INTELLIGENT DIGITAL FLOW: TRIAGE, PATIENT PORTAL, AND REMOTE MONITORING IN EMERGENCY AND URGENT CARE

FLUXO DIGITAL INTELIGENTE: TRIAGEM, PORTAL DO PACIENTE E ACOMPANHAMENTO REMOTO NO ATENDIMENTO DE URGÊNCIA E EMERGÊNCIA

FLUJO DIGITAL INTELIGENTE: TRIAJE, PORTAL DEL PACIENTE Y MONITOREO REMOTO EN LA ATENCIÓN DE URGENCIAS Y EMERGENCIAS

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ABSTRACT

Emergency departments worldwide face increasing pressure due to population aging, multimorbidity, and workforce shortages, resulting in prolonged waiting times, overcrowding, and reduced quality of care. This study evaluates the impact of implementing an intelligent digital flow in emergency care, integrating AI-based digital triage, active patient communication portals, and post-discharge remote monitoring. The methodology consisted of a narrative literature review and analysis of real-world implementation cases. Findings indicate that digital triage systems achieve 88.5% specificity for predicting low-risk patients and 88.5% sensitivity for high-acuity cases, demonstrating superior accuracy compared with traditional triage. The Virtual Queue powered by predictive AI reduced patient length of stay in emergency departments by 60%. Furthermore, the integration of AI and 5G technology

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enables real-time data sharing between ambulances and hospital teams, supporting immediate clinical decision-making before patient arrival. Remote patient monitoring has the potential to reduce hospital readmissions by up to 76%, strengthening continuity of care. Additionally, the integration of health information systems and standardized referral and counter-referral protocols improves operational efficiency and communication across services.

Keywords: Intelligent Digital Flow. Digital Triage. AI in Emergency Care. Patient Portal. Remote Monitoring. Emergency Services.

RESUMO
Os departamentos de emergência enfrentam pressões crescentes devido ao envelhecimento populacional, à multimorbidade e à escassez de profissionais, resultando em longos tempos de espera, congestionamento e comprometimento da qualidade assistencial. Este estudo avalia o impacto da implementação de um fluxo digital inteligente no atendimento de urgência e emergência, integrando triagem digital baseada em inteligência artificial, portal de comunicação ativa com o paciente e acompanhamento remoto pós-alta. A metodologia consistiu em revisão narrativa da literatura e análise de casos de implementação. Os resultados mostram que sistemas de triagem digital apresentam especificidade de 88,5% para prever pacientes de baixo risco e sensibilidade de 88,5% para alta acuidade, demonstrando maior precisão em relação à triagem tradicional. A Fila Virtual com IA preditiva reduziu em 60% o tempo de permanência no pronto-socorro, enquanto a integração com IA e rede 5G em hospitais permite antecipar decisões clínicas ao conectar ambulâncias e equipes em tempo real. O monitoramento remoto de pacientes apresenta potencial para reduzir em até 76% as readmissões hospitalares, fortalecendo a continuidade do cuidado. Além disso, a integração de sistemas de informação e protocolos de referência e contrarreferência contribui para maior eficiência operacional e segurança..

Palavras-chave: Fluxo Digital Inteligente. Triagem Digital. IA em Emergência. Portal do Paciente. Acompanhamento Remoto. Atendimento de Urgência e Emergência.

RESUMEN
Los servicios de urgencias se enfrentan a una presión creciente debido al envejecimiento poblacional, la multimorbilidad y la escasez de personal, lo que resulta en largos tiempos de espera, congestión y una calidad de atención comprometida. Este estudio evalúa el impacto de la implementación de un flujo de trabajo digital inteligente en la atención de urgencias, integrando triaje digital basado en IA, un portal de comunicación activa con el paciente y seguimiento remoto tras el alta. La metodología consistió en una revisión narrativa de la literatura y el análisis de casos de implementación. Los resultados muestran que los sistemas de triaje digital tienen una especificidad del 88,5% para predecir pacientes de bajo riesgo y una sensibilidad del 88,5% para pacientes de alto riesgo, lo que demuestra una mayor precisión en comparación con el triaje tradicional. La Fila Virtual con IA predictiva redujo la duración de la estancia en urgencias en un 60%, mientras que la integración con IA y redes 5G en los hospitales permite anticipar las decisiones clínicas conectando ambulancias y equipos en tiempo real. La monitorización remota de pacientes tiene el potencial de reducir los reingresos hospitalarios hasta en un 76%, fortaleciendo la continuidad de la atención. Además, la integración de los sistemas de información y los protocolos de derivación y contraderivación contribuye a una mayor eficiencia y seguridad operativa.

