Impact of Response Time and Prehospital Care on Mortality in Road Traffic Accidents of Balochistan

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ABSTRACT

Background: Road traffic accidents (RTAs) are a leading cause of mortality and morbidity worldwide, with delayed emergency response and inadequate prehospital care significantly impacting outcomes. In resource-limited settings like Balochistan, these factors pose critical challenges, exacerbated by infrastructural and logistical constraints.

Objective: To evaluate the impact of response time and prehospital care on mortality and recovery outcomes in RTAs in Balochistan.

Methods: This comparative cross-sectional study was conducted in four tertiary care hospitals in Balochistan, focusing on RTAs along three major highways. Data from 300 cases were analyzed, divided into two groups: 150 cases before 2019 and 150 after 2019. Information was collected through structured questionnaires and emergency service records. Response times were categorized as "early" (8–15 minutes) or "late" (>15 minutes). Prehospital care, injury type, and treatment outcomes were also assessed. Statistical analyses included chi-square and independent t-tests using SPSS 25. Ethical approval and informed consent were obtained.

Results: Group 2 demonstrated significantly longer response times (>15 minutes: 89.3% vs. 24.7%, $p<0.001$) and lower prehospital care rates (24.7% vs. 71.3%, $p<0.001$). Mortality increased in Group 2 (11.3% vs. 4.7%, $p=0.046$), while full recovery decreased (31.3% vs. 47.3%, $p=0.003$).

Conclusion: Delayed response times and reduced prehospital care significantly worsened RTA outcomes in Balochistan. Strengthening emergency systems and prehospital care is critical to reducing mortality.

INTRODUCTION

Road traffic accidents (RTAs) are a pressing global health concern, responsible for significant mortality and morbidity worldwide. Each year, millions of lives are lost, and many more are irreversibly impacted by injuries resulting from RTAs, placing an immense burden on healthcare systems and societies. The consequences of these accidents extend beyond physical trauma, encompassing substantial social and economic challenges, including reduced productivity, increased healthcare costs, and profound emotional distress among affected families (1, 2). RTAs are the leading cause of injury-related disability-adjusted life years (DALYs) and remain the eighth leading cause of mortality globally. Despite advancements in healthcare, infrastructure, and vehicular safety, fatalities due to RTAs have risen globally, from 1.2 million in 2018 to 1.4 million in 2020, underscoring the urgent need for targeted interventions (3, 4).

The effectiveness of emergency medical response and prehospital care has emerged as a critical determinant of outcomes in RTA victims. Response time, defined as the interval between receiving an emergency call and the arrival of medical services at the accident site, plays a pivotal role in reducing mortality. Studies have demonstrated that shorter response times correlate with improved survival rates, as timely intervention during the "golden hour" significantly enhances the chances of stabilizing life-threatening injuries such as uncontrolled hemorrhage, airway compromise, and traumatic shock (5, 6). However, prolonged response times, often due to traffic congestion, geographical challenges, and insufficient emergency medical service (EMS) resources, can lead to preventable fatalities (7). In parallel, prehospital care, which includes interventions such as airway management, hemorrhage control, fracture immobilization, and rapid transportation to trauma centers, is essential in mitigating the severity of injuries and ensuring better long-term outcomes. Despite its importance, variability in the quality and accessibility of prehospital care remains a significant challenge, particularly in resource-limited settings (8).

The World Health Organization (WHO) has emphasized the need for comprehensive road safety measures, identifying five pillars: road safety management, safe infrastructure, safe vehicles, safe behavior among road users, and post-crash care. Among these, post-crash care, encompassing emergency response and prehospital interventions, is critical to reducing fatalities and improving recovery outcomes (9). Global trends in RTA-related research have consistently highlighted the role of timely and effective emergency responses. For instance, studies from the United

States and Europe have shown that reducing response times by as little as 10 minutes can lower mortality rates by up to one-third (10, 11). However, resource-constrained regions like Balochistan face unique challenges, including vast geographical terrain, underdeveloped infrastructure, and limited access to trained EMS personnel. These factors exacerbate the delay in emergency response and compromise the quality of prehospital care provided to victims.

