

AI-Assisted Triage in Disaster Medicine: Enhancing Response Time and Clinical Decision-Making Without Replacing Human Judgment

Question: To what extent can AI-assisted systems improve triage accuracy and response time in disaster-related medical emergencies while preserving clinician oversight?

1. Introduction

Within minutes after a natural disaster, emergency responders are forced to make life-or-death choices in environments filled with noise, smoke, and severe resource limitations—in these moments, medical decisions shift from individual patient care to population survival.

Hundreds—sometimes thousands— of injured victims may require urgent care, while available responders, equipment, and time are drastically under constraint. These conditions require structured triage systems designed to allocate limited medical resources efficiently while preventing sure-death. Under these hectic conditions, traditional practices and models of individualized medical treatment become impractical and responders must prioritize patients in such a way that it maximizes overall survival.

This prioritization process, known as disaster triage, is a foundational component of emergency medicine during mass-casualty incidents—especially for natural disasters. Systems such as Simple Triage and Rapid Treatment (START) and Sort, Access, Lifesaving Interventions,

Treatment/Transport (SALT) provide a structured framework that allows first responders to rapidly characterize patients based on injury severity and likelihood of survival. While these systems are effective in principle, their real world applications are often challenged by the unpredictableness of the environment, extreme cognitive overload for responders, and incomplete information, all which can make the situation more chaotic for both the clinician and the patient.

Recent advances in Artificial Intelligence(AI) offer an opportunity to elevate, rather than replace, human-decision making in disaster triage. AI assisted systems have demonstrated potential in areas such as pattern recognition, real-time data analysis, and remote situational assessment, which may help to reduce triage errors and improve response times. When ethically designed and clinically supervised, these technologies can support responders providing early victim identification, decision support, and enhanced situational awareness—especially in environments that are unsafe or inaccessible to humans.

This paper examines the role of AI-assisted systems in improving triage accuracy and response efficiency in disaster medicine while preserving clinical oversight. By analyzing existing triage frameworks and current studies on AI applications in emergency care, and by evaluating a proposed AI-supported emergency response model as a case study, this research explores how technology can responsibly enhance disaster triage outcomes without undermining the ethical foundations of emergency medical practice.

2. Background and Literature Review

The most commonly used triage system in the United States is START, which categorizes patients into Red (Immediate), Yellow (Delayed), Green (Minor), and Black (Deceased/Expectant) based on ability to walk, respiratory rate, capillary refill, and follow commands. This system excels in its speed and simplicity for mass casualty accidents (MCIs), especially in chaotic situations where time is of the essence. Simple criteria (pulse, respiration, mental status) make it easy for various responders (firefighters, EMTs, bystanders) to grasp and its minimal equipment makes it efficient. But START falters when the patient may have internal injuries masked by initial stability, leading to delayed care. It may assign patients to higher categories, when their needs are less critical, diverting valuable resources (Bazyar). START is excellent for initial, rapid sorting in large incidents, but its simplicity can be a double-edged sword, risking misallocation of critical resources; it's often used as a foundation, with reassessment and more nuanced systems like SALT building upon it.

The SALT triage system is a more nuanced approach to categorizing patients in emergency crises. Studies show that SALT can be more accurate than START, particularly in correctly identifying patients needing immediate care (reducing undertriage). It was developed by a CDC-sponsored group, it aims for nationwide consistency in mass casualty incidents (MCIs) and integrates immediate lifesaving interventions (like opening airways) before final categorization, improving outcomes. It also includes more detailed assessment steps and a clear "expectant/black" category for those with poor prognosis and allows for the incorporation of bystander input during initial sorting. But the increased complexity of SALT requires training and practice than the simpler START system. Meaning that the detailed assessment can take

longer, potentially delaying resource allocation in very chaotic scenarios. It also relies more on clinical judgment, which can introduce variability between providers.

Triage accuracy studies across emergency departments generally report moderate performance, with overall correct classification often around 60% and substantial rates of both under-triage (commonly about one fifth of cases) and over-triage, depending on the specific triage scale and setting. Accuracy is strongly influenced by factors such as nurse experience, crowding, and case complexity; more experienced triage nurses and longer, less pressured triage encounters tend to yield more accurate acuity assignments, while heavy ED crowding and time pressure are associated with decreased accuracy. Educational interventions and structured training programs can improve triage accuracy and related knowledge or decision behaviors, but systematic reviews show mixed results, with some studies demonstrating clear gains and others finding minimal impact, underscoring the need for high-quality, context-specific training approaches. In low- and middle-income countries, implementing formal triage systems has been linked to improvements in process measures such as reduced waiting times and sometimes better clinical outcomes, although study designs often limit causal conclusions, and newer work is exploring AI-supported triage to enhance consistency while still struggling with ambiguous or borderline cases.

