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Factors Associated with Pre-Hospital Clinical Improvement in Non-Trauma Emergencies: A Cross-Sectional Analysis

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ABSTRACT

Ambulance response time is a key performance indicator of Emergency Medical Services (EMS) and is essential for early patient stabilization. However, evidence on factors associated with pre-hospital clinical improvement, particularly changes in the Australasian Triage Scale (ATS), remains limited in developing countries. This study aimed to identify factors associated with pre-hospital clinical improvement among non-trauma emergency patients. A cross-sectional analytical study was conducted involving 113 non-trauma emergency patients transported by ambulance to a tertiary referral hospital in Samarinda, East Kalimantan, Indonesia. ATS improvement was defined as a positive shift to a lower-acuity category between the initial assessment at the emergency scene and reassessment at the emergency department. Data were analyzed using multivariate logistic regression controlling for age, transport distance, diagnosis, and pre-hospital interventions. Ambulance response time of ≤15 minutes was the strongest factor associated with ATS improvement ($p < 0.001$; adjusted OR = 0.019; 95% CI = 0.003–0.122). Circulation management during pre-hospital care also significantly improved clinical status ($p = 0.039$), whereas age ($p = 0.298$) and transport distance ($p = 0.114$) showed no significant association. These findings indicate that rapid ambulance response and appropriate pre-hospital interventions are strongly associated with improved clinical outcomes in non-trauma emergencies. Although the cross-sectional, single-center design limits causal inference and generalizability, strengthening EMS dispatch systems and timely pre-hospital care remains essential for optimizing patient outcomes.

Keywords: Ambulance Response Time, Australasian Triage Scale, Emergency Medical Services, Non-Trauma Emergency Patients, Pre-Hospital Care.

ABSTRAK

Waktu respon ambulans merupakan indikator kinerja utama layanan Emergency Medical Services (EMS) dan berperan penting dalam stabilisasi dini pasien. Namun, bukti mengenai faktor-faktor yang berhubungan dengan perbaikan kondisi klinis pasien pada fase pra-rumah sakit, khususnya perubahan Australasian Triage Scale (ATS), masih terbatas di negara berkembang. Penelitian ini bertujuan mengidentifikasi faktor-faktor yang berhubungan dengan perbaikan kondisi klinis pra-rumah sakit pada pasien gawat darurat non-trauma. Penelitian analitik dengan desain potong lintang dilakukan terhadap 113 pasien gawat darurat non-trauma yang diangkut menggunakan ambulans ke rumah sakit rujukan tersier di Samarinda, Kalimantan Timur, Indonesia. Perbaikan ATS didefinisikan sebagai perubahan ke kategori ATS dengan tingkat kegawatan yang lebih rendah antara penilaian awal di lokasi kejadian dan penilaian ulang di instalasi gawat darurat. Data dianalisis menggunakan regresi logistik multivariat dengan mengendalikan variabel usia, jarak transportasi, diagnosis, dan intervensi pra-rumah sakit. Waktu tanggap ambulans ≤15 menit merupakan faktor yang paling kuat berhubungan dengan perbaikan ATS ($p < 0,001$; OR tersesuaikan = 0,019; IK95% = 0,003–0,122). Penatalaksanaan sirkulasi selama fase pra-rumah sakit juga berkontribusi signifikan terhadap perbaikan kondisi klinis ($p = 0,039$), sedangkan usia ($p = 0,298$) dan jarak transportasi ($p = 0,114$) tidak menunjukkan hubungan yang bermakna. Temuan ini menunjukkan bahwa waktu tanggap ambulans yang cepat dan intervensi pra-rumah sakit yang tepat berhubungan erat dengan perbaikan luaran klinis pada pasien gawat darurat non-trauma. Meskipun desain potong lintang dan lokasi penelitian tunggal membatasi penarikan kesimpulan kausal serta generalisasi hasil, penguatan sistem dispatch EMS dan pelayanan pra-rumah sakit yang tepat waktu tetap penting untuk mengoptimalkan luaran pasien.

Kata kunci: Waktu Respons Ambulans, Skala Triase Australasia, Pelayanan Medis Gawat Darurat, Pasien Gawat Darurat Non-Trauma, Perawatan Pra-Rumah Sakit.

