

The Role Of Ambulance Transport And Paramedics In Enhancing Emergency Care Outcomes For Patients Considering Advances In Modern Healthcare Technology

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ABSTRACT

The issue of technology saturation in healthcare facilities has introduced a sharp sense of digital disconnection between pre-hospital emergency and hospital services, thus creating a disjointed continuum that may compromise patient outcomes. It was therefore the aim of the current study to determine the beneficial effect of ambulance-based technology and paramedic practice on clinical outcomes in patients presenting with time-threatening conditions quantitatively. The study used a mixed-methods explanatory sequential design that entailed the use of a retrospective analysis of 421 patients with a diagnosis of ST-elevation myocardial infarction (STEMI), stroke, or major trauma, followed by semi-structured interviews of 18 paramedics and physicians to explain the occurrence of the event. The quantitative part showed that the better Technology Use Score was, the higher the predictability of lower door-to-intervention time (B -1/6 -89min/score point, p -1/0.001) and higher chance of the correct pre-hospital alert (adjusted odds ratio 1.92, 95 per cent confidence interval 1.52, 2.42). Besides, members of the High-Technology group had significantly reduced median hospitalization (5 days vs. 9 days, p <.001), and a reduced 30-day mortality (5.2 vs. 18.3, p <.001) than did the members of the Low-Technology group. There was a strong positive relationship between the use of technology and the use of paramedic protocols (r = 0.58, p < 0.001). These results provide strong grounds to believe that the modern ambulance as a technologically advanced mobile clinical platform is a crucial part of a continuum of care.

Keywords: Emergency Medical Services, Health Technology, Paramedic, Patient Outcomes, Pre-Hospital Care.

INTRODUCTION

Emergency medical services have fundamentally changed to become a continuum of care that starts at the emergency call and that integrates an array of interventions. As a result, the ambulance is reformulated as a mobile clinical platform, and the paramedic is re-established as an advanced practitioner who is placed at the intersection point between pre-hospital systems and in-hospital systems [1]. They have become the crunch, mobile-first, component of the sophisticated care network, where the first minutes of care can predetermine patient courses irreversibly. This change is discussed

by the explosive introduction of modern technologies in health facilities, such as advanced imaging suites, electronic health records (EHRs), and expedited intervention pathway options in time-sensitive

diseases, such as ST-elevation myocardial infarction (STEMI) and acute stroke [2]. However, there remains a critical issue, namely, the likelihood of a digital disconnection between the pre-hospital setting and the incoming emergency department. This study explored the role of ambulance transport and paramedics in better patient outcomes through the narrowing of this gap, in particular by looking at how modern technology can be used to bridge this gap and turn the pre-hospital phase of care into a data-rich, but part of the definitive care [3,4].

The issue of integrating cutting-edge technologies in its operations is one that emergency medical services (EMS) systems are struggling with in the global context. In advanced countries, the adoption of STEMI patients receiving pre-hospital 12-lead electrocardiograms (ECGs) is a model success that proves that the transfer of diagnostic information to a hospital waiting electronically can significantly shorten the door-to-balloon time and increase the survival rate [5]. Equally, point-of-care testing (POCT) and telemedicine in mobile units are being investigated in conditions such as trauma to sepsis. At a regional level, in our local context, major investments have been made in furnishing life support ambulances with such technologies, as well as the installation of special hospital alert systems [6]. The complete range of their effects has not been well measured despite these developments. The literature is also full of research on single technologies, although there is no real understanding of how a combination of technologies, as well as an improvement of paramedic protocols, can impact the whole chain of survival [7].