AI-driven triage systems are able to leverage structured data (for example, vital signs, age, mode of arrival) and, increasingly, unstructured text such as chief complaints and triage notes to support or automate sharp classification in the emergency department (ED). Across multiple retrospective and early prospective studies, machine learning (ML) models and language

learning models(LLMS) consistently demonstrate superior accuracy compared with conventional triage scales, with higher area under the receiver operating characteristic curve for outcomes such as intensive care unit (ICU) admission, critical care, and hospitalization.

These performance gains translate into clinically relevant process improvements. Several evaluations report reductions in under-triage among patients ultimately requiring critical care or admission, and more accurate identification of high-risk patients within intermediate triage categories. By providing real-time risk scores at first contact, AI systems can support earlier escalation to senior clinicians, timelier diagnostic testing, and more appropriate allocation of monitored beds and ICU capacity, contributing to improved patient flow and mitigation of ED crowding. In resource-limited settings, AI-enhanced triage tools have shown particular promise in augmenting nurse-led triage by using routinely collected data to predict ICU needs more accurately than existing scales, thereby helping to focus scarce resources on patients most likely to deteriorate. *In all reviewed implementations, AI functions as decision support rather than an autonomous triage authority, preserving clinician accountability.*

Drone-assisted assessment in mass-casualty triage focuses on using unmanned aerial vehicles to accelerate victim identification, remote triage, and early resource coordination at incident scenes. Studies of camera- and speaker-equipped drones in simulated and limited real-world mass-casualty scenarios show that they can rapidly survey large areas, identify ambulatory (low-acuity) victims, and broadcast instructions to direct self-evacuation or life-saving actions before first responders arrive, thereby improving initial organization of the scene. Systematic

reviews report that drones reduce time to locate victims and enhance situational awareness, giving incident commanders aerial imagery that informs estimates of victim numbers, injury patterns, hazards, and access routes, which in turn supports earlier and more targeted deployment of ground teams and medical resources. Emerging work integrates basic clinical cues from drone video—such as visible bleeding, movement, and apparent consciousness—into simple triage algorithms or AI-based computer-vision systems that can automatically assign preliminary priority categories, offering a scalable way to initiate triage in complex or hazardous environments where responder access is delayed. However, the evidence base remains dominated by simulations and small pilots, with limited high-quality data on patient-centered outcomes, and real-world implementation faces challenges related to weather, connectivity, airspace regulation, and privacy as well as the need to embed drone workflows within existing command and communication structures for mass-casualty incident management

3. Methodology

This paper employs an integrative literature review combined with a conceptual systems analysis to examine the role of artificial intelligence (AI)–assisted decision support in disaster triage. Rather than presenting original clinical data, the analysis synthesizes existing research to evaluate how AI technologies may enhance triage accuracy and response efficiency while preserving clinician oversight during mass-casualty incidents.

Peer-reviewed studies were selected based on their relevance to disaster and emergency triage frameworks, including START and SALT, as well as research examining triage accuracy, under- and over-triage rates, and the cognitive demands placed on responders in high-stress environments. Additional literature addressing AI applications in emergency medicine, such as

machine-learning–based triage tools and drone-assisted situational assessment, was included to capture emerging approaches to decision support in both prehospital and emergency department settings. Priority was given to systematic reviews, comparative studies, and recent evaluations that assessed clinical or operational outcomes.

A comparative analytical framework was used to evaluate traditional triage systems and AI-assisted models across key dimensions relevant to disaster response, including speed of assessment, accuracy of patient prioritization, cognitive burden on responders, adaptability to chaotic or resource-limited environments, and ethical considerations related to accountability and bias. This framework allows for structured comparison without assuming technological superiority or autonomy.

To illustrate the practical integration of AI within existing triage workflows, a proposed AI-supported emergency response system, MedResQ, is examined as a conceptual case study. MedResQ serves as an applied example of how AI-driven tools—such as pattern recognition and remote assessment—may support early triage decision-making while maintaining human control over final clinical judgments. This combined analytical approach enables evaluation of both theoretical frameworks and applied system design within disaster medicine.