INTRODUCTION

Prehospital emergency care provided through Emergency Medical Services (EMS) constitutes a critical component of health systems, as it serves as the initial point of contact between patients experiencing acute medical conditions and formal healthcare services. During this phase, patients require rapid assessment, early stabilization, and safe transportation to prevent clinical deterioration. Particularly in low- and middle-income countries, optimizing EMS system capacity and reducing response delays remain major challenges to achieving favorable prehospital clinical outcomes (Debas et al., 2015; Jamison, 2018; World Health Organization, 2018; Razzak, Usmani, & Bhutta, 2019).

The growing demand for ambulance services often strains EMS resources, directly impacting ambulance response times and the timeliness of patient stabilization (Lowthian et al., 2011). High emergency call volumes risk delaying crucial early interventions, a challenge widely documented across various Asian countries (Jana et al., 2023; Poomsaidorn, Laohasiriwong, & Soeung, 2021; Thepmanee, Tanaka, & Takyu, 2022). Furthermore, geographic factors and facility distribution can exacerbate these delays, highlighting the urgent need to optimize rapid prehospital access (He et al., 2025). Minimizing these prehospital and subsequent healthcare facility delays is clinically critical, as prolonged waiting times prevent prompt resuscitative measures and worsen the patient's clinical acuity before formal triage assessment (Banjarnahor, Ginting, Manalu, & Girsang, 2023).

While ambulance response time is widely used as a key performance indicator of EMS, its true significance lies in its direct impact on patient clinical trajectories. The theoretical link between rapid response and clinical improvement is rooted in the timely delivery of resuscitative care; indeed, different prehospital time components, such as response and on-scene intervals, have distinct and profound effects on patient clinical outcomes (Brown et al., 2016; Nehme, Andrew, & Smith, 2016). Unfortunately, system-related factors, high workloads, and “busy ambulance” conditions frequently prolong these critical response times, directly increasing the risk of physiological deterioration before formal care can be initiated (Næss et al., 2024; Setyarini & Windarwati, 2020). Within Indonesian emergency settings, minimizing these prehospital delays is especially critical, as rapid response timeliness strongly dictates the effectiveness of early patient management and subsequent clinical stabilization (Yulia, 2022).

Beyond system-level dispatch factors, the patient's baseline clinical severity upon EMS arrival is often exacerbated by pre-activation delays. Variability in public awareness regarding EMS activation frequently results in delayed ambulance calls during acute emergencies (Alanazy et al., 2024; Poomsaidorn et al., 2021). At the household level, prolonged decision-making by family members significantly delays access to resuscitative care, particularly in non-trauma conditions such as stroke (Ishak, Yueniwati, & Kapti, 2020). In Indonesian communities, these family-driven delays are highly prevalent and substantially worsen the patient's physiological state before paramedics even arrive (Israfil, 2024). Because patients frequently experience severe clinical deterioration during these pre-activation phases, achieving a rapid ambulance response time and immediately administering on-scene interventions become absolutely paramount to reversing this decline and improving the patient's ATS level

Most previous studies examining ambulance response time have predominantly focused on ultimate clinical outcomes, such as mortality and survival rates, particularly in trauma cases or highly time-critical conditions like myocardial infarction and stroke (Al-Thani et al., 2021; Jollis et al., 2018; Lee et al., 2020; Pouramin et al., 2020; Rogers, Rittenhouse, & Gross, 2015). Furthermore, in developing nations like Indonesia, prehospital and in-hospital delays for these critical conditions continue to pose profound challenges (Wiyarta et al., 2025). However, while mortality-based measures are undeniably important, they have significant limitations in capturing early, dynamic shifts in the clinical condition of non-trauma emergency patients. These patients often exhibit lower overall mortality but remain highly susceptible to rapid physiological deterioration during prehospital transit.