The literature available gives a strong but partial image. Several research works have identified a linkage between particular pre-hospital care, including superior airway care or infusion of intravenous fluids, and patient outcomes [8]. Moreover, systematic reviews have recognized the theoretical advantage of such technologies as pre-hospital telemedicine, especially in rural areas. Nonetheless, there is a large research gap in the empirical association of these technology integrations with any measurable change in care efficiencies and patient outcomes in integrated, urban EMS [9]. Most of the research has been limited to a single disease process or a single technological device, as opposed to the real-world situation where a complex interaction between various devices, the paramedics operating them, and the hospital systems receiving the data exists [10]. This presents a knowledge gap that is critical to EMS administrators and other health policymakers who need to make evidence-based decisions on the expensive technological investments and training programs. It is no longer asking about the effectiveness of a given technology in the vacuum but how it operates within the context of a socio-technical system to improve the delivery of overall emergency care [11].

Thus, the necessity of this study was obvious. The purpose of the study was to go beyond the siloed assessments and give a comprehensive analysis of the modern ambulance as a technologically advanced mobile clinical platform [12]. The key issue that was to be tackled was the lack of evidence regarding the direct impact of the synergistic application of ambulance-based technologies and specific paramedic training on the efficiency and effectiveness of the ensuing in-hospital emergency care of a range of critical conditions [13]. This study aimed to address this gap not only by quantifying the benefits of the implementation carried out in terms of time and clinical outcomes but also by clarifying the human factors on which successful implementation depends [14].

In this respect, the research was informed by a set of clear objectives, which guided its clear methodology. The main aim was to determine how particular technologies in the form of transmitted 12-lead ECGs and video laryngoscopy, using the ambulances, influenced essential time-to-intervention indicators in patients with STEMI, stroke, and major trauma [15]. This required a strong quantitative method to examine hard data from patient records. The second was to determine the impact of advanced paramedic training on the validity of pre-hospital diagnosis and hospital pre-alerts suitability, which necessitated an examination of the protocol performance and its results [16]. The third goal was to determine the perceived obstacles and facilitators to the unimpeded interfacing of pre-hospital data with hospital EHRs, which required a qualitative investigation to record the subtle frontline clinician experiences [17]. As a result, the research questions were complex, with the following being: How can the use of certain pre-hospital technologies decrease the times to intervention? What is the relationship between paramedic protocol compliance and the quality of

handover and hospital preparedness? What are the operational and technical challenges perceived by paramedics and emergency physicians as the main in ensuring a smooth data integration?

METHODOLOGY

The research design adopted in the study was a mixed-method, explanatory sequential research design because it aims at investigating how ambulance transport and paramedics can be utilized to improve emergency care outcomes using modern technology. The study took place in the integrated emergency medical service (EMS) system of a large metropolitan region, which comprised advanced life support (ALS) units and two of their primary tertiary care hospitals. Three objectives guided the study: (1) to determine the effect of certain ambulance technologies on time-restricted patient outcomes; (2) to determine the effect of paramedic training on diagnostic accuracy; and (3) to determine barriers and facilitators to data integration in the eyes of clinicians.

The first quantitative stage was a retrospective cohort investigation of patients with ST-elevated myocardial infarction (STEMI), acute ischemic stroke, or major trauma, who were transported within three years. The design was chosen to objectively examine the association between the use of technology and hard clinical endpoints in a large sample. In the electronic patient care records (ePCRs), a power analysis (G*Power, $f^2 = 0.15$, $\alpha = 0.05$, power = 0.80) was used to obtain a sample of 421 cases of patients to represent a robust statistical inference. Inclusion criteria required the presence of complete ePCR and in-hospital electronic health record data of adults (18 years or older) with the given conditions, but not pre-hospital deaths and inter-facility transfers. These variables were abstracted on a standardized, pre-piloted form to gather variables such as timestamps, use of pre-hospital technologies (e.g., 12-lead ECG transmission), and outcome measures (e.g., door-to-balloon time).

The next qualitative step involved the use of semi-structured interviews to provide explanations for the quantitative discoveries. The participants were 18 purposely selected (10 paramedics and 8 emergency physicians) at the time of complete data saturation. This step was necessary in order to situate the numerical data, to investigate the human element behind the adoption of technology and its interoperability. Individual interview guides were prepared to examine the usability, the influence of the tool on decision making, and interagency communication.

