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The Application of Pre-hospital Emergency Care in Patients with Traumatic Brain Injury Following Road Traffic Collisions

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Abstract: *Objective:* To analyze the efficacy of pre-hospital emergency measures implemented during the treatment of patients with traumatic brain injury resulting from motor vehicle collisions. *Methods:* Sixty patients with traumatic brain injury from road traffic accidents were randomly selected between February 2023 and August 2024. They were divided into two groups of 30 each: a control group receiving conventional emergency care and an observation group receiving pre-hospital emergency care. The efficacy of different treatment approaches was analyzed. *Results:* Comparison of outcomes between the observation and control groups revealed higher success rates and lower mortality rates in the observation group ($p < 0.05$). Compared to the control group, the observation group demonstrated shorter pre-hospital response times, admission times, transport times, and emergency treatment times ($p < 0.05$). Complication rates were lower in the observation group (6.67% vs 26.67%, $p < 0.05$). *Conclusion:* Implementing pre-hospital emergency care for patients with traumatic brain injury following road traffic accidents reduces overall emergency response time, improves resuscitation success rates, and decreases complication incidence.

Keywords: Road traffic accident; Traumatic brain injury; Pre-hospital emergency care

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1. Introduction

The acceleration of modernization has led to a rise in high-energy incidents, particularly road traffic collisions, which constitute a significant cause of traumatic brain injury. Patients often present with multiple injuries, complex clinical conditions, and rapid deterioration, potentially triggering various complications. This results in high mortality risks and considerable treatment challenges, making early intervention critical for therapeutic outcomes and prognosis [1]. Generally, the first hour post-trauma constitutes the critical golden hour for emergency intervention, with prompt treatment significantly enhancing success rates [2]. Thus, pre-hospital emergency care is vital for such patients. As a critical component of the trauma care system, it involves accurately assessing the patient's condition and implementing a series of emergency measures. This approach shortens the emergency response time, ensures the quality of care, and minimizes the

duration of on-site treatment. Consequently, patients can be admitted to hospital for specialized care as swiftly as possible, which is of paramount importance in saving lives [3]. Research indicates that pre-hospital emergency care buys critical time for disease management, facilitating seamless transition between out-of-hospital and in-hospital care. This enables patients to receive specialized treatment promptly, thereby achieving favorable outcomes. Presently, pre-hospital emergency care for patients with traumatic brain injury receives considerable clinical attention. Emergency protocols are increasingly refined, incorporating various effective emergency interventions that demonstrate both timeliness and professionalism in treatment. This has yielded commendable outcomes within the field of trauma care. Consequently, this study analyses the efficacy of implementing pre-hospital emergency measures during the treatment of patients with traumatic brain injury resulting from road traffic collisions, as detailed below.

2. General information and methods

2.1. General information

A randomized sample of 60 patients was selected, all presenting with traumatic brain injury resulting from motor vehicle collisions, with the study period spanning February 2023 to August 2024.

2.1.1. Inclusion criteria

(1) CT-confirmed traumatic brain injury caused by a motor vehicle collision;
(2) Time from injury to hospital admission less than 6 hours;
(3) Normal comprehension and communication abilities;
(4) Informed consent and active cooperation.

2.1.2. Exclusion criteria

(1) Presence of severe complications;
(2) History of psychiatric disorders or cognitive impairment;
(3) Death during hospitalization or refusal of resuscitation;
(4) Hypotensive shock

2.1.3. Study group

Following randomization, 30 patients were assigned to each group. The male-to-female ratio in the control group was 18:12; ages ranged from 22 to 78 years, with a mean of (45.45 ± 4.23) years. In the observation group, the male-to-female ratio was 17: 13; ages ranged from 23 to 76 years, with a mean of (45.67 ± 4.19) years. Analysis demonstrated good balance of the above data ($p > 0.05$).

2.2. Treatment methods

For patients in the control group receiving conventional emergency care, upon receiving the emergency call, the emergency department nurse arranges for an ambulance to attend the scene. The patient is then transported to the hospital, where their injuries are treated. Cardiovascular monitoring is initiated, and the patient is positioned appropriately to alleviate discomfort. Following an assessment of their actual condition, vital signs are closely monitored for any abnormalities. A series of treatment measures are then implemented according to the patient's specific circumstances.

The application of pre-hospital emergency measures to patients in the observation group entailed the following.

