 2019).
	Role Transformation	Unit coordinators become digital hub operators (Musty, 2023).
Financial/System	Bed Throughput & Capacity	Improved inpatient bed utilization (Rathlev et al., 2020).
	Compliance with Value-Based Metrics	Supports reduced readmissions and efficient care (Kansagara et al., 2011).

Figure 2. Integrated Health Informatics Ecosystem Supporting Patient Flow from Emergency Department to Inpatient Admission

Persistent Challenges and Barriers to Integration

Despite the demonstrated potential, significant challenges impede the full realization of a seamlessly integrated digital flow system.

Technological and Interoperability Hurdles

The lack of true, seamless interoperability remains the foremost technical barrier. Many systems are "integrated" through fragile interfaces that break or require manual reconciliation (Vest & Gamm, 2010). EHRs from different vendors, or even different modules from the same vendor, often do not share data in a usable, real-time manner, forcing workarounds. Data standardization is also an issue; a "clean bed" may mean different things to different departments. Furthermore, many legacy systems were not designed with fluid patient flow in mind, leading to clunky workflows where the technology hinders rather than helps (Graber et al., 2017).

Human Factors and Workflow Misalignment

Technology must serve the human workflow, not dictate it. A common failure is imposing a rigid digital process on a complex, adaptive clinical environment without sufficient input from end-users (Ash et al., 2009). This leads to "workarounds" that undermine system integrity—for example, staff using personal sticky notes or secondary whiteboards because the official system is too slow or non-intuitive. Resistance to change is a major human factor; clinicians and staff may view new systems as surveillance tools or extra work, especially if implemented without adequate training or demonstration of benefit (Holden & Karsh, 2010).

Financial, Training, and Leadership Gaps

The upfront capital investment for enterprise-grade patient flow software, sensors, and infrastructure is substantial, posing a barrier for smaller institutions (Moore et al., 2020). Ongoing costs for maintenance, upgrades, and vendor support are also significant. Compounding this, investment in training is often inadequate. Training tends to focus on button-clicking at go-live rather than on the strategic use of the system for flow management and role-based competency development over time (Wisner et al., 2019). Finally, success requires unwavering leadership commitment. Flow initiatives cut across departmental empires and require sustained focus and conflict resolution from senior health management. Without this, initiatives falter (Ben-Tovim, 2017).

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Conclusion and Future Directions

This review underscores that integrated health informatics is no longer a luxury but a fundamental necessity for managing the crisis of patient flow in modern hospitals. The journey from ED to admission is a critical nexus where clinical care, administrative efficiency, and information management converge. Technologies like EHRs, patient tracking systems, and dashboards, when implemented with interoperability and human-centered design, create powerful synergies. They transform nursing into proactive flow coordination, empower ED managers with predictive command tools, reinvent the unit secretary as a digital linchpin, and provide health administrators with the data to drive system-wide efficiency.

The evidence clearly indicates positive impacts on key metrics: reduced ED length of stay, decreased boarding, lower LWBS rates, and potential improvements in clinical outcomes and staff workflow. However, the path is fraught with persistent challenges—interoperability quagmires, workflow misalignment, and insufficient investment in change management and training.

Future directions must focus on several key areas. First, the industry must move beyond interfacing to true plug-and-play interoperability through the adoption of universal data standards (e.g., FHIR - Fast Healthcare Interoperability Resources) (Benson & Grieve, 2021). Second, the next wave of innovation lies in advanced predictive and prescriptive analytics, using artificial intelligence and machine learning not just to forecast demand but to recommend optimal actions for bed placement, staffing, and discharge planning (Zafar et al., 2023; Sun et al., 2012). Third, the human-technology interface must be prioritized through participatory design, ensuring systems are intuitive and support, rather than complicate, clinical reasoning and teamwork (Holden & Karsh, 2010).

Finally, and most crucially, health informatics for patient flow must be recognized as an organization-wide strategic initiative, not an IT project. It requires visionary health management that champions the change, invests in continuous role-based training, and fosters a culture of data-driven, collaborative problem-solving across all levels—from the ED nurse and unit coordinator to the C-suite. In doing so, hospitals can transform a perennial crisis into a managed process, ensuring that the right patient receives the right care in the right place at the right time, which is the very definition of a safe, efficient, and high-quality health system.