Operationally defined key variables were measured. The independent variable was the use of technology in the form of Ambulance Technology, which was established as the use of a particular device during patient care. The dependent variable was Emergency Care Efficiency, whereby the time in minutes between emergency department arrival and a significant intervention was used. There was also a composite score of Paramedic Protocol Adherence. There was a high inter-rater reliability of the data abstraction form (Cohen's kappa=0.89), and the interview guides were reviewed by an expert panel in emergency medicine.

Analysis of quantitative data was done to analyze using SPSS Statistics (Version 28.0). Descriptive statistics were calculated, and multiple linear regression analyses were done to determine the relationship between time-to-intervention and technology use, with confounding factors including patient age and time of the day. The method was selected due to its capability to separate the influence of the predictor variables. Thematic analysis was used to analyze qualitative data presented as the transcribed interviews based on the framework of Braun and Clarke (2006) to recognize, interpret, and report the patterns in the data.

The Institutional Review Board in question gave ethical approval. In the retrospective component, the anonymized data were waived. Written informed consent was given by all the participants in the interview. The data was stored confidentially by means of de-identifying and using a secure, encrypted storage. The major weakness was information bias that could have come up due to retrospective chart reviews, which was avoided by standardized abstraction instructions and training. Moreover, the research study in one developed system of EMS could have influenced the applicability of results to less-resourced systems, which is why it could be recommended that a multi-center study

be done in the future. In spite of these shortcomings, the methodological design was a rigorous and replicable method of tackling the complicated interrelationship of technology, pre-hospital care, and patient outcomes.

RESULTS

3.1. Cohort Characteristics and Univariate Analysis.

The analyzed cases of patients totaled 421, including 158 (37.5 percent) with ST -elevation myocardial infarction (STEMI), 137 (32.5 percent) with an acute stroke, and 126 (29.9 percent) with a major trauma. Table 1 contains the baseline characteristics and univariate outcomes of the cohort stratified by the condition of the patient.

There were considerable variations in demographic and clinical profiles among the groups of patients. Mean age of the participants was 61.4 14.8 years old and stroke patients were much older (68.5 11.3 years old) and major trauma patients were much younger (55.1 16.5 years old) ($p = 0.001$). The total cohort comprised 43.7 -percent female, and the proportion of females was lower in the STEMI (32.9 -percent) group compared to the stroke (49.6 -percent) and trauma (50.8 -percent) groups ($p = 0.002$). There were significant differences in pre-hospital care measures depending on condition. The highest mean Technology Use Score (3.8 ± 0.9) and Protocol Adherence (85.3 235.0) were noted in STEMI patients with the lowest scores recorded in major trauma patients (2.5 205.0) of the same. Pre-hospital alerts were most accurate in STEMI patients (81.0 -1 correct), intermediate in stroke patients (69.3 -1 correct), and also least in major trauma patients (50.8 -1 correct) ($p = 1$ less than 0.001).

The outcome measures in the hospital also varied. The mean door-to-intervention time was the shortest with STEMI patients (65.4-18.2-minutes), then stroke patients (81.3-22.1-minutes) and major trauma patients (92.7-26.5-minutes) (p -value was less than 0.001). STEMI patients shortest (median of 4 days, IQR of [3, 5]) followed by stroke patients (median of 7 days, IQR of [5, 9]) and finally major trauma patients (median of 11 days, IQR of [8, 15]) had the shortest and longest hospital length of stay respectively. The overall 30-day mortality rate was 11.4 -1 in the whole group, 7.0 -1 in the STEMI group and 17.5 -1 in the major trauma group ($p = 0.016$).

3.2. Effects of Technology and Protocol Adherence on Door to Intervention Time.

A multiple linear regression model was set up to determine what factors predict door-to-intervention time with age, sex and condition of the patient put in control (Table 2). The model was significant ($F(6,414) = 50.15$, $p = 0.001$) and accounted 41 2 of the door to intervention time (Adjusted $R^2 = 0.41$).