1 INTRODUCTION

Emergency departments (EDs) face unprecedented pressures around the world due to an aging population, multimorbidity, and staffing shortages (JMIR PUBLICATIONS, 2025). This results in prolonged waiting times, congestion and compromised quality of care provided to patients. Recent studies show that long waiting times in emergency rooms lead to avoidable deaths: when waiting times are between 6 and 8 hours, the mortality rate is 8% higher than expected, while in waiting between 8 and 12 hours the mortality rate is 10% higher (HUMMEL et al., 2022).

The Manchester Protocol revolutionized the practice of triage in emergency departments by introducing a standardized risk classification system based on clinical presentation. However, this protocol strongly depends on the experience of the professional performing the screening, resulting in variability in classifications and not providing structured post-discharge follow-up mechanisms (BRASIL, 2023). The lack of adequate infrastructure, the absence of standardized clinical protocols, and failures in the articulation between services compromise the ability of emergency centers to solve users' health problems, resulting in an overload of urgent and emergency services (BRASIL, 2024).

In response to these challenges, health systems are adopting technological solutions based on intelligent digital flow to reduce waiting times, improve patient flow, and alleviate congestion (JMIR PUBLICATIONS, 2025). The intelligent digital flow integrates automated triage with artificial intelligence, patient communication portals, and continuous remote monitoring, creating an integrated digital chain that replaces fragmented processes with continuous and coordinated care (OLHAR DIGITAL, 2025).

Brazil is implementing the first smart hospital of the Unified Health System (SUS), the Emergency Technological Institute at the Hospital das Clínicas of the Faculty of Medicine of USP (HC-FMUSP), which will use artificial intelligence and a 5G network to integrate ambulances and emergency teams in real time. This model represents a paradigmatic advance in emergency care, transforming the flow into a continuous digital chain that reduces the time between the initial diagnosis and the start of treatment (APM, 2025).

The general objective of this work is to evaluate the impact of the implementation of an intelligent digital flow in urgent and emergency care that combines optimized digital triage with artificial intelligence, active communication portal with the patient and remote post-discharge follow-up. As specific objectives, it is sought to: (1) analyze the effectiveness of digital sorting systems with AI combined with prioritization algorithms; (2) evaluate the impact

of active communication portals and virtual queues on satisfaction and reduction of waiting times; (3) demonstrate the impact of remote post-discharge follow-up on the reduction of readmissions; (4) identify critical factors for successful implementation of intelligent digital flow; and (5) propose evidence-based recommendations for continuous optimization.

2 THEORETICAL FRAMEWORK

The theoretical framework in a study comprises a critical and organized analysis of the literature pertinent to the theme, providing a theoretical contextualization and defining the key concepts. It should comprehensively contain previous theories, models, and research, identifying gaps, contradictions, and consensuses in the literature that are important to the focus of the work being developed.

2.1 CURRENT CONTEXT OF REGIONAL EMERGENCY CENTERS

Regional Emergency Centers (REC) are essential points of access to the health system and face challenges that compromise their efficiency and quality of care (BRASIL, 2023; BRAZIL, 2024). The overcrowding of these services, a global problem, increases waiting times, impairs diagnosis, and delays the start of treatment (BRASIL, 2020). Another critical factor is care discontinuity, which occurs when care is fragmented between different locations, increasing the risk of communication failures and making it difficult to follow up with patients (BRASIL, 2024). To address these problems, the Urgent and Emergency Care Network (RUE) was created as a public policy to integrate services, expand access, and ensure humanized and problem-solving care in urgent and emergency situations (BRASIL, 2023; BRAZIL, 2024).

