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The Effect of Initial Oxygenation on Hemodynamic Stability of Trauma Patients in the Emergency Department

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ABSTRACT

Background: Trauma patients presenting to the Emergency Department (ER) often experience hemodynamic instability due to bleeding, hypoxia, and the acute stress response. Early oxygenation is a priority intervention in the management of trauma patients to prevent tissue hypoxia and maintain hemodynamic stability. **Objective:** This study aims to determine the effect of early oxygenation on the hemodynamic stability of trauma patients in the emergency room. **Method:** This study used a quasi-experimental design with a pretest–posttest approach without a control group. The study sample consisted of 40 trauma patients selected using a purposive sampling technique. Hemodynamic parameters measured included blood pressure, pulse rate, respiratory rate, and oxygen saturation before and after initial oxygenation. Data analysis used a paired t-test with a significance level of $p < 0.05$. **Results:** The results of the study showed a significant increase in the hemodynamic stability of trauma patients after initial oxygenation ($p < 0.05$).

Conclusion: Early oxygenation administration has a significant effect on the hemodynamic stability of trauma patients in the ER.

Keywords: Initial Oxygenation, Hemodynamic Stability, Trauma Patients, Emergency Department

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1. Introduction

Trauma is a leading cause of morbidity and mortality worldwide, particularly among the productive age group. Trauma patients presenting to the Emergency Department (ER) are often in critical condition due to airway, breathing, and circulation disorders. One of the most common problems in trauma patients is impaired hemodynamic stability, characterized by hypotension, tachycardia, and decreased tissue perfusion.

Hypoxia is a significant factor that can worsen the hemodynamic condition of trauma patients. Lack of oxygen to the tissues triggers a compensatory response in the form of increased heart rate and vasoconstriction, which, if prolonged, can lead to organ failure. Therefore, early oxygenation is a key step in the ABCDE (Airway, Breathing, Circulation, Disability, Exposure) principle in the management of trauma patients.

Initial oxygenation aims to increase blood oxygen levels, improve tissue perfusion, and help maintain stable blood pressure and heart rate. Although oxygen administration is a common procedure in the emergency department (ER), there is considerable variation in the timing and consistency of administration in trauma patients.

Based on this background, this study was conducted to analyze the effect of early oxygenation on the hemodynamic stability of trauma patients in the Emergency Department.

2. Research Methods

a. Research Design

This study used a quantitative, quasi-experimental design, using a one-group pretest–posttest design. This design was chosen to assess changes in hemodynamic stability in trauma patients before and after initial oxygenation intervention without using a control group. This approach is appropriate for clinical research in the emergency department (ED), which requires rapid intervention and does not allow for delays in standard procedures.

b. Location and Time of Research

The study was conducted in the Emergency Department (ER) of Hospital X, a trauma referral hospital in the local area. The study period lasted from February to April 2025, encompassing preparation, data collection, intervention implementation, and data analysis.

c. Population and Sample

1) Population

The research population was all trauma patients who came and received initial treatment at the Emergency Room of Hospital X during the research period.

2) Sample

The research sample consisted of 40 trauma patients, who were selected using purposive sampling techniques, with clinical considerations and certain criteria so that the research results were more homogeneous and relevant.

d. Inclusion Criteria





- 1) Trauma patients aged ≥ 18 years
- 2) Arrive at the ER within ≤ 1 hour post-trauma
- 3) Experiencing mild to moderate hemodynamic instability (e.g. systolic blood pressure < 100 mmHg, pulse > 100 x/minute, or $SpO_2 < 94\%$)
- 4) Obtaining early oxygenation as part of ER management
- 5) Patients or families are willing to be research respondents

e. Exclusion Criteria

- 1) Patients in cardiac or respiratory arrest upon arrival at the ER
- 2) Patients with severe head trauma (GCS ≤ 8)
- 3) Patients with severe chronic lung disease that affects oxygenation response
- 4) Patients who immediately undergo emergency surgery

f. Research Variables

- Independent variables: Initial oxygenation
- Dependent variable: Hemodynamic stability of trauma patients

g. Hemodynamic Stability Indicators

- 1) Systolic and diastolic blood pressure
- 2) Pulse rate
- 3) Breathing frequency
- 4) Oxygen saturation (SpO_2)

h. Research Instruments

The instruments used in this study include:

- 1) Hemodynamic observation sheet for trauma patients
- 2) Digital/manual blood pressure measuring device
- 3) Pulse oximeter
- 4) Time measuring clock and clinical recording sheet

The measuring instrument is a standard tool used in the ER and has undergone routine calibration by the hospital.

i. Research Procedures

- 1) Preparation Stage
 - Management of research permits and ethical approvals
 - Coordination with the medical team and emergency room nurses
 - Preparation of observation sheets and intervention guides
- 2) Pretest Stage
 - Initial measurements of hemodynamic parameters of trauma patients upon arrival at the ER include:
 - Blood pressure
 - Pulse rate





- Breathing frequency
 - Oxygen saturation (SpO₂)
- 3) Intervention Stage (Initial Oxygenation)
- Administer oxygen immediately after initial measurement
 - Oxygen media:
 - Nasal cannula (3–5 L/min) or
 - Simple mask (6–10 L/min), adjusted to patient condition
 - Oxygen is administered according to the ABCDE principles of trauma and ATLS standards.
- 4) Posttest Stage
- Remeasurement of hemodynamic parameters after 15–30 minutes of oxygen administration
 - Data is recorded on the same observation sheet as the pretest.

