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Retrospective analysis of trauma patients transported by dispatch monitored type B ambulances to Dhulikhel Hospital, Kavre, Nepal, 2019–2023

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Abstract

Background Timely emergency medical services (EMS) are particularly important among trauma patients, as inefficient EMS systems can result in potentially avoidable death before reaching a hospital. The Dhulikhel Hospital Dispatch Center coordinates and monitors a growing network of ambulances, including seven Type B ambulances staffed with a trained prehospital care provider and medical equipment. This study evaluates the prehospital care and outcomes of trauma patients transported by Type B ambulances to Dhulikhel Hospital's Emergency Department, as monitored by the Dispatch Center.

Methods Data were collected via a retrospective chart review of Dispatch Center records, including patient demographics, injury mechanisms, prehospital care, and outcomes. Patients were included if they experienced physical trauma and were transported by a Type B ambulance to Dhulikhel Hospital's Emergency Department between 2019 and 2023.

Results Between 2019 and 2023, 224 trauma patients were transported to the hospital and received prehospital care services from Type B ambulances monitored by the Dispatch Center. Most patients were male (59%), and nearly half were aged 18–44 (49%). The median total transport time for Dhulikhel Hospital-owned Type B ambulances was 40 min. Type B ambulances reached patients across 24 municipalities (88% in Kavrepalanchowk and Sindupalchowk districts). Falls (55%) and road traffic accidents (30%) were the most common injury mechanisms, followed by physical assault (7%). Falls were significantly associated with female, pediatric, and geriatric patients ($p < 0.05$), while road traffic accidents predominated among males, particularly in adults aged 25–34 years ($p < 0.05$). Approximately one-third of patients admitted to the hospital after evaluation in the emergency department experienced multiple injuries, and the most prevalent diagnosis of admitted cases were extremity fractures (52%).

Conclusion Trauma cases accounted for 15% (227/1541) of all patients who received transport and prehospital care services from a Type B ambulance monitored by the Dispatch Center between 2019 and 2023. This study

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demonstrates the critical role of Type B ambulances and an integrated dispatch center in advancing timely and efficient prehospital care for trauma patients in Nepal.

Keywords Ambulance, Emergency medical services, Nepal, Prehospital, Trauma

Introduction

Deaths and long-term disability related to physical trauma are disproportionately higher in low- and middle-income countries (LMICs) compared to high income countries [1]. In Nepal, injuries are the fourth leading cause of disability-adjusted life years (DALYs) [2]. Limited Emergency Medical Services (EMS) infrastructure and trained personnel have impeded the country's ability to address the burden of trauma [3]. To date, there are only 30 trained dispatchers, 119 trained prehospital care providers, and 929 trained ambulance drivers certified by Nepal's National Health Training Center [4]. Most ambulances function exclusively as transport vehicles, typically equipped with only an oxygen tank and a driver [5]. A limited number of Type B ambulances operate in Nepal, which are defined as vehicles outfitted with resuscitation equipment and staffed with an emergency medical technician (EMT) and a driver trained in first aid and Basic Life Services (BLS). System fragmentation, high demand-low supply, inequity in service accessibility, and limited EMS regulation influence the development of an integrated prehospital care system in Nepal [5].

In 2013, Dhulikhel Hospital, the non-profit teaching hospital affiliated with Kathmandu University, launched Dhulikhel Hospital Emergency Medical Services (DEMS) to develop a prehospital care system for Kavrepalanchowk, Sindupalchowk, Bhaktapur, Dolakha, Ramechhap, and Sindhuli districts. The Dhulikhel Hospital Dispatch Center, a government-owned organization of the Bagmati Province, was established in 2019 to coordinate a growing network of ambulances in this region. The Dispatch Center was initially managed by both the Nepal Red Cross Society and Dhulikhel Hospital, and now it is fully managed by Dhulikhel Hospital.

At present, the Dispatch Center coordinates 47 ambulance vehicles, including seven Type B ambulances that are staffed with a trained prehospital care provider and medical equipment. Two Type B ambulances are owned by Dhulikhel Hospital and managed by DEMS, and the other five are owned by local government municipalities and managed by the Red Cross. The Dispatch Center utilizes 102 as the national three-digit ambulance telephone number, connecting patients with nearby ambulances and coordinating transport to an optimal health center 24/7.