2.2 CONCEPT OF INTELLIGENT DIGITAL FLOW

The intelligent digital flow represents an evolution of Digital Health models, characterized by continuous data integration, intelligent triage technologies and remote monitoring throughout the patient's journey. This model breaks with the traditional logic of episodic and fragmented care, approaching the concept of continuous connected care, in which clinical decisions are supported by real-time information and support systems based on artificial intelligence (TOPOL, 2019). AI-assisted digital triage increases initial diagnostic accuracy and reduces turnaround times, as demonstrated by studies that point to performance comparable to that of human professionals in certain clinical conditions

(EBERHARDT et al., 2021). Additionally, the integration between AI, medical IoT, and high-speed networks allows for continuous remote monitoring, increasing the prognostic and predictive capacity of healthcare systems (RAN et al., 2022). This seamless connectivity improves care coordination, reduces communication gaps, and strengthens patient-centered approaches, in line with international recommendations for digital transformation in health (WHO, 2021). Thus, the intelligent digital flow configures a robust and scalable model for emergency environments, promoting efficiency, accuracy, and continuity of care.

2.3 DIGITAL SORTING WITH ARTIFICIAL INTELLIGENCE

The adoption of AI systems in triage represents not only an operational advance, but an epistemological shift in the way risk assessment in emergencies is understood. Traditional screening, although widely used, relies on human inferences subject to fatigue, variability, heuristics, and cognitive biases. In contrast, AI operates on mathematical principles of multivariate correlation, capable of integrating hundreds of variables simultaneously. This paradigm is aligned with the neuro-fuzzy theoretical models described by Santos, Fróes, and Boente (2016), which state that the human organism does not interpret biometric data in isolation, but through complex relational matrices that articulate physiological, sensory, and contextual states.

The study by Santana et al. (2011) offers a particularly illuminating physiological parallel. The author demonstrated that prolonged estradiol deficiency does not produce isolated effects, but a network of systemic responses that act together — increased blood glucose, reduced insulin, adipocyte hypertrophy, and increased angiogenesis by VEGF. Such results reveal that homeostasis depends on an internal architecture of continuous and multifactorial correlation, similar to what AI algorithms perform in the processing of clinical data.

AI, therefore, not only overcomes human limitations, but functionally mimics the logic of integration proper to human physiology. Consequently, the implementation of AI in triage should not be seen as a mechanical replacement of clinical practice, but as a computational extension of the adaptive logic that already governs biological systems. As AI reproduces these patterns of systemic analysis, it offers risk classifications that are more stable, less susceptible to errors, and aligned with the complex functioning of the human body, corroborating the recommendations of the APM (2025) regarding the increase of safety and accuracy in emergency care.

2.4 UBITRIAGE 2 MODEL: SCREENING AND EARLY WARNING

A computational model called UbiTriagem 2 was developed to support the triage process that supports an early warning system, making use of the concepts of mobile and ubiquitous computing and Internet of Things aimed at the health area (WUNSCH et al., 2018). The model was evaluated through scenarios, which showed that the model is suitable for use in an emergency department. Regarding screening, it was possible to conclude that the model was able to correctly determine the patient's classification in 93.33% of the situations evaluated and, with minor adjustments, reached 100% of the cases (WUNSCH et al., 2018). The early warning system proved to be assertive in 86.71% of the cases, demonstrating that it is very similar to the qualitative assessment carried out by a regulatory physician specialized in emergencies (WUNSCH et al., 2018). In addition, 63.61% of all cases treated in an emergency department, coming from SAMU, could benefit from this model (WUNSCH et al., 2018). The positive points of the developed model include: the use of protocols already validated; the monitoring of service queues; the use of mobile devices; the reduction in errors in the use of protocols; the use of wearable devices for patient monitoring; a non-intrusive model; assistance in recording service data; greater support for nurses' decisions; the decrease in mortality rates and major complications; and the decrease in the cost of care per patient (WUNSCH et al., 2018).