References

1. Abbassi, A., Hasni, N., & Hamida, E. B. (2022, November). Impact of computerized physician order entry system on parenteral nutrition medication errors in a teaching neonatal intensive care unit. In *Annales pharmaceutiques francaises* (Vol. 80, No. 6, pp. 819-826). Elsevier Masson. https://doi.org/10.1016/j.pharma.2022.05.002
2. Ash, J. S., Sittig, D. F., Dykstra, R., Campbell, E., & Guappone, K. (2009). The unintended consequences of computerized provider order entry: findings from a mixed methods exploration. *International journal of medical informatics*, *78*, S69-S76. https://doi.org/10.1016/j.ijmedinf.2008.07.015
3. Ben-Tovim, D. I. (2017). *Process redesign for health care using lean thinking: a guide for improving patient flow and the quality and safety of care*. CRC Press.
4. Benson, T., & Grieve, G. (2021). *Principles of health interoperability*. Springer International Publishing.
5. Booker, C., Turbutt, A., & Fox, R. (2016). Model of care for a changing healthcare system: are there foundational pillars for design?. *Australian Health Review*, *40*(2), 136-140. https://doi.org/10.1071/AH14173
6. Boyle, A., Abel, G., Raut, P., Austin, R., Dhakshinamoorthy, V., Ayyamuthu, R., ... & Burton, J. (2016). Comparison of the International Crowding Measure in Emergency Departments (ICMED) and the National Emergency Department Overcrowding Score (NEDOCS) to measure emergency department crowding: pilot study. *Emergency Medicine Journal*, *33*(5), 307-312. https://doi.org/10.1136/emermed-2014-203616
7. Carter, E. J., Pouch, S. M., & Larson, E. L. (2014). The relationship between emergency department crowding and patient outcomes: a systematic review. *Journal of Nursing Scholarship*, *46*(2), 106-115. https://doi.org/10.1111/jnu.12055
8. Collins, S. A., Bakken, S., Vawdrey, D. K., Coiera, E., & Currie, L. M. (2011). Agreement between common goals discussed and documented in the ICU. *Journal of the American Medical Informatics Association*, *18*(1), 45-50. https://doi.org/10.1136/jamia.2010.006437
9. Di Somma, S., Paladino, L., Vaughan, L., Lalle, I., Magrini, L., & Magnanti, M. (2015). Overcrowding in emergency department: an international issue. *Internal and emergency medicine*, *10*(2), 171-175. https://doi.org/10.1007/s11739-014-1154-8
10. Forstater, A., Sicks, S., Collins, L., & Schmidt, E. (2019). Team SAFE: a large-scale interprofessional simulation-based TeamSTEPPS® curriculum. *Journal of Interprofessional Education & Practice*, *16*, 100221. https://doi.org/10.1016/j.xjep.2018.12.002
11. Graber, M. L., Byrne, C., & Johnston, D. (2017). The impact of electronic health records on diagnosis. *Diagnosis*, *4*(4), 211-223. https://doi.org/10.1515/dx-2017-0012