In Pakistan, Balochistan's unique socio-geographical landscape underscores the urgency of addressing these challenges. The region's vast, sparsely populated terrain and limited healthcare infrastructure contribute to high RTA mortality rates. Available data suggest that highway accidents in Balochistan result in five times more fatalities than other incidents, including terrorist attacks, highlighting the need for targeted interventions to improve road safety and emergency response systems (12). While efforts have been made to enhance EMS capabilities in the region post-2019, significant gaps persist in terms of response efficiency and the delivery of prehospital care. This study aims to assess the impact of response time and prehospital care on RTA outcomes in Balochistan by comparing mortality and recovery rates before and after these advancements. Understanding the relationship between these factors is crucial to identifying systemic inefficiencies and developing strategies to reduce the burden of RTAs on affected communities and the healthcare system.

By investigating the regional dynamics of emergency response and prehospital care in Balochistan, this research addresses a critical gap in the literature. The findings will provide valuable insights for healthcare policymakers and stakeholders, guiding the development of evidence-based strategies to enhance RTA management systems in resource-limited settings. Furthermore, the study's outcomes may inform broader global initiatives aimed at achieving the United Nations' target of halving RTA-related deaths and injuries by 2030 (13).

MATERIAL AND METHODS

This study was a comparative cross-sectional investigation conducted to evaluate the impact of response time and prehospital care on mortality and recovery outcomes in road traffic accidents (RTAs) in Balochistan. The research was carried out in four purposively selected tertiary care public hospitals, including District Headquarters Hospital (DHQ) Quetta, Combined Military Hospital (CMH) Quetta, CMH Zhob, and Sheikh Zayed Hospital Quetta. These hospitals were chosen based on their strategic location and role in providing emergency medical services to RTA victims along the major highways of Balochistan. The study involved two groups: data from 150 RTA cases before 2019 and 150 cases after 2019, ensuring an equal sample size for a robust comparison.

The study population comprised RTA victims who were transported to the selected hospitals from accidents occurring on three major highways in Balochistan. Participants were enrolled based on inclusion criteria, which required them to have been involved in RTAs within the study period and received treatment at the selected hospitals. Cases of deaths on the spot without hospital transfer were excluded to maintain consistency in outcome evaluation. Data were collected using a structured, modified questionnaire that captured information on demographics, type of injury, type of vehicle involved, response time, prehospital care received, and treatment outcomes. The questionnaire was validated through a pilot study conducted on a small subset of the population, and necessary modifications were made to enhance clarity and reliability.

Ethical approval for the study was obtained from the institutional ethics review committee of the lead research institution. The study adhered to the principles outlined in the Declaration of Helsinki, ensuring that participants' rights, confidentiality, and welfare were safeguarded throughout the research. Written informed consent was obtained from all participants or their legal guardians before data collection, with an emphasis on voluntary participation and the right to withdraw from the study at any point without repercussions.

Data collection was conducted collaboratively with emergency services staff deployed along the highways and healthcare providers at the selected hospitals. Emergency response records and hospital documentation were reviewed to gather accurate and comprehensive data. Response time was categorized into "early" (within 8-15 minutes) and "late" (after 15 minutes), while prehospital care was classified as "received" or "not received." Treatment outcomes were classified into three categories: fully recovered, partially recovered, and deceased.

The data analysis was performed using IBM SPSS Statistics for Windows, Version 25.0. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were calculated to summarize the data. Comparative analyses between the two groups were conducted using chi-square tests for categorical variables and independent t-tests for continuous variables. Associations between response time, prehospital care, and treatment outcomes were evaluated, with a p-value of less than 0.05 considered statistically significant. Missing data were handled through multiple imputation to minimize bias.

This study provided a detailed assessment of RTA cases before and after the enhancement of emergency medical services in 2019, focusing on critical factors influencing mortality and recovery. The findings contribute to identifying gaps in the emergency response system and informing evidence-based improvements to prehospital care delivery in resource-limited settings like Balochistan.

RESULTS

A total of 300 participants were included in this study, divided equally into two groups: Group 1 (before 2019) and Group 2 (after 2019). The demographic characteristics, nature of vehicle involvement, type and severity of injuries, emergency response time, prehospital care, and treatment outcomes were assessed. Significant differences were observed across multiple parameters, providing insights into the evolving dynamics of emergency services in

Balochistan. The mean age of participants in Group 1 was 35.93 ± 10.90 years, while in Group 2, it was 40.24 ± 10.55 years, indicating that Group 2 participants were significantly older on average ($p < 0.001$). While the gender distribution did not differ significantly between groups, males were the predominant demographic in both groups (88% in Group 1 and 83.3% in Group 2). These results suggest that RTAs disproportionately affect males, consistent with findings in similar settings globally (Table 1).