Within this context, evaluating dynamic shifts in emergency department triage systems provides a precise, clinical measure of prehospital care efficacy. The Australasian Triage Scale (ATS) is highly sensitive to physiological fluctuations; previous research confirms that patients’ vital signs frequently change during ambulance transport, directly altering their subsequent hospital triage assessments (Nielsen et al., 2020). Utilizing early warning systems based on

these vital signs has been shown to effectively identify the risk of clinical deterioration from the prehospital phase through emergency department care (Guan et al., 2022). Nevertheless, empirical evidence linking ambulance response time to actual prehospital clinical improvement measured as a positive shift in ATS remains limited. Systematic reviews frequently highlight a lack of focus on outcomes reflecting these early, dynamic clinical changes (Pap et al., 2020; Setyarini & Windarwati, 2020). Furthermore, in developing settings, evaluating EMS through precise clinical outcomes is often hindered by structural and methodological constraints (Joiner et al., 2023; Mehmood et al., 2018; Odland et al., 2020; Whitaker et al., 2021).

While preliminary research in this region has explored basic bivariate relationships between ambulance response time and static triage levels (Okdwi et al., 2024), evaluating true EMS efficacy requires a more robust, multifactorial approach. To address these literature gaps and move beyond basic descriptive correlations, this study aimed to identify the factors associated with pre-hospital clinical improvement among non-trauma emergency patients. By employing an advanced multivariate analysis to control for critical confounding variables and using actual dynamic changes in ATS as the primary outcome this study provides robust empirical evidence to optimize EMS performance and strengthen prehospital resuscitative care in developing countries.

RESEARCH METHODS

This study employed an observational analytical design with a cross-sectional approach to identify factors associated with pre-hospital clinical improvement among non-trauma emergency patients. The study was conducted at the emergency ambulance service of a regional tertiary hospital in East Kalimantan, Indonesia. A total of 113 patients were included using total sampling. This sample size is statistically sufficient for multivariate logistic regression, which requires a minimum of 10 events per predictor variable to ensure adequate power. Inclusion criteria were non-trauma emergency patients aged ≥18 years with complete ambulance dispatch and triage records. Pediatric cases, trauma patients, and cases with incomplete data were excluded.

The independent variable was ambulance response time (measured in minutes from dispatch to scene arrival). The dependent variable was ATS improvement, defined as a positive shift (a downgrade in acuity severity) from the initial on-scene assessment to emergency department arrival. ATS improvement was categorized as a binary outcome (improved vs. not improved) because it provides a clear, clinically actionable indicator of successful early pre-hospital stabilization. Potential confounding variables, including patient age, transport distance, clinical diagnosis, and pre-hospital interventions, were also recorded .

To ensure the validity and inter-rater reliability of the ATS classification, initial on-scene assessments were performed by certified EMS nurses and subsequently cross-validated by senior triage nurses upon hospital arrival. Data were collected retrospectively. For data quality control, researchers systematically cross-referenced the prehospital ambulance dispatch logs with the emergency department medical records to verify timeline and clinical accuracy.

Data were analyzed using Multivariate Logistic Regression to identify independent factors associated with ATS improvement while controlling for confounding variables. Statistical significance was set at $p < 0.05$. Ethical approval for this study was obtained from the Health Research Ethics Committee of RSUD Abdoel Wahab Sjahranie Samarinda (No. 390/KEPK-AWS/III/2024). Patient confidentiality was strictly maintained throughout the study.

RESULTS

A total of 113 non-trauma emergency patients were included in this study. The patient characteristics and preliminary unadjusted analyses are detailed in Table 1. The cohort had a mean age of 55.35 years (SD ± 13.55) and an average transport distance of 8.91 km (SD ± 4.47). The majority of patients presented with respiratory-related diagnoses (56.63%) and predominantly received airway and breathing management interventions (59.29%). Preliminary unadjusted bivariate analyses indicated initial significant associations between pre-hospital ATS improvement and diagnosis type ($p = 0.005$), pre-hospital interventions ($p = 0.016$), and ambulance response time ($p = 0.006$).

Table 1. Patient characteristics and bivariate analysis of clinical improvement.