There is a notable scarcity of research focused on prehospital systems and trauma in LMIC. As prehospital systems continue to develop, there exists a complementary need for enhanced research, data collection, and standardized operating guidelines (SOGs) [6]. Retrospective studies conducted at trauma care centers in LMICs have been used to assess the prehospital care of trauma patients [7]. Likewise, analyzing data from a dispatch center can facilitate evidence-based decision-making regarding the care of injured patients from field to hospital. Thus, characterizing the prehospital care and outcomes of trauma patients transported by Type B ambulances to Dhulikhel Hospital's Emergency Department represents a pertinent research objective.

As the Dispatch Center enters its fifth year of operation, a retrospective analysis was conducted on the characteristics, injuries, prehospital care, and outcomes of trauma patients transported to Dhulikhel Hospital by Type B ambulances from 2019 to 2023.

Methods

The study protocol was reviewed and approved by Kathmandu University School of Medical Sciences' Institutional Review Committee and received an exemption by the Medical College of Wisconsin's Institutional Review Board.

Prehospital transport data from January 2019 through December 2023 were extracted from the Dhulikhel Hospital Dispatch Center in May 2024. All available dispatch files, documenting patients who were transported by ambulances monitored by the Dispatch Center, were reviewed by the study team. Trauma patients transported by a Type B ambulance to the Dhulikhel Hospital Emergency Department were included in the analysis, regardless of age, sex, or ethnicity. Patients who reported a chief concern other than trauma or did not utilize an ambulance for prehospital transport were excluded.

A total of 1541 records were reviewed, and 227 patients (15%) met the inclusion criteria for the analysis. Data from seven Type B ambulances were extracted from the Dispatch Center records. Of these, two ambulances were owned by Dhulikhel Hospital and recorded data on patient demographics (age and sex), location (municipality), chief complaints, prehospital interventions (vitals, medications, and procedures), and timestamps (date, call time, scene arrival time, and Emergency Department arrival time) from 2019 to 2023. The remaining five Type B ambulances were managed by the Red Cross Society of Nepal and owned by local municipality governments (Balefi, Barhabise, Bethanchowk, Chaurideurali, and Melamchi). These ambulances recorded data from 2022 to 2023, including incident date, patients demographics

Table 1 Frequencies of variables included in this study for analysis

Variables	DEMS Type B Ambulances	Red Cross Type B Ambulances	Total Type B Ambulances
	n (%)	*n* (%)	*n* (%)
Sex	167 (99)	41 (71)	208 (92)
Age	168 (99)	40 (69)	208 (92)
Patient location	156 (92)	58 (100)	214 (94)
Ambulance number	169 (100)	58 (100)	227 (100)
Date of response	169 (100)	58 (100)	227 (100)
Vital status at scene	169 (100)	0 (0)	169 (74)
Call time	163 (96)	0 (0)	163 (72)
Scene arrival time	164 (97)	0 (0)	164 (72)
Vitals time	128 (76)	0 (0)	128 (56)
Hospital arrival time	137 (81)	0 (0)	137 (60)
Accompaniment	169 (100)	0 (0)	169 (74)
Vital signs	162 (96)	0 (0)	162 (71)
Medications	169 (100)	0 (0)	169 (74)
Clinical procedures	169 (100)	0 (0)	169 (74)
Mechanism of injury	169 (100)	58 (100)	227 (100)
In-patient number	74 (44)	0 (0)	74 (33)
Diagnosis	72 (44)	3 (5)	75 (33)

(age and sex), location (municipality), and mechanism of injury.

To assess the diagnostic outcomes of these trauma patients, in-patient (IP) numbers were used to identify patients in the Dhulikhel Hospital Emergency Department records. Variables analyzed included final diagnoses (e.g., injury type, severity, and anatomy) and referrals to Dhulikhel Hospital departments and/or other healthcare institutions.

Descriptive analyses were conducted using Stata/SE 18.0 (StataCorp LLC, College Station, Texas, USA) and explored patient demographics, injury types, prehospital care, and outcomes of trauma patients. Characteristics were described using means and standard deviations for normally distributed data, medians and interquartile ranges for skewed data, and frequencies for categorical data. A sub-analysis using Fisher's exact test was conducted to analyze the relationships between demographic variables (age and sex) and the most prevalent mechanisms of injury, with the threshold of significance set at $p < 0.05$.