2.2.1. Formation of an emergency response team

Comprising key personnel from the department, the team included one emergency physician, one stretcher bearer, one nurse, and one driver, all possessing extensive professional experience. The emergency physician was responsible for

delivering pre-hospital emergency care to patients, the stretcher bearer for patient transport, and the nurse for assisting the physician in emergency procedures.

2.2.2. Enhanced emergency protocol training

Team members undergo concentrated training covering pre-hospital emergency procedures, key points of medical-nursing coordination, and critical aspects of emergency care. Through scenario simulations, team members master core operational protocols, followed by assessment. Only those achieving full qualification may participate in subsequent emergency operations.

2.2.3. Conducting pre-hospital emergency care

(1) Pre-hospital support

Upon receiving an emergency call, the emergency nurse verifies the functionality of emergency equipment, notifies the emergency physician, and immediately accompanies the ambulance with the emergency kit, ensuring arrival within 3 minutes. En route, the nurse contacts the patient's family or witnesses to ascertain the patient's condition and provide appropriate emergency guidance.

(2) Upon arrival at the scene

Medical personnel must reach the scene as swiftly as possible. Based on the specific circumstances, they must rapidly assess the patient's injuries and vital signs to make an objective evaluation of the condition. Immediate on-site treatment measures must be implemented. For critically ill patients who may become unconscious or exhibit loss of pupillary reflexes, intravenous access must be established. pupillary reflexes absent, requiring establishment of an intravenous line. Administer medications to reduce intracranial pressure as prescribed, position the patient appropriately to ensure airway patency, manage trauma promptly, and maintain blood oxygen saturation above 90%. For critically ill patients unable to breathe independently, airway secretions were immediately cleared. The head was turned to one side, and a jaw-thrust maneuvers combined with tongue forceps was employed to thoroughly clear the airway, preventing aspiration. For patients with fractures, simple bandaging was applied followed by splinting. For those experiencing respiratory arrest, tracheal intubation was performed to assist ventilation. For cardiac arrest patients, loosen clothing and belts before commencing chest compressions. For patients with major hemorrhage, apply immediate pressure to arrest bleeding and prevent secondary injury, while elevating the bleeding site and administering timely fluid resuscitation to prevent shock.

(3) Transport

Upon completion of on-site intervention, transfer the patient to the ambulance while closely monitoring vital signs. Implement appropriate therapeutic measures based on the patient's specific condition. Maintain close communication with the emergency department, providing an accurate estimated time of arrival to enable advance preparation of resuscitation medications and equipment. Verify that resuscitation apparatus is operational and ensure all emergency preparations are in place to establish a green channel for the patient. During transport, the emergency physician explains the patient's condition to them and their family, outlining the treatment plan and prognosis to foster confidence in recovery. Appropriate reassurance is provided to encourage cooperation. When moving the patient, maintain stability and avoid jolts. Upon arrival at the emergency department, position the patient securely, conduct a thorough handover, and inform departmental staff of any specific considerations.

2.3. Observation indicators

(1) Record the success rate of emergency treatment and mortality rate for patients.

(2) Record the pre-hospital emergency response time, triage time, transport time, and emergency resuscitation time for patients.

(3) Record the incidence rates of pulmonary infection, cerebral herniation, electrolyte imbalance, and hemorrhagic

shock in patients.

2.4. Statistical methods

Data were analyzed using SPSS version 25.0, with $p < 0.05$ indicating statistically significant differences.

3. Results

3.1. Outcome of the rescue

Comparison of resuscitation outcomes between the observation group and the control group revealed a higher success rate and lower mortality rate ($p < 0.05$), as shown in **Table 1**.

Table 1. Comparison of resuscitation outcomes between two patient groups [n (%)]

Group	n	Success rate	Mortality rate
Control group	30	21 (70.00)	9 (30.00)
Observation group	30	29 (96.67)	1 (3.33)
χ^2		7.680	
p		0.006	

3.2. Emergency response time

Compared with the control group, the observation group demonstrated shorter pre-hospital emergency response times, admission times, and transport times, as well as shorter emergency resuscitation times ($p < 0.05$). See **Table 2** for details.

Table 2. Comparison of emergency response times between two patient groups (min)

Group	Pre-hospital emergency response time	Consultation hours	Delivery time	Emergency resuscitation time
Control group (n = 30)	29.69 ± 5.32	2.23 ± 0.45	6.12 ± 1.23	20.34 ± 3.12
Observation group (n = 30)	22.98 ± 4.45	1.45 ± 0.23	4.45 ± 0.67	15.23 ± 3.02
t	5.299	8.454	18.262	6.446
p	< 0.001	< 0.001	< 0.05	< 0.001

3.3. Incidence of complications

The incidence of complications was lower in the observation group than in the control group (6.67% vs 26.67%) ($p < 0.05$), as shown in **Table 3**.