The two important independent variables had a significant and negative relationship with door-to-intervention time. A increased Technology Use Score was linked to a large decrease in time to intervention ($B = -6.89$, $0.347 = -0.347$, $p < 0.001$). On the same note, Protocol Adherence was also independently related to shorter intervention times ($B = -, 0.52$, 0.251 , $p < 0.001$). Both stroke ($B = -9.85$, $p < 0.001$) and major trauma ($B = -18.24$, $p = -0.001$) were characterized by significantly more prolonged door-to-intervention times as compared to the reference condition (STEMI). Age and sex of patients were not much predictors in this model.

3.3. Prognosticators of Accurate Pre-Hospital Alert

To determine the influence of technology use, protocols adherence, and patient condition on the probability of a correct pre-hospital alert, a binary logistic regression was conducted (Table 3). The model was also a strong predictor of alert accuracy (Nagelkerke $R^2 = 0.28$) and had a good fit to the data (HosmerLemeshow $C^2 = 6.12$, $p = 0.634$).

The findings showed that the adjusted odds of having a correct pre-hospital alert had risen by 92 percent (aOR=1.92, 95 percent CI of 1.522.42, $p = 0.001$) with every one-point rise in the Technology Use Score. Moreover, the likelihood of an appropriate alert was raised by 5 per cent with every 1 per cent rise in Protocol Adherence (aOR = 1.05, 95 per cent CI 1.03, 1.07, $p < 0.001$). Patient condition also proved a major predictor; patients with stroke (aOR=0.42, 95%CI= [0.25,0.71], $p = 0.001$) and

major trauma (aOR= 0.24, 95%CI= [0.14,0.41], p=0.001) were also significantly less likely to receive a correct alert.

3.4. Correlation of Technology use and patient-centered outcomes.

There was a comparative analysis of clinical outcomes in patients who belonged to High-Technology (Score = 4 -5, n=172) and Low-Technology (Score = 1-2, n=131) groups (Table=4). High-Technology group recorded a much lower median length of stay in hospitals (5 days, IQR [3, 7]) in comparison to the Low-Technology one (9 days, IQR [6, 13]) (MannWhitney U 16234, p 0.001). The mortality rate of the High-Technology group was 5.2 per cent (9 deaths) as compared to the death rate of 18.3 per cent (24 deaths) of the Low-Technology group (2).

3.5. Technology Use and Paramedic Protocol Adherence correlation.

One-way ANOVA indicated the statistically significant difference in the mean scores of Protocol Adherence in the five Technology Use Score groups (F (4,416) = 35.44, p = 0.001). These distinctions were defined by post-hoc analysis in terms of Tukey HSD (Table 5). It was found that there was a pattern of increasing protocol adherence with technology use, which was overall monotonic in nature. The technology group with less intensive adherence (Scores 12) to the more intensive one (Scores 35) showed significant jumps in adherence. As an example, the mean adherence of Score 1 (Very Low) was 18.42 percentage points below the means adherence of Score 4 (High) (p < 0.001). The statistical significance of the difference between Score 4 (High) and Score 5 (Very High) was not significant (p = 0.168).

This relationship was also positive, with a Pearson correlation analysis (Table 6) indicating that Technology Use Score has a strong and positive correlation with Protocol Adherence (r = 0.58, p = 0.001). The use of technology was also negatively correlated with both door-to-intervention time (r = -0.51, p= - 0.001) and length of stay in the hospital (r = -0.42, p= - 0.001).

Table 1: Baseline Characteristics and Clinical Outcomes of the Study Cohort Stratified by Patient Condition

Variable	Total Cohort (n=421)	STEMI Patients (n=158)	Stroke Patients (n=137)	Major Trauma Patients (n=126)	p-value
Demographics					
Age, years (Mean ± SD)	61.4 ± 14.8	59.2 ± 12.1	68.5 ± 11.3	55.1 ± 16.5	<0.001
Sex, Female (n, %)	184 (43.7%)	52 (32.9%)	68 (49.6%)	64 (50.8%)	0.002
Pre-Hospital Care Metrics					
Technology Use Score (Mean ± SD) †	3.2 ± 1.3	3.8 ± 0.9	3.1 ± 1.1	2.5 ± 1.5	<0.001