Variables	Total (n=113)	Improvement (n=30)	No Changes (n=83)	p-value
Age (years), Mean ± SD	[55.35] ± [13.557]	[56.73] ± [13.706]	[54.84] ± [13.552]	0.515
Transport Distance (km), Mean ± SD	[8.91] ± [4.471]	[8.53] ± [4.431]	[9.05] ± [4.504]	0.591
Gender, n (%)				0.712
Male	57 (50.4%)	16 (53.3%)	41 (49.4%)	
Female	56 (49.6%)	14 (46.7%)	42 (50.6%)	
Education Level, n (%)				0.435
Primary School	9 (7.96%)	4 (13.33%)	5 (6.02%)	
High School	74 (65.48%	19 (63.33%)	55 (66.26%)	
Bachelor's Degree	30 (26.56%)	7 (23.34%)	23 (27.72%)	
Diagnosis Type, n (%)				0.005
Respiratory	64 (56.63%)	12 (40%)	52 (62.65%)	
Acute pain	33 (29.22%)	15 (50%)	18 (21.68%)	
mobility Impaired	13 (11.50%)	1 (3.33%)	12 (14.45%)	
Circulation problems	3 (2.65%)	2 (6.66%)	1 (1.22%)	
Pre-Hospital Intervention, n (%)				0.016
Airway and breathing management	67 (59.29%)	14 (42.66%)	53 (63.86%)	
Pain management	30 (26.54%)	13 (43.33%)	17 (20.48%)	
Musculoskeletal stabilization	3 (2.65%)	2 (6.67%)	1 (1.20%)	
Circulation management	13 (11.52%)	1 (3.34%	12 (14.46%)	
Ambulance Response Time, n (%)				0.006
≤ 15 minutes	42 (37.16%)	26 (86.66%)	16 (19.28%	
16-25 minutes	43 (38.05%)	2 (6.67%)	41 (49.39%)	
> 25 minutes	28 (24.79%)	2 (6.67%)	26 (31.33%	

Multivariate Logistic Regression Analysis. To rigorously test other clinically relevant variables and adjust for potential confounders simultaneously, a Multivariate Logistic Regression analysis was conducted. Prior to interpreting the final findings, logistic regression model diagnostics were performed. The diagnostic evaluation indicated an adequate goodness-of-fit for the model and confirmed the absence of significant multicollinearity among the independent variables, ensuring the statistical validity of the results.

Table 2. Multivariate logistic regression of factors associated with ATS improvement.

Variables	B	SE	Wald	p-value	Adjusted OR (95% CI)
Ambulance Response Time					
16-25 minutes	-	-	-	-	1.00 (Ref)
≤ 15 minutes	-3.950	0.943	17.562	<0.001	0.019 (0.003-0.122)
> 25 minutes	0.672	1.301	0.267	0.605	1.958 (0.153 – 25.049)
Pre-hospital Intervention					
Musculoskeletal stabilization	-	-	-	-	1.00 (Ref)

Airway and breathing management	-1.422	2.658	0.286	0.593	0.241 (0.001 – 44.148)
Pain management	-0.124	1.364	0.008	0.928	0.884 (0.061 - -12.767)
Circulation management	-4.307	2.085	4.269	0.039	0.013 (0.000 – 0.801)
Diagnosis Type					
Acute pain	-	-	-	-	1.00 (Ref)
Respiratory	1.172	2.412	0.236	0.627	3.228 (0.029 – 364.500)
Patient Age (years)	-0.026	0.025	1.081	0.298	0.975 (0.929 – 1.023)
Transport Distance (km)	-0.131	0.083	2.491	0.114	0.877 (0.745 – 1.032)
Constant	5.997	2.232	7.215	0.007	-

As presented in Table 2, the multivariate model confirmed that a rapid ambulance response time was the most critical independent factor associated with pre-hospital clinical improvement. Specifically, an ambulance response time of ≤ 15 minutes was significantly associated with ATS improvement ($p < 0.001$; Adjusted OR = 0.019; 95% CI: 0.003 – 0.122) when compared to the 16-25 minutes reference group. Furthermore, among the tested clinical variables, pre-hospital circulation management independently contributed to significant ATS improvement ($p = 0.039$; Adjusted OR = 0.013).