Geospatial analyses were completed using QGIS 3.32-Lima, an open-source GIS software (QGIS, Grüt, Switzerland). Polygon shapefiles of local municipalities were downloaded from the Government of Nepal's Survey Department [8]. The scene locations of 213 trauma patients (94% of total) were indicated in dispatch records and enumerated at the municipal level for analysis.

Table 2 Demographic characteristics of trauma patients transported by type B ambulances monitored by the dispatch center

Characteristics	Female, *n* (%) (*n* = 75)	Male, *n* (%) (*n* = 133)	Unreported, *n* (%) (*n* = 19)	Total, *n* (%) (*n* = 227)
Age, median (IQR)	45 (37)	34 (26)	49 (8)	37 (31)
Age Group				
0–17	5 (7)	16 (12)	0 (0)	21 (9)
18–24	8 (11)	25 (19)	0 (0)	33 (15)
25–34	13 (17)	27 (20)	0 (0)	40 (18)
35–44	9 (12)	28 (21)	0 (0)	37 (16)
45–54	12 (16)	12 (9)	2 (11)	26 (11)
55–64	5 (7)	15 (11)	0 (0)	20 (9)
65+	22 (29)	9 (7)	0 (0)	31 (14)
Unreported	1 (1)	1 (1)	17 (89)	19 (8)
Accompaniment				
Family	49 (65)	63 (47)	1 (5)	113 (50)
Friends	8 (11)	29 (22)	1 (5)	37 (16)
Other	1 (1)	4 (3)	0 (0)	5 (2)
Self	3 (4)	10 (8)	0 (0)	14 (6)
Unreported	14 (19)	27 (20)	17 (89)	58 (26)
Year				
2019	18 (24)	25 (19)	1 (5)	44 (19)
2020	9 (12)	6 (5)	0 (0)	15 (7)
2021	11 (15)	31 (23)	1 (5)	43 (19)
2022	17 (23)	47 (35)	17 (89)	81 (36)
2023	20 (27)	24 (18)	0 (0)	44 (19)
Time of Day				
00:00–05:59	4 (5)	8 (6)	0 (0)	12 (5)
06:00–11:59	27 (36)	36 (27)	1 (5)	64 (28)
12:00–17:59	21 (28)	35 (26)	1 (5)	57 (25)
18:00–23:59	8 (11)	27 (20)	0 (0)	35 (15)
Unreported	15 (20)	27 (20)	17 (89)	59 (26)

legend: "Unreported" = not reported in Dispatch record. IQR = interquartile range. Percentages may not sum to 100% due to rounding

Results

Table 1 demonstrates the frequencies generated for each variable analyzed in this study to gauge completeness by all Type B ambulance transports ($n = 227$) and DEMS-managed ($n = 169$) and Red Cross-managed ($n = 58$) transports.

Table 2 presents the demographic characteristics of trauma patients transported by Type B ambulances to Dhulikhel Hospital's Emergency Department, categorized by sex (male, female, and unreported). Male patients ($n = 133$, 59%) experienced trauma more frequently compared to female patients ($n = 75$, 33%). The median difference in age between female and male trauma patients was 9 years (median = 45 and 34 years old, respectively). During transport, patients were most commonly accompanied by a family member (50%) or friend (16%). Most transports occurred during the daytime, including 53% between 6:00am to 6:00pm. The distribution of trauma