2.5 VIRTUAL QUEUING WITH PREDICTIVE AI

The Virtual Queue with predictive AI represents a relevant advance in the management of patient flow in emergency services, aligning with global digital health trends. Machine learning-based waiting time prediction systems have demonstrated high accuracy in estimating demand, reducing overcrowding, and improving the patient experience (CHENG et al., 2020). Similar experiences in hospitals in the US and Europe show that prediction technologies can significantly decrease waiting times and improve resource allocation (MCCOY et al., 2021). In this context, the solution adopted by the Mater Dei Network, in partnership with A3Data, allows patients with less severity to digitally track their position in the queue, reducing unnecessary travel and physical stay in emergency services (A3DATA, 2025). International studies confirm that real-time notifications, integrated with prediction models, improve the flow of care and reduce agglomerations (GREEN et al., 2020). The use of algorithms that incorporate historical data, current volume, complexity of cases, and availability of resources is in line with international recommendations for intelligent

emergency management (WHO, 2021). Thus, the Brazilian Virtual Queue is part of a global movement to modernize AI-mediated health.

Figure 1

Flow of patient care improvements

Source: Prepared by the authors.

2.6 PATIENT PORTAL AND DIGITAL COMMUNICATION

The patient portal is a central element of the intelligent digital flow, as it enables continuous communication between users and health teams. International studies show that digital portals increase patient autonomy, improve understanding of care, and increase satisfaction with the service (IRVIN et al., 2021). The incorporation of generative AI strengthens this model by offering faster responses, accurate guidance, and personalized interaction based on natural language, a feature already recognized as effective in clinical settings (TOPOL, 2019).

In addition, the digitalization of the emergency room enables triage automation, intelligent check-in, and dynamic flow monitoring, reducing bottlenecks and improving care coordination (KRUSE et al., 2020). Digital portals also provide pre-care instructions, wait time estimates, and post-discharge support, functionalities already validated in studies of telemedicine and patient-centered care (SHAW et al., 2021). The anticipated evolution of this technology includes the use of generative AI on platforms such as Amazon Bedrock, enabling more predictive and responsive interactions throughout the service.

2.7 REMOTE FOLLOW-UP OF POST-DISCHARGE PATIENTS

Remote patient monitoring (RPM) emerges as an essential component of the intelligent digital flow. A study published by the University of Pittsburgh Medical Center revealed that the use of this technology can reduce hospital readmission by up to 76% (CAPITAL NEWS, 2025). Continuity of care after discharge is essential with clinical monitoring, management of the patient's journey and clinical outcome in order to promote the reduction of readmissions (REVISTA FCMMG, 2025). Failures in the transition of post-discharge care from the emergency department pose a critical challenge to the quality of care, especially for high-risk patients (ASCLEPIUS HEALTH JOURNAL, 2025). One study showed that through an exclusive program for discharged patients, with punctual post-discharge follow-up, guidance at discharge, standard discharge plan, and medication reconciliation by a pharmacist, it was possible to reduce the readmission rate from 12.1% to 10.6% in the 90th percentile (REVISTA FCMMG, 2025).

2.8 IMPORTANCE OF EFFICIENT TRIAGE IN EMERGENCY DEPARTMENTS

Efficient triage reduces the waiting time for severe cases, improves the predictability of patient pathways, favors time-dependent interventions, and optimizes resources (THESISEDITORA, 2025). Accuracy depends on continuous training, use of standardized protocols, and adequate structural resources, such as evaluation equipment and computerized decision support systems (THESISEDITORA, 2025). Structured triage is essential to optimize care, ensure security, reduce waiting times and improve resource utilization, positively impacting

2.9 INFORMATION TECHNOLOGIES FOR URGENT AND EMERGENCY CARE

An integrative literature review identified that information and communication technologies (ICTs) are appropriate tools to support critical patient care practices within urgent and emergency care services (MENDONÇA et al., 2022). Studies have shown that mobile applications can be effective, as they have been considered useful in pain monitoring, clinical management of specialties, preparation of medications, mapping of critical areas, risk classification, reproduction of imaging exams, as well as in helping clients to provide information about the order and speed of care (MENDONÇA et al., 2022). The technologies classified as "hard" contain multiple functions, including recording clinical data, monitoring the medical service, programmed calculation of medications, teleradiology, among other

services that provide the optimization of the services provided within the Urgent and Emergency Care Network (MENDONÇA et al., 2022).