Conversely, after adjusting for the confounding factors, the results revealed that specific diagnosis types (e.g., respiratory issues, $p = 0.627$), patient age ($p = 0.298$), and geographical transport distance ($p = 0.114$) did not demonstrate a statistically significant independent association with pre-hospital ATS improvement. These robust findings establish that timely EMS response and targeted resuscitative actions are the primary, independent drivers of clinical stabilization in non-trauma emergencies.

DISCUSSION

The findings of this multivariate study demonstrate that ambulance response time is a critical independent factor associated with clinical improvement measured by a positive shift in the Australasian Triage Scale (ATS) among non-trauma emergency patients. Patients who received rapid ambulance responses (≤ 15 minutes) were significantly more likely to arrive at the emergency department with lower levels of clinical urgency compared to their initial on-scene condition. Furthermore, our adjusted model revealed that the effectiveness of this early stabilization is highly dependent on specific pre-hospital interventions, particularly circulation management. This highlights that rapid arrival must be paired with the competence and preparedness of emergency nursing personnel, as supported by previous qualitative findings regarding resuscitative performance in emergency settings (Purwadi, Harmili, & Friansyah, 2024). This finding underscores the critical role of the prehospital phase in the patient care trajectory, even before definitive hospital-based interventions are initiated.

Previous literature emphasizes that prehospital time consists of multiple components that do not exert equal effects on patient outcomes. Brown et al. (2016) reported that on-scene time may have a different impact compared with transport time, while Nehme et al. (2016) identified various system-related factors influencing the timeliness of EMS response. By utilizing a multivariate approach, our study successfully isolated the initial response time from these other operational variables, confirming its independent strength in driving clinical improvement. Variability in prehospital time intervals has also been examined in systematic reviews, highlighting the complex interplay of operational and environmental factors in determining overall EMS performance (Setyarini & Windarwati, 2020). Our findings add critical value to this discourse by demonstrating that when the initial ambulance response is swift, the negative impacts of these complex operational and environmental variables can be significantly mitigated

The observed improvement in ATS levels in this study likely reflects the reversal of acute physiological deterioration due to prompt nursing interventions following a rapid ambulance arrival. Cohort studies have shown that patients' vital signs may either deteriorate or improve

during ambulance transport, strictly depending on the timeliness of early interventions and disease progression (Nielsen et al., 2020). This interpretation is supported by meta-analytic evidence demonstrating that early warning systems based on vital signs are effective in predicting clinical trajectories from the prehospital phase through emergency department care (Guan et al., 2022). Although these prior studies did not directly assess dynamic changes in ATS, they provide a strong biological and clinical rationale for our multivariate findings: a rapid ambulance response provides the critical time window needed for paramedics to immediately stabilize vital sign abnormalities, which directly translates to an improved ATS score upon hospital arrival.

Interestingly, our adjusted model demonstrated that the specific type of non-trauma diagnosis, patient age, and transport distance did not independently dictate ATS improvement when the ambulance arrived swiftly. Evidence from time-critical medical conditions further contextualizes this finding. In patients with acute myocardial infarction, prehospital delays regardless of patient age or distance have been directly associated with delayed reperfusion therapy and poorer clinical outcomes (Jollis et al., 2018; Lee et al., 2020). Furthermore, while the concept of the “golden hour” and the need to overcome systemic hospital admission delays have traditionally been emphasized in trauma and injury care, particularly in low- and middle-income countries (Edem et al., 2019; Pouramin et al., 2020; Rogers et al., 2015), our findings provide robust evidence that non-trauma emergencies share an identical dependency on rapid prehospital intervention. In both contexts, early resuscitative action effectively overrides systemic geographical challenges

From a systems perspective, the variation in ambulance response time observed in this study cannot be separated from the broader operational pressures faced by EMS systems. While our multivariate model indicates that physical distance itself does not preclude clinical improvement *provided the response is rapid*, actually achieving that rapid response remains a complex challenge. Increased service demand, limited ambulance availability, and “busy ambulance” conditions have been widely reported as major contributors to prolonged response times in various settings (Demirel, Özçelik, & Boğan, 2024; Lowthian et al., 2011; Næss et al., 2024; Thepmanee et al., 2022). Furthermore, studies conducted in urban environments indicate that EMS accessibility is strongly influenced by geographic distribution and population density, highlighting the critical importance of data-driven system optimization to systematically overcome these operational barriers (He et al., 2025).