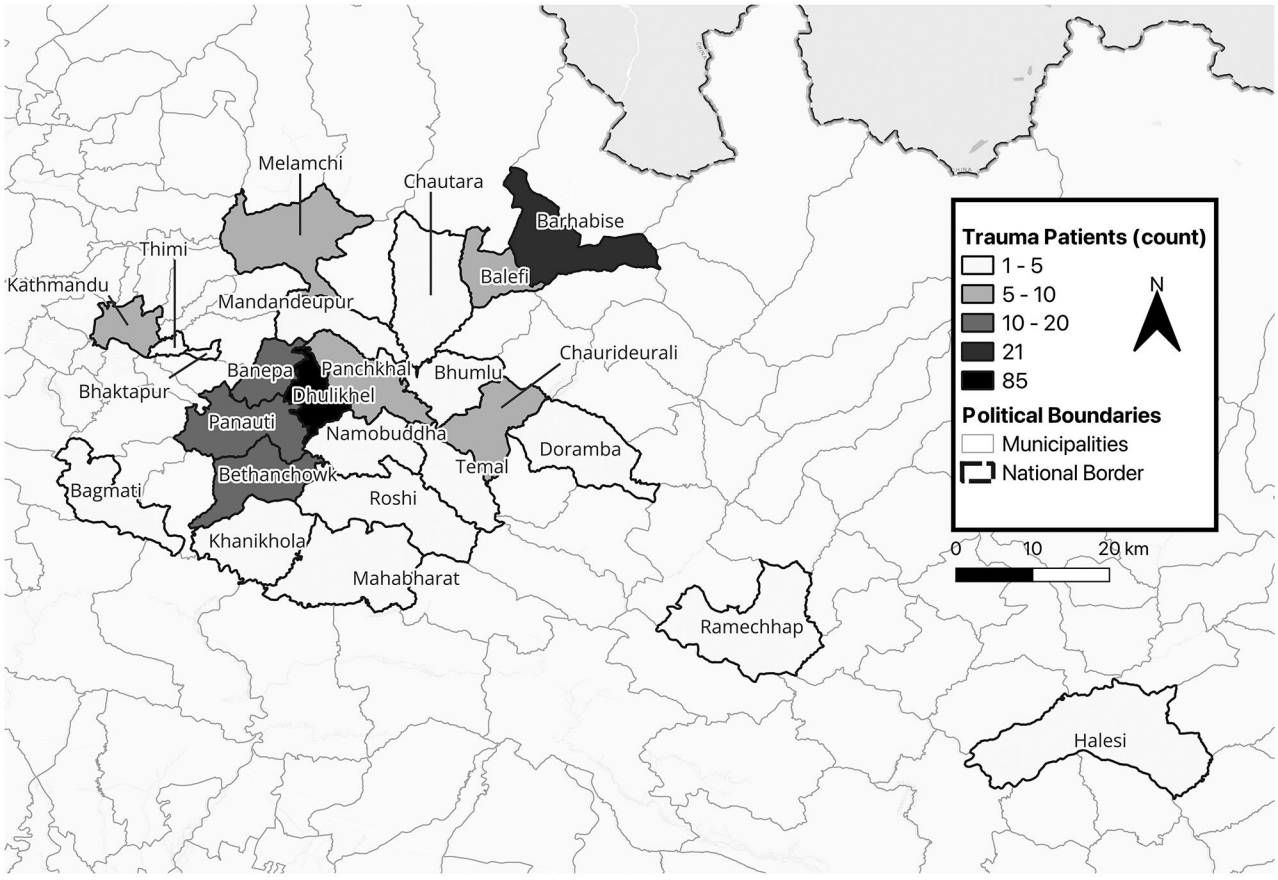

Fig. 1 Geospatial distribution of trauma patient locations by municipality, 2019–2023

Table 3 Distribution of trauma injury etiology

Injury Mechanism	*n* (%)
Fall	125 (55)
Road traffic accident	68 (30)
Physical assault	15 (7)
Cut	11 (5)
Crush	2 (1)
Natural disaster	2 (1)
Electric	2 (1)
Animal-related	1 (< 1)
Burn	1 (< 1)
Total	227 (100)

patients by year was 44 in 2019 (19%), 15 in 2020 (7%), 43 in 2021 (19%), 81 in 2022 (36%), and 44 in 2023 (19%).

Figure 1 displays the geospatial distribution of 213 trauma patients' scene locations (94% of total), enumerated at the municipal level. Overall, the seven Type B ambulances reached patients across 24 municipalities in Nepal. Most patients came from Dhulikhel ($n = 85$, 40%), Barhabise ($n = 21$, 10%), Banepa ($n = 16$, 8%), Panauti ($n = 13$, 6%), Bethanchowk ($n = 11$, 5%), and Balefi ($n = 10$, 5%).