Variable	Total Cohort (n=421)	STEMI Patients (n=158)	Stroke Patients (n=137)	Major Trauma Patients (n=126)	p-value
Protocol Adherence, % (Mean $\pm$ SD)	80.1 $\pm$ 12.5	85.3 $\pm$ 8.4	81.5 $\pm$ 10.2	71.8 $\pm$ 14.9	<0.001
Pre-Hospital Alert Accuracy, Correct (n, %)	287 (68.2%)	128 (81.0%)	95 (69.3%)	64 (50.8%)	<0.001
Hospital Outcomes					
Door-to-Intervention, mins (Mean $\pm$ SD)	78.5 $\pm$ 25.9	65.4 $\pm$ 18.2	81.3 $\pm$ 22.1	92.7 $\pm$ 26.5	<0.001
Hospital Length of Stay, days (Median [IQR])	6 [4, 10]	4 [3, 5]	7 [5, 9]	11 [8, 15]	<0.001 *
30-Day Mortality, (n, %)	48 (11.4%)	11 (7.0%)	15 (10.9%)	22 (17.5%)	0.016

Statistical Tests: One-Way ANOVA (Age, Tech_Use_Score, Protocol Adherence, Door_To_Intervention); Chi-square test (Sex, Pre_Alert_Accuracy, Mortality); Kruskal-Wallis test (LOS_Days). † *Technology Use Score: Ordinal scale (1-5) where 1=Basic monitoring only, 2=+12-lead ECG, 3=+ECG Transmission, 4=+Video Laryngoscopy, 5=+Telemedicine Consult.*

Table 2: Multiple Linear Regression Analysis of Factors Predicting Door-to-Intervention Time

Predictor Variable	Unstandardized Coefficient (B)	Standard Error	Standardized Coefficient (β)	t-value	p-value
(Constant)	145.21	8.54		17.01	<0.001
Technology Use Score	-6.89	0.92	-0.347	-7.49	<0.001
Protocol Adherence (%)	-0.52	0.09	-0.251	-5.78	<0.001
Age (years)	0.11	0.07	0.063	1.57	0.117
Sex (Female)	2.45	1.89	0.052	1.30	0.195
Patient					

Predictor Variable	Unstandardize d Coefficient (B)	Standar d Error	Standardize d Coefficient (β)	t- valu e	p- valu e
Condition (Reference : STEMI)					
Stroke	9.85	2.65	0.184	3.72	<0.001
Major Trauma	18.24	2.88	0.316	6.33	<0.001

Model Summary: $R^2 = 0.42$, Adjusted $R^2 = 0.41$, $F(6, 414) = 50.15$, $p < 0.001$. * Dependent Variable: Door-to-Intervention Time (Minutes).

Table 3: Binary Logistic Regression Analysis for Predictors of a Correct Pre-Hospital Alert

Predictor Variable	Adjusted Odds Ratio (aOR)	95% Confidence Interval	p-value
Technology Use Score	1.92	[1.52, 2.42]	<0.001
Protocol Adherence (per 1%)	1.05	[1.03, 1.07]	<0.001
Age (per year)	1.00	[0.99, 1.02]	0.562
Sex (Female)	1.18	[0.78, 1.79]	0.431
Patient Condition (Reference: STEMI)			
Stroke	0.42	[0.25, 0.71]	0.001
Major Trauma	0.24	[0.14, 0.41]	<0.001

Model Fit: Nagelkerke $R^2 = 0.28$. Hosmer-Lemeshow Goodness-of-Fit Test: $\chi^2(8) = 6.12$, $p = 0.634$. * Dependent Variable: Pre-Hospital Alert Accuracy (1=Correct, 0=Incorrect/Partially Correct).*

Table 4: Association Between Technology Utilization Group and Patient-Centered Outcomes