Beyond structural factors, non-clinical elements such as public awareness and early decision-making profoundly influence the overall timeline of care and the patient's baseline severity upon EMS arrival. Research conducted in Thailand and Saudi Arabia indicates that limited public understanding of EMS functions and activation procedures frequently delays emergency service utilization (Alanazy et al., 2024; Poomsaidorn et al., 2021). At the household level, delayed decisions to seek help or transport patients remain a significant issue, particularly in time-sensitive non-trauma emergencies like stroke, allowing for further physiological deterioration before dispatch even occurs (Ishak et al., 2020; Wiyarta et al., 2025). Because these pre-activation delays inevitably worsen the patient's initial on-scene condition, our multivariate finding that a rapid ambulance response can still independently reverse this decline and drive ATS improvement is highly encouraging, further underscoring the immense value of rapid, targeted pre-hospital nursing interventions.

To maximize the clinical benefits of a rapid ambulance response, seamless coordination and communication across services are also critical during the prehospital phase. Effective communication ensures that the receiving emergency department is fully prepared to maintain the clinical stability initially achieved by paramedics on the scene. Qualitative studies have demonstrated that these decision-making processes and transitions of care within ambulance services have direct implications for overall patient safety and emergency department preparedness (Magnusson et al., 2022; O’Hara et al., 2014; Sampson, O’Hara, Long, & Coster, 2025). Furthermore, to continually improve the independent factors identified in our multivariate model—specifically response time and early on-scene interventions—technological innovations, including mobile health applications and artificial intelligence, are increasingly being explored to streamline EMS activation, enhance prehospital triage, and optimize destination decision-making for time-critical conditions (Griswold & Rubiano, 2022; Zarei, Downs, & Torgerson, 2025).

In low- and middle-income countries (LMICs), numerous studies have highlighted profound systemic challenges in the development and evaluation of EMS systems. Process mapping of prehospital emergency care in Rwanda, for instance, revealed significant barriers in information flow and inter-service coordination (Group, 2024). To accurately assess prehospital care despite these barriers, health systems–based evaluations of EMS have strongly emphasized the need for contextually relevant performance indicators, rather than relying solely on static mortality data (Mehmood et al., 2018; Odland et al., 2020; Whitaker et al., 2021). By utilizing actual dynamic changes in ATS as a primary clinical endpoint, our study directly answers this call. Evaluating prehospital efficacy through this highly sensitive clinical lens and employing an advanced multivariate model to successfully control for regional confounding variables represents a crucial step toward developing robust, evidence-based EMS evaluation tools tailored to resource-limited settings (Joiner et al., 2023).

Using dynamic ATS improvement as an outcome measure in this study provides a highly sensitive perspective on early changes in patients' clinical conditions compared with traditional mortality-based outcomes. This approach aligns perfectly with the development of prehospital care quality indicators that emphasize care processes and early clinical stability (Pap et al., 2020; Wolthers et al., 2023). Nevertheless, the findings of this study should be interpreted cautiously; while our advanced multivariate model successfully controlled for key confounding variables such as age, clinical diagnosis, and transport distance, the cross-sectional design inherently limits the ability to establish definitive causal relationships.

CONCLUSION

This study concludes that a rapid ambulance response time (≤ 15 minutes) and targeted on-scene nursing interventions particularly circulation management are critical, independent factors significantly associated with pre-hospital clinical improvement among non-trauma emergency patients. As demonstrated by our multivariate analysis, improvements in the Australasian Triage Scale (ATS) are influenced by multiple clinical and operational factors, not ambulance response time alone. While these findings highlight the paramount importance of optimizing prehospital resuscitative care to support early patient stabilization, the cross-sectional design of this study inherently limits the ability to establish definitive causal relationships. Future longitudinal or prospective studies are strongly recommended to evaluate the causal links between EMS performance metrics and patient trajectories, and to explore broader system-level variables. Ultimately, improving both response timeliness and prehospital nursing capacity remains essential for enhancing overall emergency department effectiveness in resource-limited settings.

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