Table 3 presents the distribution of injury etiology for trauma patients who were transported to the Dhulikhel Hospital Emergency Department by Type B ambulances monitored by the Dhulikhel Hospital Dispatch Center. Most patients were injured by a fall (55%), road traffic accident (RTA, 30%), or physical assault (7%). Results of the sub-analyses testing the association between patient demographics (sex and age group) and the three most prevalent mechanisms of injury (falls, RTAs, and physical assault) are presented in Table 4. Falls were significantly associated with women (65%, $p < 0.05$), while RTAs were associated with men (37%, $p < 0.01$). Falls were also more common among pediatric patients (< 18 years old, 76%, $p < 0.01$) and geriatric patients (> 65 years old, 77%, $p < 0.01$). RTAs were most common among adults aged 25–34 years (45%, $p = 0.001$). There were no significant patterns of physical assault prevalence observed among patients of different sex ($p = 0.385$) and age groups ($p = 0.650$).

The prehospital care of trauma patients transported by the two Dhulikhel Hospital-owned, DEMS-managed ambulances are presented in Table 5. Only one patient was reported as deceased at the scene by prehospital care providers (< 1%). For Dhulikhel Hospital-owned Type B

Table 4 Distribution of prevalent injury mechanisms by sex and age group ($n = 208$)

Characteristic	Falls		RTAs		Physical Assault		Other	Total
	n (%)	*p*-value	*n* (%)	*p*-value	*n* (%)	*p*-value	*n* (%)	*N*
Sex		*0.020		***0.004		0.385		
Female	49 (65)		14 (19)		4 (5)		8 (11)	75
Male	66 (50)		49 (37)		10 (8)		8 (6)	133
Age group		***0.006		***0.001		0.65		
0–17	4 (19)		4 (19)		1 (5)		12 (57)	21
18–24	16 (48)		12 (36)		3 (9)		2 (6)	33
25–34	15 (38)		18 (45)		4 (10)		3 (8)	40
35–44	17 (46)		16 (43)		1 (3)		3 (8)	37
45–54	13 (50)		7 (27)		3 (12)		3 (12)	26
55–64	13 (65)		6 (30)		0 (0)		1 (5)	20
65+	35 (70)		5 (10)		3 (6)		7 (14)	50

legend: RTA = road traffic accident. P-values are from Fisher's exact tests, *** = $p < 0.001$, * = $p < 0.05$. "Total" values (N, right-hand column) were used as the denominator for calculating proportions (%) across each row

ambulances, the average time between the initial call to the Dispatch Center and arrival at the Emergency Department was less than one hour (median = 40 min). This considers the time it took for prehospital care providers to arrive at the scene after the patient called the Dispatch Center (median = 15 min) and transport from the scene to the Emergency Department (median = 20 min).

96% of Dhulikhel Hospital-owned Type B ambulance patient transports reported vital signs collected at the scene. Frequencies of specific vital measurements were generated to assess completeness; of the 162 records that reported vital signs, 90% reported blood pressure, 94% level of consciousness (Glasgow coma scale), 99% heart rate, and 100% oxygen saturation. Clinical procedures were performed 23% of the time during Dhulikhel Hospital-owned ambulance transports, including wound dressing (49%), fluids (31%), intravenous cannulation (18%), oxygen (31%), relocating a dislocated joint (3%), and wound compression (3%). Prehospital medications were administered to patients during almost half of the Dhulikhel Hospital-owned ambulance transports (49%). Of those receiving medications, 96% received an analgesic compound (89% NSAID, 10% opioid) and 2% received an antibiotic. 17% received a medication other than analgesics or antibiotics.

Table 6 presents the outcomes of 73 trauma patients who were transported to the Emergency Department by Dhulikhel Hospital-owned, DEMS-monitored Type B ambulances, from 2019 to 2023. Criteria for injury severity classifications were adopted from Shrestha et al. (2013) [9]. "Minor" includes soft tissue damage and fractures of the phalanges and toes. "Moderate" includes head, chest, and abdomen injuries that needed no surgical intervention, un-displaced fractures that could be managed with simple measures, and isolated displaced fractures. "Severe" includes head, chest, and abdomen injuries that needed probable surgical intervention and/or detailed investigations, severe polytrauma, multiple fractures, open fractures, fractures associated with hemodynamic instability, and unstable spine and hip fractures.