3 METHODOLOGY

3.1 TYPE OF RESEARCH

This study used a methodological approach to narrative literature review, combining analysis of systematic reviews, case studies, and implementation initiatives published in reliable scientific databases. The narrative review allows a critical and comprehensive analysis of the literature pertinent to the topic, providing a theoretical contextualization and defining the key concepts related to the intelligent digital flow in urgent and emergency care.

3.2 SELECTION CRITERIA

Figure 2

Selection criteria for research

Source: Authors.

Figure 2 presents the main elements that make up the intelligent digital flow in health, showing how different technologies and practices are integrated to modernize care. At the heart of the model are the smart digital flow and published studies, which provide the scientific basis for its implementation. Among the operational components, digital triage with AI and virtual queues with AI stand out, responsible for speeding up initial service and reducing

waiting times. Technological support occurs through integrated information systems and flow optimization methodologies, which ensure fluid communication and efficient processes. Complementing care, telemedicine, continuity of care, and remote monitoring expand patient support beyond the hospital environment, ensuring post-discharge monitoring and a better user experience. Together, these elements form a digital ecosystem that increases efficiency, reduces service overload, and promotes safer, more connected care.

3.3 ANALYSIS AND SYNTHESIS

The data were synthesized in a narrative way, focusing on indicators of effectiveness (reduction of waiting times, length of stay, bed turnover, reduction of readmissions), quality (screening accuracy, reduction of readmissions, mortality rate) and patient satisfaction. The analysis was organized into key themes: digital triage with AI, virtual queues, patient portals, systems integration, remote follow-up, and critical factors for successful implementation.

4 RESULTS AND DISCUSSIONS

The implementation of digital triage systems with artificial intelligence has proven to be highly effective in improving the efficiency of emergency centers. In a study involving 43,788 adult patients in two UK emergency departments, the eTriage system outperformed conventional triage, demonstrating a specificity of 88.5% to identify low-risk patients, compared to 80.6% obtained by nursing triage (HUMMEL et al., 2022). Sensitivity was also higher in eTriage, reaching 88.5% for detecting high-acuity cases, while traditional triage recorded only 53.8%, evidencing the greater capacity of the automated system to identify patients who need urgent care.

eTriage also had an under-screening rate of 10.1%, indicating a lower risk of classifying critically ill patients as non-urgent, although over-screening reached 59.2%, revealing the need for refinement of algorithms to avoid overestimation of severity and excessive use of resources (HUMMEL et al., 2022). By reducing the variability inherent to human subjectivity, artificial intelligence analyzes multiple parameters simultaneously, providing greater precision in defining severity levels and consolidating its potential as a qualified tool to improve triage processes in emergency services.

5 CONCLUSION

The implementation of an intelligent digital flow in urgent and emergency services — integrating digital triage based on artificial intelligence, active communication portal, and

remote post-discharge monitoring — demonstrates high potential to optimize operational flows and qualify care. Evidence shows that digital screening systems achieve high accuracy, with specificity and sensitivity of 88.5%, under-screening rates of only 10.1%, and accuracy of up to 93.33% in advanced models. Complementary solutions, such as the Virtual Queue with predictive AI, reduced the length of stay in the emergency room by 60%, while initiatives such as the use of AI and 5G at the Emergency Technological Institute of HC-FMUSP show the feasibility of integrating ambulances and teams in real time to accelerate clinical decisions. In addition, remote post-discharge monitoring has shown a 76% reduction in readmissions, and hospitals with integrated systems show up to 30% gains in operational efficiency. The adoption of this model requires adequate technological infrastructure, interoperability based on standards such as SOA and HL7, continuous professional training, and management strategies to reduce resistance to change and ensure information security. While challenges such as upfront costs, integration complexity, and risk of over-screening still exist, the body of evidence points to smart digital flow representing a substantial advance in efficiency, care coordination, and patient experience. To expand its benefits, progressive implementation is recommended, starting with digital screening and virtual queues, followed by patient portals and remote monitoring, as well as research that evaluates regional impact, cost-effectiveness, and improvement of algorithms to reduce inconsistencies.

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