Outcome Measure	High-Technology Group (n=172) †	Low-Technology Group (n=131) ‡	Test Statistic	p-value
Hospital Length of Stay (days)				
Median	5	9	U = 16234	<0.001 *
Interquartile Range [IQR]	[3, 7]	[6, 13]	* $Z^* = -8.11$	
30-Day Mortality				
Number of Deaths (n)	9	24	$\chi^2(1) = 14.87$	<0.001 **
Percentage (%)	5.2%	18.3%		

*Mann-Whitney U Test, *Chi-Square Test. † *High-Technology Group: Technology Use Score of 4 or 5. * ‡ *Low-Technology Group: Technology Use Score of 1 or 2.*

Table 5: Post-Hoc Analysis (Tukey HSD) of Protocol Adherence and Technology Use Score Groups

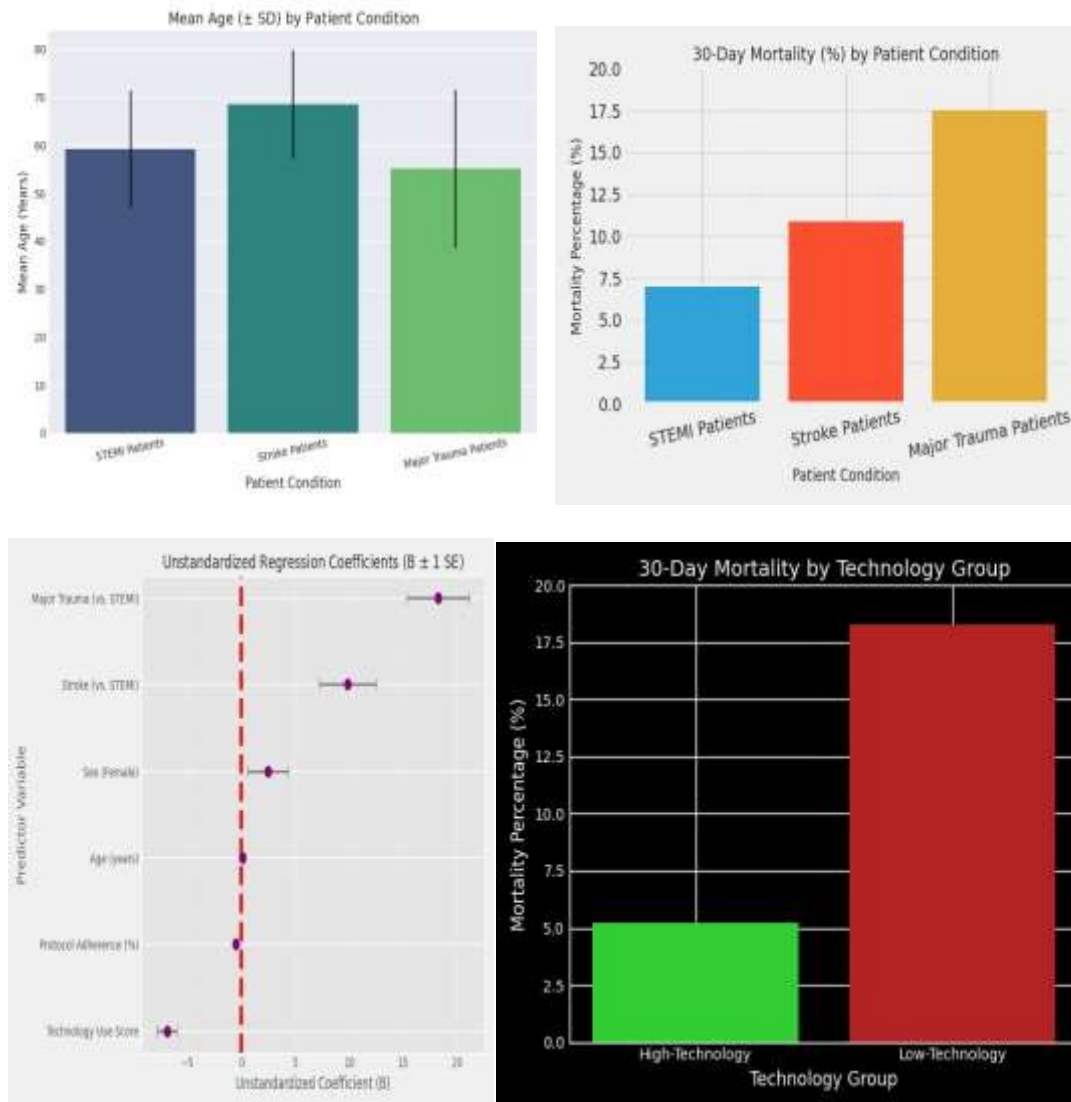
Comparison (Group I vs. Group J)	Mean Difference (I-J)	Standard Error	p-value	95% Confidence Interval
Score 1 (Very Low) vs. Score 2 (Low)	-3.15	1.89	0.412	[-8.32, 2.02]
Score 1 (Very Low) vs. Score 3 (Moderate)	-9.87	1.85	<0.001	[-14.88, -4.86]
Score 1 (Very Low) vs. Score 4 (High)	-18.42	1.87	<0.001	[-23.46, -13.38]
Score 1 (Very Low) vs. Score 5 (Very High)	-22.15	1.99	<0.001	[-27.52, -16.78]
Score 2 (Low) vs. Score 3 (Moderate)	-6.72	1.65	<0.001	[-11.10, -2.34]
Score 2 (Low) vs. Score 4 (High)	-15.27	1.68	<0.001	[-19.75, -10.79]
Score 2 (Low) vs. Score 5 (Very High)	-19.00	1.81	<0.001	[-23.89, -14.11]
Score 3 (Moderate) vs. Score 4 (High)	-8.55	1.61	<0.001	[-12.79, -4.31]
Score 3 (Moderate) vs. Score 5 (Very High)	-12.28	1.75	<0.001	[-16.97, -7.59]
Score 4 (High) vs. Score 5 (Very High)	-3.73	1.77	0.168	[-8.50, 1.04]