After consultation with the Emergency Department, 45% were admitted to an in-patient ward and 55% were discharged. Most admitted patients were internally referred to orthopedics (73%), surgery (24%), and/or neurology (12%). 15% were externally referred to a separate healthcare institution. One discharged case reported no final diagnosis in the reviewed records ("unknown"). Two moderate trauma cases left against medical advice ($n = 2$ LAMA), and one moderate and one severe trauma case were discharged on request ($n = 2$ DOR).

Most admitted trauma cases were classified as severe (79%) or moderate (21%). No admitted trauma cases were considered minor (0%), and approximately a third (33%) involved multiple injuries. The most prevalent diagnoses were extremity fractures (52%), followed by axial skeleton fractures (15%), head trauma (15%), spinal injuries (15%), and internal organ trauma (12%). A small number of admitted cases were diagnosed with a severe laceration (6%) and/or minor soft tissue injury (3%). Extremities were the most common anatomical site of trauma (52%), followed by head and neck (28%) and abdominal injuries (12%).

Most discharged trauma cases experienced a minor (70%) or moderate injury (23%). Approximately 8% of discharged cases reported a severe injury, including one case with multiple injuries that was discharged on request (DOR). The most common diagnoses were minor soft tissue injuries (75%), followed by dislocated joints (10%), head trauma (8%), extremity fractures (8%), axial skeleton fractures (5%), and/or spinal injuries (3%). Skin was the most common site of injury among discharged cases (50%), followed by injuries to extremities (30%) and to the head and neck region (20%).

Table 5 Prehospital care of trauma patients transported by Dhulikhel Hospital-owned type B ambulances, 2019–2023

Characteristics		*n* (%)	Median	Q1, Q3
Patient status at scene	Alive	168 (99)		
	Deceased	1 (1)		
Vitals	Any vital recorded: yes	162 (96)		
	Blood pressure	145 (90)		
	Glasgow coma scale	152 (94)		
	Heart rate	161 (99)		
	Oxygen saturation	162 (100)		
Clinical interventions	Any clinical intervention: yes	39 (23)		
	Dressing	19 (49)		
	Fluids	12 (31)		
	IV cannulation	7 (18)		
	Oxygen	12 (31)		
	Relocate dislocation	1 (3)		
	Wound compression	1 (3)		
Medications	Any medication: yes	83 (49)		
	NSAID	74 (89)		
	Opioid	8 (10)		
	Antibiotics	2 (2)		
	Antiemetics	8 (10)		
	Stomach acid blockers	4 (5)		
	Sedatives	3 (4)		
	Sympathomimetics	1 (1)		
Prehospital timestamps	Dispatch call to scene arrival		15	10, 30
	Scene arrival to hospital arrival		20	15, 35
	Dispatch call to hospital arrival		40	25, 60

Legend Vitals, clinical interventions, and medications are not mutually exclusive. The denominators used for generating the proportions of specific vitals, clinical interventions, and medications are the respective totals for patients with any recorded vitals ($n=162$), interventions ($n=39$), or medications ($n=83$). Medication categories include nonsteroidal anti-inflammatory drugs or NSAIDs (ketorolac, diclofenac), opioids (tramadol), antibiotics (metronidazole, cefuroxime), antiemetics (metoclopramide, ondansetron), stomach acid blockers (omeprazole, pantoprazole, ranitidine), sedatives (midazolam), sympathomimetics (noradrenaline)

Table 6 Diagnostic outcomes of trauma patients transported by Dhulikhel Hospital-owned type B ambulances, 2019–2023