Table 1: Demographic Characteristics of Participants

Variable	Group 1 (n = 150)	Group 2 (n = 150)	p-value
Age (Mean ± SD)	35.93 ± 10.90	40.24 ± 10.55	< 0.001*
Gender (Male)	88% (n = 132)	83.3% (n = 125)	0.220
Gender (Female)	12% (n = 18)	16.7% (n = 25)	

A detailed analysis of the types of vehicles involved in crashes revealed significant differences between groups. HTV-to-LTV accidents were more prevalent in Group 2 (45.3%) compared to Group 1 (31.3%, $p = 0.009$), suggesting an increased risk of severe collisions involving heavier vehicles post-2019. Conversely, car-to-bike accidents showed a decline in prevalence in Group 2 (36.7%) compared to Group 1 (48%, $p = 0.045$), potentially reflecting changes in traffic patterns or safety regulations (Table 2).

Table 2: Vehicle Involvement in Crashes

Vehicle Type	Group 1 (n = 150)	Group 2 (n = 150)	p-value
Car to Bike	48% (n = 72)	36.7% (n = 55)	0.045*
Bike to Bike	14% (n = 21)	12.7% (n = 19)	0.780
LTV to LTV	6.7% (n = 10)	5.3% (n = 8)	0.643
HTV to LTV	31.3% (n = 47)	45.3% (n = 68)	0.009*

Injury patterns and severity were also assessed. While the prevalence of head injuries was similar between groups, multiple injuries were slightly more frequent in Group 2 (30.7%) compared to Group 1 (26%). Severe injuries were predominant in both groups but slightly more common in Group 2 (60.7%) than Group 1 (54.7%). Mild injuries, on the other hand, were significantly lower in Group 2 (6.7%) compared to Group 1 (14%, $p = 0.048$), indicating a shift toward more severe outcomes post-2019 (Table 3).

Table 3: Injury Types and Severity

Variable	Group 1 (n = 150)	Group 2 (n = 150)	p-value
Injury Type			
Head Injury	56% (n = 84)	58% (n = 87)	0.704
Multiple Injuries	26% (n = 39)	30.7% (n = 46)	0.391
Fractures	17.3% (n = 26)	10% (n = 15)	0.093
Other	0.7% (n = 1)	1.3% (n = 2)	0.561
Severity			
Mild	14% (n = 21)	6.7% (n = 10)	0.048*
Moderate	31.3% (n = 47)	32.7% (n = 49)	0.806
Severe	54.7% (n = 82)	60.7% (n = 91)	0.312

Emergency response time and prehospital care demonstrated significant disparities. Group 1 benefited from earlier emergency responses, with 75.3% of participants receiving care within 8–15 minutes, compared to only 10.7% in Group 2. Similarly, prehospital care was more commonly received in Group 1 (71.3%) than in Group 2 (24.7%). These findings are highly significant ($p < 0.001$) and highlight systemic delays in emergency response post-2019, which may be associated with an increased volume of RTAs or inefficiencies in service expansion (Table 4).

Table 4: Emergency Service Response Time and Prehospital Care

Variable	Group 1 (n = 150)	Group 2 (n = 150)	p-value
Response Time			
Early (8–15 mins)	75.3% (n = 113)	10.7% (n = 16)	< 0.001*
Late (>15 mins)	24.7% (n = 37)	89.3% (n = 134)	
Prehospital Care			
Received	71.3% (n = 107)	24.7% (n = 37)	< 0.001*
Not Received	24.7% (n = 37)	75.3% (n = 113)	
Died on the Spot	4% (n = 6)	0% (n = 0)	0.016*

Treatment outcomes revealed critical differences. While Group 1 had a higher rate of full recovery (47.3%) compared to Group 2 (31.3%, p = 0.003), the mortality rate in Group 2 (11.3%) was significantly higher than in Group 1 (4.7%, p = 0.046). These findings underscore the detrimental impact of delayed responses and insufficient prehospital care on patient outcomes post-2019 (Table 5).

Table 5: Treatment Outcomes

Variable	Group 1 (n = 150)	Group 2 (n = 150)	p-value
Fully Recovered	47.3% (n = 71)	31.3% (n = 47)	0.003*
Partially Recovered	48% (n = 72)	57.3% (n = 86)	0.126
Deceased	4.7% (n = 7)	11.3% (n = 17)	0.046*

The results reveal significant gaps in emergency response efficiency and prehospital care delivery post-2019, leading to poorer treatment outcomes, including higher mortality rates and lower recovery rates. These findings emphasize the need for targeted interventions to address systemic delays and enhance the quality of emergency services in Balochistan.