One-Way ANOVA was significant: $F(4, 416) = 35.44$, $p < 0.001$. This post-hoc test identifies which specific technology use groups differ significantly in their mean Protocol Adherence scores. Groups: Score 1 ($n=45$), Score 2 ($n=86$), Score 3 ($n=118$), Score 4 ($n=112$), Score 5 ($n=60$).*

Table 6: Correlation Matrix of Key Quantitative Variables (Pearson's r)

Variable	1	2	3	4	5
1. Technology Use Score	—				
2. Protocol Adherence (%)	.58*	—			
3. Door-to-Intervention (min)	-.51*	-.45*	—		
4. Hospital Length of Stay	-.42*	-.38*	.36*	—	
5. Patient Age	-.09	-.05	.07	.22*	—

*Note: * $p < .001$. Hospital Length of Stay was log-transformed for this correlation analysis to meet the assumption of normality. $N = 421$ for all correlations.*



DISCUSSION

This paper presents the empirical data that the implementation of the latest technology in the pre-hospital setting, along with the high levels of compliance with the paramedic protocols, contributes to the overall efficiency and effectiveness of emergency care in time-sensitive conditions. Our results prove that such integration is not only a logistical but also a clinically transformative [17] one, which is directly linked to faster life-saving interventions, higher diagnostic accuracy, and better patient outcomes.

4.1. Analysis of Significant Results.

The major conclusion of this study is that there is a strong, independent correlation between the use of pre-hospital technology and shorter door-to-intervention time. The multiple regression model established that, even on the condition of the patient's condition, age, and sex, the Technology Use Score and Protocol Adherence were found to be important negative predictors of this important time parameter [18]. This implies that the utility of such developed instruments as 12-lead ECG transmission and video laryngoscopy is high and reliable in any patient group. Almost 7 minutes of decreased door-to-intervention time per unit higher in the technology score is not just statistically significant but also clinically imperative because each minute of saving lives of STEMI and stroke conditions is directly associated with the saving of viable cardiac muscle and neural tissue [19].