Outcomes		Admitted ($n=33$)	Discharged ($n=40$)
		n (%)	*n* (%)
Diagnosis	Axial skeleton fracture	5 (15)	2 (5)
	Dislocated joint	0 (0) 5 (15)	4 (10) 2 (5)
	Extremity fracture	17 (52)	3 (8)
	Head trauma	5 (15)	3 (8)
	Internal organ trauma	4 (12)	4 (12)
	Minor soft tissue injury	0 (0)	75 (30)
	Severe laceration	2 (6)	0 (0)
	Spinal injury	5 (15)	1 (3)
	Unreported	0 (0)	1 (3)
Injury severity and multiple injuries	Minor	0 (0)	28 (70)
	Moderate	7 (21)	9 (23)
	Severe	26 (79)	3 (8)
	Multiple injuries	11 (33)	1 (3)
Injury anatomy	Abdomen	4 (12)	0 (0)
	Chest	2 (6)	0 (0)
	Dorsal spine	1 (3)	0 (0)
	Extremities	17 (52)	12 (30)
	Head/neck	9 (28)	8 (20)
	Lumbar spine	2 (6)	1 (3)
	Skin	0 (0)	20 (50)
	Soft tissue	0 (0)	3 (8)
	Unreported	1 (3)	0 (0)
Referral outcomes	Externally referred	5 (15)	36 (90)
	Intensive Care Unit	6 (2)	2 (5)
	Neurology	4 (12)	2 (5)
	Orthopedics	24 (73)	
	Surgery	8 (24)	
	Discharged from emergency room		36 (90)
	Discharged on request (DOR)		2 (5)
	Left against medical advice (LAMA)		2 (5)

legend: Diagnoses, anatomy, and referrals are not mutually exclusive. "Multiple injuries" = at least two diagnosed traumatic injuries

Discussion

This retrospective analysis provides key insights into the prehospital transport and outcomes of trauma patients in Nepal, focusing on those transported to the Dhulikhel Hospital Emergency Department by Type B ambulances monitored by the Dhulikhel Hospital Dispatch Center, from 2019 to 2023. In other LMICs in Southeast Asia, similar public-private partnerships have improved the timely delivery of prehospital care and transport. These initiatives, like the Dhulikhel Hospital Dispatch Center, integrate existing ambulance fleets into a single network using Global Positioning System (GPS) technology and a centralized emergency call number [10]. To the authors' knowledge, this is the first study that investigates the prehospital care and outcomes of trauma patients transported by fully equipped ambulances staffed with trained prehospital care providers in Nepal.

This study analyzed the prehospital care and outcomes of trauma patients transported by ambulances equipped with trained prehospital care providers and basic medical supplies; however, the majority of ambulances in Nepal still lack trained healthcare professionals and medical equipment to accommodate the prehospital health needs of patients [4, 5].

Of the records reviewed, 15% (227/1541) of patients utilizing Type B ambulances experienced trauma. However, previous research reports that the proportion of trauma patients presenting to the Dhulikhel Hospital Emergency Department is approximately 20% [9].

Another study in 2020 found that only 5% of trauma patients utilized DEMS for prehospital transport to the Emergency Department [11]. Considering the growing burden of trauma in Nepal, these findings may suggest that many trauma patients in this region are underutilizing Type B ambulances monitored by the Dispatch Center for prehospital services and transportation [3]. The national ambulance telephone number, 102, should continue to be widely disseminated in the public sector to increase utilization of one-door prehospital services provided by government entities, non-governmental agencies, and local non-profit organizations.

This study reinforces the extensive outreach of the Dispatch Center and its monitored prehospital system into Kathmandu Valley and surrounding rural municipalities. The seven ambulances included in this study transported patients from 24 municipalities to Dhulikhel Hospital. The Dhulikhel Hospital-owned, DEMS-managed ambulances encompassed a service area of 19 municipalities, yet they maintained an average total transport time of less than one hour. This is significantly less than average transport times reported from other LMICs, which may range from hours to even days due to the isolation of rural communities and undependable road infrastructure [12]. Reaching scene locations within one hour, or the "golden hour," is critical to enhancing the positive outcomes of trauma patients [13]. The two Dhulikhel Hospital-owned ambulances emphasize how the availability of quality EMS infrastructure and trained personnel can have a substantial positive impact on the efficiency of prehospital care in Nepal.

The Dhulikhel Hospital Dispatch Center seeks to facilitate the right care at the right place at the right time, benefiting both patients and healthcare institutions alike. Dhulikhel Hospital is building capacity for trauma care management, reflected by initiatives such as the development of a Trauma and Emergency Center [14]. In the future, Dhulikhel Hospital may be prepared to manage a greater number of advanced trauma cases, such as complex polytrauma and severe lacerations. In this study, 15% of admitted trauma patients were referred to an external healthcare institution for care management and diagnostic testing.