4. Case Study: MedResQ

To contextualize the potential role of artificial intelligence in disaster triage, this section examines MedResQ, a proposed AI-supported emergency response system, as a conceptual case study. Rather than serving as a validated clinical tool, MedResQ is presented to illustrate how AI-driven decision support may be integrated into established triage frameworks such as START

and SALT while maintaining human clinical oversight. By grounding system design in documented challenges—including delayed situational awareness, responder cognitive overload, and hazardous access conditions—this case study demonstrates how AI technologies may augment, rather than replace, existing disaster triage processes.

4.1 System Overview

MedResQ is a proposed semi-autonomous robotic platform designed to support early search, assessment, and situational awareness in disaster settings. The system is conceptually intended for multi-terrain operation, enabling navigation across land surfaces, shallow water, and aerial environments. This design reflects the unpredictable conditions commonly encountered during natural disasters, where debris, flooding, or structural instability may restrict human access.

To support victim identification, MedResQ integrates a thermal imaging camera capable of detecting heat signatures consistent with human body temperature. Machine learning–based computer vision algorithms are applied to distinguish human heat signatures from non-human environmental sources such as debris, vehicles, or machinery. This selective recognition is intended to reduce false positives and assist responders in locating potential victims more efficiently during the initial response phase.

In addition to visual sensing, MedResQ incorporates ultrasonic distance sensors to support navigation and obstacle avoidance. These sensors emit ultrasonic pulses and calculate distance based on signal return time. Distance data are processed by an onboard central processing unit (CPU), which evaluates whether detected objects fall within predefined proximity thresholds. When obstacles are identified, control signals are transmitted to a motor driver to halt movement

and adjust steering through servo actuation. This closed-loop sensor system enables basic autonomous navigation while maintaining predictable and controlled movement behavior.

4.2 Data Flow and AI-Supported Triage Integration

The primary function of MedResQ within disaster triage is data acquisition and early situational assessment rather than independent clinical decision-making. Thermal imaging data, movement detection, and spatial information are collected and processed in real time to identify potential victims and characterize their location and apparent condition. These data are transmitted to human responders or incident command systems, providing early awareness prior to physical access to the scene.

Within established triage workflows, MedResQ's outputs are intended to support the initial "sort" and "assess" phases of START and SALT triage. For example, identification of ambulatory individuals through movement analysis may assist in preliminary categorization of low-acuity patients, while detection of non-moving heat signatures may flag individuals requiring immediate assessment. Importantly, final triage categorization remains the responsibility of trained clinicians or first responders, with AI functioning solely as a decision-support tool.

4.3 Human Oversight and Decision Control

A central design principle of MedResQ is the preservation of human authority in all clinical decisions. The system does not autonomously assign triage categories or initiate medical interventions. Instead, it provides structured, interpretable information intended to reduce cognitive load and improve situational awareness under time pressure. Human responders retain

full control over triage classification, resource allocation, and treatment decisions, consistent with ethical guidelines for AI use in healthcare.

This human-in-the-loop design mitigates risks associated with algorithmic bias, data uncertainty, and overreliance on automated systems. By positioning AI as an assistive layer rather than a replacement for clinical judgment, MedResQ aligns with current ethical recommendations for responsible AI integration in emergency medicine.

4.4 Hypothetical Disaster Scenario Application

To illustrate potential application, consider a large-scale flood affecting a residential area where rising water and debris restrict ground access. In the early response phase, MedResQ units are deployed to survey the affected zone. Thermal imaging identifies multiple heat signatures within partially submerged structures, while movement analysis distinguishes ambulatory individuals from those who appear immobile. Ultrasonic sensing assists navigation through debris-filled areas.

Data transmitted to responders allow incident commanders to estimate victim numbers, identify high-priority locations, and deploy rescue teams more strategically. Upon arrival, responders apply standard START or SALT triage protocols using direct clinical assessment. In this scenario, MedResQ does not replace triage systems but enhances their effectiveness by enabling earlier, safer, and more informed decision-making.

5. Ethical, Legal, and Clinical Safeguards

The integration of AI into disaster triage introduces significant ethical, legal, and clinical considerations that must be addressed to ensure patient safety and maintain trust in emergency response systems. Because triage decisions directly influence the allocation of limited medical resources, any AI-supported system must be designed with strict safeguards that prioritize human judgment, transparency, and accountability.