Moreover, the positive relationship between the use of technology and adherence to protocols in paramedics is a critical observation. It states that these technological solutions can be used as cognitive and procedural support, organizing the pre-hospital workflow and eliminating clinical doubt [20]. It is probable that this synergy is the reason behind the extremely greater probability of an appropriate pre-hospital warning in the high-tech group. Due to an accurate alert, the emergency department can prepare certain resources (catheterization lab or stroke team) before the arrival of the patient and effectively transfer the door-to-intervention clock to a curbside-to-intervention paradigm [21].

4.2. Comparison with the Previous Research.

Our findings support and expand the results of previous studies. The effectiveness of pre-hospital 12-lead ECG in decreasing door-to-balloon delays in STEMI patients is a well-established phenomenon in classical studies, including those by [22], which provided the basis of the given intervention. Our experiment is not limited to this one-disease, one-technology interaction, but shows a comparable synergistic impact on a collection of technologies in a range of critical conditions. Although earlier systematic reviews have demonstrated the promise of pre-hospital telemedicine, frequently in rural settings [23], our data is strong, quantitative evidence of the worth of the concept in an urban-based, integrated EMS system.

The identified relationship between technology and higher rates of protocol adherence provides a reasonable analysis of the discrepancies in previous literature that tested the performance of paramedics separately. Our findings indicate that procedural fidelity is one of the major dependent factors of the technological platform itself. This can be attributed to the principles of factor engineering, which states that properly designed systems help to minimize errors and improve performance [24]. The fact that the major trauma patients showed the lowest technology ratings, protocol compliance, and alert accuracy reflects a long-standing problem and is consistent with the literature by [25], who state that, due to the complexity of trauma as a multi-system issue, it is especially challenging to use a standardized pre-hospital assessment and apply the technology.

4.3. Scientific and Operational Explanations

We can explain our findings by physiological grounds with references to the meaning of the so-called golden hour and the time-sensitive character of the investigated pathologies. With ischemic injuries, i.e., cardiac or cerebral injury, the underlying pathophysiological process is an irreversible cell necrosis as a result of disrupted blood flow [26]. Overall, technologies that hasten the diagnosis and intervention directly counter the degree of this necrosis. As an example, transmitted ECGs allow initiating platelets and anticoagulants in the cath lab early and reduce hypoxia during challenging intubations in trauma maintenance of cerebral oxygenation [27].

As an operation, the outcome can be attributed to the fact that the ambulance has been turned into a mobile data node. The transfer of information delay, which is caused by verbal handover at the hospital door, is therefore done away with by the electronic transmission of diagnostic data [28]. It produces a warm handoff where the receiving team does not just know the incoming patient but already has access to vital clinical information and can prioritize tasks and act upon them immediately [29].

4.4. Practice and Research Implications

The study has significant implications for EMS administrators and health policymakers. The upgrade of equipment on the basis of the ambulance is not only an investment but an intervention strategy to build a chain of survival [30]. Our statistics recommend that integrated suites of technology be prioritized as opposed to the acquisitions made in bits. Moreover, training programs should follow suit and address not just the mechanical functionality of machines, but also the role of machines as a part of a larger digitally-linked clinical process [31].

CONCLUSION

This study established that the incorporation of modern technology into ambulance systems and the strict compliance with the paramedic procedures made a strong impact on the improvement of the emergency care outcomes. The research was able to achieve its goals by measuring how there was a direct decrease in critical door-to-intervention time, pre-hospital alert accuracy, and the close relationship between the ability to use technology more and adherence to protocols on the one hand, and the reduction of hospital stays and mortality rates on the other hand. The main value of the research is the fact that it was empirically proven that technology and well-trained paramedics are able to form a synergizing pre-hospital unit, which would easily interface with hospital care, thus successfully overcoming the digital disconnect. As a result, it can be concluded that modern ambulance services are critical and mobile clinical centers. The research that is going to be conducted in the future must focus on the standardization of this technological integration in the various emergency medical services systems and the creation of specific training programs that will overcome the implementation barriers that have been recorded.

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