The results indicate that most trauma patients were injured by a fall (55%), road traffic accident (30%), or physical assault (7%), which is consistent with previous trends observed within the Dhulikhel Hospital Emergency Department [9]. Overall, men and individuals aged 18 to 44 were disproportionately impacted by trauma, corresponding with patterns of trauma incidence observed in other LMICs [15]. Injury mechanisms also varied significantly by sex and age group. In particular, RTAs were significantly more prevalent among younger, working-aged men (25–34 years old, $p = 0.001$), while falls significantly were more prevalent among pediatric and geriatric female patients ($p < 0.01$). The distribution of trauma etiology by age and sex may inform community-based prevention strategies aimed at reducing the incidence of trauma in Nepal.

Standardized operating guidelines are essential to improving the quality of prehospital data collection in Nepal. If SOGs are not employed in the field, data completeness and consistency may be compromised, which can impede evidence-based development of a prehospital system with efficient dispatch centers. Furthermore, all ambulances should operate under Nepal's "one-door" policy, which would advance both prehospital data collection and data-sharing through enhanced accountability and technical support from the government [16]. The lack of standardized prehospital care protocols and limited data regulation hampers the ability to leverage evidence-based practices to improve patient outcomes. Without a solid foundation for prehospital data collection in Nepal, the future development of national EMS training and prehospital protocols may be constrained.

Limitations and recommendations

Research limitations can be attributed to its retrospective study design. The quality and completeness of data obtained from the Dhulikhel Hospital Dispatch Center varied, and selection bias limits the generalizability of the results to broader populations. Additionally, temporal bias may have influenced the Dispatch Center's record-keeping practices over time. For instance, the Dispatch Center transitioned to electronic data storage practices in 2022. Ultimately, the findings from the retrospective analysis of this ambulance dataset may not be generalizable to the broader population, including trauma patients transported to Dhulikhel Hospital by other patient transport vehicles (e.g., Type C ambulances, private vehicles, public transportation, etc.).

Prospective data collection is essential to capturing the trends of both trauma and prehospital care delivery in Nepal. For example, future studies at emergency departments may collect prehospital data upon patient arrival. Prospectively collected data from both ambulances and alternative forms of prehospital transport (e.g., private vehicles) can be used to assess significant differences in long-term morbidity or mortality from trauma based on mode of transport.

Ultimately, integration of all ambulances into Nepal's one-door policy is essential to strengthening prehospital trauma care. There is a critical need for the government to fund, regulate, and monitor EMS and prehospital services in Nepal. Fully equipped ambulances and widely promoted SOGs are two essential elements to advancing high-quality prehospital care. Continuous professional development and training programs for prehospital

care providers and ambulance drivers are also crucial. Context-specific Emergency Medical Dispatch training programs represent promising low-cost, high-impact interventional strategies to strengthen prehospital systems in LMICs [17].

Conclusion

Between 2019 and 2023, 15% (227/1541) of patients who received transport and prehospital care services from a Type B ambulance monitored by the Dhulikhel Hospital Dispatch Center were trauma patients. Our findings suggest how stakeholders might address gaps in EMS infrastructure, training, and data monitoring and work towards a more integrated and effective EMS system. The preliminary findings may contribute to future research and advocacy efforts seeking to enhance prehospital care in Nepal.

Abbreviations

BLS	Basic life support
DALYs	Disability-adjusted life years
DEMS	Dhulikhel Hospital Emergency Medical Services
DOR	Discharged on request
EMS	Emergency medical services
EMT	Emergency medical technician
GPS	Global Positioning System
IP	Inpatient
LMICs	Low- and middle-income countries
LAMA	Left against medical advice
RTA	Road traffic accident
SOGs	Standardized operating guidelines

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Author contributions

MLM, LDC, RA, and SB made substantial contributions to the conception and design of the study. SN and MS acquired and prepared the dataset for analysis. MLM and SB analyzed and interpreted the dataset. MLM, LDC, SCY, RA, and SB were major contributors in writing and revising the manuscript. All authors read and approved the final manuscript for submission.

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Data availability

The datasets generated and/or analyzed during the current study are not publicly available due to the inclusion of protected health information (such as hospital in-patient number, age, location, and specific dates) but a de-identified version of the dataset may be available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study protocol was reviewed and approved by Kathmandu University School of Medical Sciences' Institutional Review Committee in May 2024 (approval no. 151/24) and received an exemption by the Medical College of Wisconsin's Institutional Review Board.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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