One primary ethical concern is algorithmic bias. Machine learning systems trained on limited or non-representative datasets may perform unevenly across populations, potentially disadvantaging certain groups during emergency response. To mitigate this risk, AI components within systems such as MedResQ should be trained on diverse datasets and routinely evaluated for performance disparities. Importantly, MedResQ is conceptualized as a decision-support tool rather than an autonomous decision-maker, reducing the risk that biased outputs directly translate into clinical actions.

Data reliability and uncertainty present additional challenges in disaster environments, where smoke, debris, extreme temperatures, and sensor occlusion may degrade data quality. To address this, MedResQ is designed to provide probabilistic and contextual information rather than definitive classifications. Human responders retain the responsibility to validate AI-generated insights through direct assessment before making triage determinations.

From a legal and clinical perspective, clear accountability structures are essential. MedResQ does not assign triage categories or initiate medical interventions, ensuring that liability remains with trained professionals operating within established protocols such as START and SALT. A human-in-the-loop design, combined with manual override capabilities, prevents overreliance on automated systems and aligns with current ethical guidelines for AI use in healthcare.

By emphasizing transparency, human oversight, and conservative system boundaries, AI-supported tools like MedResQ can be ethically integrated into disaster medicine while preserving the primacy of clinical judgment.

6. Discussion

The integration of AI-assisted systems into disaster triage has the potential to meaningfully improve response time, decrease mortality rates, and early-identification of high-risk patients during mass-casualty accidents. By augmenting traditional triage frameworks such as START and SALT, AI-supported tools may help mitigate the cognitive overload and time pressure that often contribute to triage errors in chaotic disaster environments. In particular, early victim localization, rapid scene assessment, and decision-support analytics can enable responders to allocate limited resources more effectively and prioritize care for those most likely to benefit.

The MedResQ case study illustrates how semi-autonomous robotic platforms could extend these benefits into hazardous or inaccessible environments. By operating across land, water, and air and using sensor fusion—including thermal imaging and ultrasonic distance sensing—MedResQ demonstrates a model in which AI enhances early disaster response without replacing clinician judgment. The system’s design emphasizes preliminary assessment and information relay rather than definitive triage decisions, reinforcing the role of human responders as final decision-makers.

Despite these potential advantages, significant limitations remain. Most existing evidence supporting AI-assisted and drone-enabled triage originates from simulations, retrospective analyses, or small pilot studies rather than large-scale real-world deployments. Environmental variability, sensor failure, and communication disruptions may reduce system reliability during

actual disasters. Additionally, integrating AI-supported tools into established incident command structures requires training, interoperability standards, and clear protocols to prevent workflow fragmentation or overreliance on automated outputs. Importantly, the greatest benefit of AI-assisted triage may not lie in replacing existing frameworks, but in reducing variability introduced by fatigue, stress, and information scarcity—factors repeatedly shown to impair triage accuracy in high-pressure environments.

Future research should focus on prospective field trials, standardized performance metrics, and human–AI interaction studies that evaluate not only accuracy but also usability, trust, and decision-making under stress. Investigating how AI tools perform across diverse disaster types and population contexts will be essential to ensure equitable and scalable implementation.

Overall, AI-assisted triage systems hold promise as force multipliers in disaster medicine when thoughtfully designed, ethically constrained, and clinically supervised. Their success will depend not on replacing human responders, but on strengthening their capacity to make timely, informed decisions in the most demanding circumstances.

7. Conclusion

As natural disasters increase in frequency and severity, emergency response systems face escalating demands that challenge traditional triage practices. In high-pressure, resource-limited environments, even well-established frameworks such as START and SALT are vulnerable to cognitive overload, environmental uncertainty, and delayed situational awareness. Strengthening triage effectiveness is therefore essential to minimizing preventable mortality during mass-casualty incidents.

This paper has argued that AI-assisted decision-support systems can meaningfully enhance triage speed and prioritization accuracy when implemented within a human-in-the-loop framework that preserves clinician authority and ethical safeguards. By augmenting early victim identification, improving situational awareness, and reducing cognitive burden on responders, AI-supported tools such as the conceptual MedResQ platform illustrate how technology may extend—not replace—human clinical judgment.

However, responsible integration remains critical. Ethical oversight, transparency, bias mitigation, and clear accountability structures must guide implementation to prevent overreliance on automated outputs. When thoughtfully designed and carefully deployed, AI-assisted triage systems represent a strategic evolution in disaster medicine—one that combines technological capability with human expertise to support timely, life-saving decisions in the most demanding circumstances.

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