12. Gross, T. K., Lane, N. E., & Timm, N. L. (2023). Crowding in the emergency department: challenges and best practices for the care of children. *Pediatrics*, *151*(3), e2022060972. https://doi.org/10.1542/peds.2022-060972
13. Holden, R. J., & Karsh, B. T. (2010). The technology acceptance model: its past and its future in health care. *Journal of biomedical informatics*, *43*(1), 159-172. https://doi.org/10.1016/j.jbi.2009.07.002
14. Kansagara, D., Englander, H., Salanitro, A., Kagen, D., Theobald, C., Freeman, M., & Kripalani, S. (2011). Risk prediction models for hospital readmission: a systematic review. *Jama*, *306*(15), 1688-1698. doi:10.1001/jama.2011.1515
15. Kelen, G. D., Sauer, L., Clattenburg, E., Lewis-Newby, M., & Fackler, J. (2015). Pediatric disposition classification (reverse triage) system to create surge capacity. *Disaster Medicine and Public Health Preparedness*, *9*(3), 283-290. doi:10.1017/dmp.2015.27
16. Khanna, S., Sier, D., Boyle, J., & Zeitz, K. (2016). Discharge timeliness and its impact on hospital crowding and emergency department flow performance. *Emergency Medicine Australasia*, *28*(2), 164-170. https://doi.org/10.1111/1742-6723.12543
17. Moore, E. C., Tolley, C. L., Bates, D. W., & Slight, S. P. (2020). A systematic review of the impact of health information technology on nurses' time. *Journal of the American Medical Informatics Association*, *27*(5), 798-807. https://doi.org/10.1093/jamia/ocz231
18. Morais Oliveira, M., Marti, C., Ramlawi, M., Sarasin, F. P., Grosgurin, O., Poletti, P. A., ... & Rutschmann, O. T. (2018). Impact of a patient-flow physician coordinator on waiting times and length of stay in an emergency department: A before-after cohort study. *Plos one*, *13*(12), e0209035. https://doi.org/10.1371/journal.pone.0209035
19. Morley, C., Unwin, M., Peterson, G. M., Stankovich, J., & Kinsman, L. (2018). Emergency department crowding: a systematic review of causes, consequences and solutions. *PloS one*, *13*(8), e0203316. https://doi.org/10.1371/journal.pone.0203316
20. Musty, B. (2023). Analyzing the changing role of professional secretary in dealing with the impact of digital technology (A case study on professional secretaries in Indonesia). *International Journal of Business, Economics, and Social Development*, *4*(1), 12-19. https://doi.org/10.46336/ijbesd.v4i1.380
21. Nguyen, Q., Wybrow, M., Burstein, F., Taylor, D., & Enticott, J. (2022). Understanding the impacts of health information systems on patient flow management: A systematic review across several decades of research. *PloS one*, *17*(9), e0274493. https://doi.org/10.1371/journal.pone.0274493
22. Phattharapornjaroen, P., Carlström, E., & Khorram-Manesh, A. (2022). Developing a conceptual framework for flexible surge capacity based on complexity and collaborative theoretical frameworks. *Public Health*, *208*, 46-51. https://doi.org/10.1016/j.puhe.2022.04.012
23. Pines, J. M., Hilton, J. A., Weber, E. J., Alkemade, A. J., Al Shabanah, H., Anderson, P. D., ... & Schull, M. J. (2011). International perspectives on emergency department crowding. *Academic Emergency Medicine*, *18*(12), 1358-1370. https://doi.org/10.1111/j.1553-2712.2011.01235.x
24. Rathlev, N. K., Visintainer, P., Schmidt, J., Hettler, J., Albert, V., & Li, H. (2020). Patient characteristics and clinical process predictors of patients leaving without being seen from the emergency department. *Western Journal of Emergency Medicine*, *21*(5), 1218. https://doi.org/10.5811/westjem.2020.6.47084
25. Reznek, M. A., Murray, E., Youngren, M. N., Durham, N. T., & Michael, S. S. (2017). Door-to-imaging time for acute stroke patients is adversely affected by emergency department crowding. *Stroke*, *48*(1), 49-54. https://doi.org/10.1161/STROKEAHA.116.015131
26. Shapiro, J. S., Johnson, S. A., Angiollilo, J., Fleischman, W., Onyile, A., & Kuperman, G. (2013). Health information exchange improves identification of frequent emergency department users. *Health Affairs*, *32*(12), 2193-2198. https://doi.org/10.1377/hlthaff.2013.0167
27. Shenvi, E., Boxwala, A., Sittig, D., Zott, C., Lomotan, E., Swiger, J., & Dullabh, P. (2023). Visualization of patient-generated health data: a scoping review of dashboard designs. *Applied Clinical Informatics*, *14*(05), 913-922. DOI: 10.1055/a-2174-7820
28. Singer, A. J., Thode Jr, H. C., Viccellio, P., & Pines, J. M. (2011). The association between length of emergency department boarding and mortality. *Academic Emergency Medicine*, *18*(12), 1324-1329. https://doi.org/10.1111/j.1553-2712.2011.01236.x
29. Sun, Y., Teow, K. L., Heng, B. H., Ooi, C. K., & Tay, S. Y. (2012). Real-time prediction of waiting time in the emergency department, using quantile regression. *Annals of emergency medicine*, *60*(3), 299-308. https://doi.org/10.1016/j.annemergmed.2012.03.011
30. Tsai, W. C., Liu, C. F., Lin, H. J., Hsu, C. C., Ma, Y. S., Chen, C. J., ... & Chen, C. C. (2022, August). Design and implementation of a comprehensive AI dashboard for real-time

prediction of adverse prognosis of ED patients. In *Healthcare* (Vol. 10, No. 8, p. 1498). MDPI. https://doi.org/10.3390/healthcare10081498

31. Vest, J. R., & Gamm, L. D. (2010). Health information exchange: persistent challenges and new strategies. *Journal of the American Medical Informatics Association: JAMIA*, *17*(3), 288. https://doi.org/10.1136/jamia.2010.003673
32. Wisner, K., Lyndon, A., & Chesla, C. A. (2019). The electronic health record's impact on nurses' cognitive work: An integrative review. *International Journal of Nursing Studies*, *94*, 74-84. https://doi.org/10.1016/j.ijnurstu.2019.03.003
33. Wong, G., Greenhalgh, T., Westhorp, G., Buckingham, J., & Pawson, R. (2013). RAMESES publication standards: realist syntheses. *BMC medicine*, *11*(1), 21. https://doi.org/10.1186/1741-7015-11-21

Zafar, Z., Ashraf, N., Alamgir, W., Rehman, A., & Ilyas, S. (2023). Comparison of the International Crowding Measure in Emergency Departments (ICMED) and the National Emergency Department Overcrowding Study (NEDOCS) in Tertiary Care Hospital to Measure Emergency Department Crowding. *Pakistan Armed Forces Medical Journal*, *73*(1). DOI: 10.51253/pafmj.v73i1.8202

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