DISCUSSION

The findings of this study highlighted significant disparities in the outcomes of road traffic accidents (RTAs) in Balochistan before and after 2019, focusing on response times, prehospital care, and subsequent treatment outcomes. A critical observation was the substantial delay in emergency response times post-2019, with only 10.7% of participants in Group 2 receiving care within 8–15 minutes compared to 75.3% in Group 1. This delay was accompanied by a stark decline in the provision of prehospital care, which dropped from 71.3% in Group 1 to 24.7% in Group 2. These findings align with prior research emphasizing the importance of timely medical intervention in reducing RTA-related mortality, particularly within the "golden hour" (1, 2). Studies in high-income countries have consistently shown that shorter response times significantly improve survival rates by facilitating early stabilization and transport to definitive care (3).

The observed increase in mortality in Group 2 (11.3%) compared to Group 1 (4.7%) underscores the detrimental impact of systemic inefficiencies in post-2019 emergency services. Despite advancements in infrastructure, the findings suggest that the scaling up of services may have outpaced resource allocation and operational efficiency. This is consistent with global trends in resource-limited settings, where expanded service delivery often encounters logistical challenges, inadequate training of first responders, and limited access to advanced medical equipment (4, 5). Additionally, the prevalence of severe injuries in Group 2 (60.7%) further supports the notion that delayed response times and inadequate prehospital care exacerbate the severity of outcomes. Comparable findings have been reported in rural India and sub-Saharan Africa, where delayed emergency response and fragmented prehospital care systems have been linked to increased mortality and morbidity among RTA victims (6, 7-13).

The study also revealed a shift in the patterns of vehicle involvement in crashes, with a significant rise in heavy transport vehicle (HTV)-to-light transport vehicle (LTV) accidents in Group 2. This trend may reflect changes in traffic volumes, road conditions, or enforcement of traffic regulations. Previous research has identified HTV-related collisions as being associated with higher fatality rates due to the increased force of impact and likelihood of multiple injuries (8). The predominance of single-road accidents in both groups highlights the infrastructural challenges in Balochistan, where narrow, poorly maintained roads with insufficient safety measures contribute to a high RTA burden. Such findings are consistent with global literature demonstrating that rural and underdeveloped regions face higher rates of RTAs due to inadequate road infrastructure and enforcement of safety regulations (9, 10-18).

The study's strengths lie in its robust comparative design, which allowed for the assessment of trends over time and the impact of systemic changes in emergency services. By including a diverse sample from major highways in Balochistan, the study captured a comprehensive representation of the region's RTA dynamics. However, certain limitations should be acknowledged. The retrospective nature of data collection introduced the potential for recall and reporting biases. Additionally, the exclusion of on-the-spot fatalities may have led to an underestimation of the true mortality burden associated with RTAs in the region. The reliance on purposive sampling limits the generalizability of findings, although the inclusion of multiple tertiary care centers mitigated this concern to some extent (19-24).

The implications of these findings extend beyond the immediate context of Balochistan, offering valuable insights into improving emergency response systems in resource-limited settings. Key recommendations include optimizing response times through the implementation of GPS-enabled dispatch systems and increasing the number of emergency response units strategically positioned along high-risk routes. Enhancing the training of first responders in basic and advanced life support and equipping ambulances with standardized medical supplies are critical for improving the quality of prehospital care. Furthermore, integrating telemedicine technologies could facilitate real-time consultations and decision-making, particularly in remote areas where access to specialized care is limited (25-28).

Public awareness campaigns focusing on road safety and the importance of timely reporting of RTAs are essential to complement systemic interventions. Strengthening collaborations between emergency services, law enforcement, and healthcare facilities would enhance the continuity of care and streamline patient transfers. Policymakers must prioritize investments in emergency

medical infrastructure and data-driven strategies to address systemic delays and inefficiencies. These measures are particularly crucial for achieving the United Nations' target of halving RTA-related deaths and injuries by 2030 (11).

CONCLUSION

In conclusion, this study highlighted critical gaps in the emergency response and prehospital care systems in Balochistan post-2019, underscoring their significant impact on RTA outcomes. The findings emphasize the need for targeted interventions to address systemic delays, enhance prehospital care delivery, and improve recovery rates. While the study contributes to the growing body of evidence on the importance of emergency medical systems in resource-limited settings, further research is required to evaluate the long-term effectiveness of implemented strategies and explore innovative approaches to reducing the RTA burden.

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