Table 3. Comparison of complication incidence between the two patient groups [n (%)]

Group	Pulmonary infection	Cerebral herniation	Electrolyte imbalance	Hemorrhagic shock	Complication rate
Control group (n = 30)	2 (6.67)	2 (6.67)	3 (10.00)	1 (3.33)	8 (26.67)
Observation group (n = 30)	1 (3.33)	0 (0.00)	1 (3.33)	0 (0.00)	2 (6.67)
χ^2 value					4.320
p value					0.038

4. Discussion

Cranial brain injuries involve multiple brain regions, making it challenging to precisely determine the extent and severity of a patient's damage. While patients with milder conditions generally have a favorable prognosis, those with severe injuries often experience complications such as cerebral hemorrhage and cerebral oedema, causing significant damage to brain tissue. Furthermore, most such patients sustain additional injuries, and the condition can deteriorate rapidly within a short timeframe, posing a risk of mortality [5]. Consequently, prompt implementation of emergency measures for these patients is of paramount importance. Research suggests that following trauma, psychological states undergo changes, leading to organ dysfunction and unstable vital signs. Implementing emergency interventions within the first hour post-trauma can enhance treatment efficacy and improve patient outcomes [6]. Further studies indicate that for patients with traumatic brain injury, optimizing emergency protocols and elevating treatment quality to ensure prompt and effective care are pivotal to increasing resuscitation success rates [7].

Pre-hospital emergency care constitutes the primary emergency response measure implemented domestically. Upon receiving an emergency call, ambulances rapidly arrive at the scene to administer a series of stabilizing interventions before transferring the patient to hospital. There, comprehensive assessment of injuries enables targeted therapeutic measures. This model ensures both the timeliness and efficacy of care, rendering treatment more purposeful. Transforming medical intervention from reactive to proactive, this approach optimizes emergency protocols while enhancing overall efficiency [8,9]. Research indicates that seamless coordination between pre-hospital and hospital departments following pre-hospital care for patients with traumatic brain injury significantly reduces resuscitation time and mitigates severity of injury [10]. The present study demonstrates that compared to the control group, the observation group achieved higher success rates, lower mortality rates, and fewer complications. This indicates that pre-hospital emergency care enhances rescue success rates and reduces the incidence of complications. Reasoning: Pre-hospital emergency care employs standardized protocols, ensuring orderly execution of procedures. Emergency physicians tailor interventions to specific circumstances, implementing effective measures according to established workflows. This guarantees the timeliness and scientific rigor of emergency response, securing valuable time for patient treatment. Consequently, patients gain access to further medical intervention, leading to favorable outcomes. The implementation of pre-hospital emergency care ensures seamless continuity between out-of-hospital and in-hospital emergency services, preventing delays that could worsen the patient's condition. This enhances the success rate of treatment and reduces the risk of various complications [11]. Moreover, during pre-hospital care, emergency physicians deliver specialized medical services, demonstrating professional competence in treatment. This provides patients with comprehensive care, not only elevating the standard of emergency response but also achieving standardized management across both pre-hospital and hospital settings, thereby further improving treatment success rates [12,13].

This study found that compared with the control group, the observation group exhibited shorter pre-hospital emergency response times, admission times, and transport times to emergency resuscitation. This demonstrates that pre-hospital emergency care can reduce overall treatment duration. Reasoning: Pre-hospital emergency care consistently adheres to a 'patient-centered' treatment philosophy. Prior to implementing emergency measures, a dedicated emergency team is formed with clearly defined roles and comprehensive training. This ensures personnel possess robust clinical skills, enabling them to accurately assess patient injuries, and handle emergencies. This enhances their teamwork and communication skills, enabling better coordination during emergencies to deliver superior patient care. They accurately assess injuries, maintain stable vital signs, and notify emergency department staff during transport to prepare critical equipment and medications. This ensures patients receive prompt, effective treatment upon arrival, improving resuscitation efficiency while maintaining high-quality medical service [14].

In summary, when administering treatment to patients with traumatic brain injury resulting from road traffic accidents, the implementation of pre-hospital emergency care contributes to reducing response times, enhancing the success rate of emergency interventions, and minimizing the occurrence of complications.

Disclosure statement

The author declares no conflict of interest.

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