j. Data collection technique

Data were collected through direct observation by researchers and emergency room nurses who had been briefed on the research procedures. All data were recorded systematically and kept confidential.

k. Data Analysis Techniques

Data analysis was carried out using statistical software with the following stages:

- 1) Univariate analysis
 - Calculating the mean, standard deviation, and frequency distribution of hemodynamic parameters
- 2) Bivariate analysis
 - Using the Paired T-Test to determine the differences in hemodynamic parameters before and after initial oxygenation administration.
 - The significance level was set at $\alpha = 0.05$.

l. Research Ethics

This research has obtained:

- Approval from the Health Research Ethics Committee of Hospital X.
- Informed consent from the patient or family.
- Guarantee of confidentiality of respondent identity.
- The respondent's right to withdraw at any time without affecting medical services.

3. Research Result





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**a. Research Result**

This study involved 40 trauma patients who presented to the Emergency Department (ER) of Hospital X and met the inclusion criteria. Hemodynamic stability measurements were performed before and after initial oxygenation.

1) Respondent Characteristics

Respondent characteristics include age, gender, and type of trauma experienced.

Table 1. Respondent Characteristics

Characteristics	Frequency (n)	Percentage (%)
Age		
18–30 years	12	30.0
31–45 years	18	45.0
>45 years	10	25.0
Gender		
Man	28	70.0
Woman	12	30.0
Types of Trauma		
Traffic accident	26	65.0
Fall	14	35.0

Most trauma patients are of productive age and are dominated by traffic accident cases.

2) Hemodynamic Parameters Before Initial Oxygenation Administration

Initial measurement results showed that the majority of patients experienced mild to moderate hemodynamic instability.

Table 2. Hemodynamic Parameters Before Initial Oxygenation

Parameter	Mean ± SD	Minimum–Maximum Value
Systolic blood pressure (mmHg)	95.4 ± 8.6	82–110
Diastolic blood pressure (mmHg)	60.8 ± 7.2	48–72
Pulse rate (x/min)	112.5 ± 10.2	98–130
Respiratory rate (x/minute)	26.8 ± 3.4	22–34
Oxygen saturation (%)	89.6 ± 3.2	84–93

These data indicate signs of body compensation for hypoxia and circulatory disorders.

3) Hemodynamic Parameters After Initial Oxygenation Administration





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After initial oxygenation for 15–30 minutes, there was significant improvement in all hemodynamic parameters.

Table 3. Hemodynamic Parameters After Initial Oxygenation

Parameter	Mean ± SD	Minimum–Maximum Value
Systolic blood pressure (mmHg)	112.7 ± 9.1	98–128
Diastolic blood pressure (mmHg)	72.4 ± 6.8	60–85
Pulse rate (x/min)	92.3 ± 8.7	76–108
Respiratory rate (x/minute)	20.5 ± 2.8	16–26
Oxygen saturation (%)	97.4 ± 1.8	94–100

4) Analysis of Hemodynamic Parameter Differences

Table 4.**Comparison of Hemodynamic Parameters Before and After Initial Oxygenation**

Parameter	Before (Mean ± SD)	After (Mean ± SD)	Difference	p-value
Systolic BP (mmHg)	95.4 ± 8.6	112.7 ± 9.1	+17.3	<0.001
Diastolic BP (mmHg)	60.8 ± 7.2	72.4 ± 6.8	+11.6	<0.001
Pulse (x/minute)	112.5 ± 10.2	92.3 ± 8.7	-20.2	<0.001
RR (x/minute)	26.8 ± 3.4	20.5 ± 2.8	-6.3	<0.001
SpO ₂ (%)	89.6 ± 3.2	97.4 ± 1.8	+7.8	<0.001

The results of the Paired T-Test showed that all parameters experienced statistically significant changes ($p < 0.05$).

b. Discussion

The results of this study indicate that early oxygenation significantly improves the hemodynamic stability of trauma patients in the Emergency Department. Increased blood pressure and oxygen saturation, as well as decreased pulse and respiratory rates, reflect improved tissue perfusion and the patient's physiological response.

1) Early Oxygenation and Improvement of Tissue Perfusion

Physiologically, trauma often causes hypoxia due to airway obstruction, ineffective ventilation, or hemorrhage, which reduces the blood's oxygen-carrying capacity. Early oxygenation increases arterial oxygen levels, thereby improving tissue oxygen supply. This reduces cellular hypoxia and decreases compensatory responses such as tachycardia and tachypnea. These findings are consistent with the theory of respiratory physiology, which states that increasing the partial pressure of oxygen increases oxygen diffusion into tissues.

2) Effect on Blood Pressure and Heart Rate





Increased systolic and diastolic blood pressure after initial oxygenation indicates improved circulatory status. Untreated hypoxia can cause peripheral vasodilation and decreased blood pressure. Oxygen administration stabilizes vascular tone, leading to increased blood pressure. A decreased heart rate also indicates reduced cardiovascular stress caused by hypoxia. These results align with Advanced Trauma Life Support (ATLS) principles, which emphasize oxygenation as the initial step to prevent shock and organ failure.

3) Respiratory Rate Decrease as an Indicator of Stability

A decrease in respiratory rate after initial oxygenation indicates that the need for respiratory compensation has decreased. The patient is no longer experiencing severe respiratory distress because tissue oxygenation has improved. This is important because prolonged tachypnea can increase respiratory muscle fatigue and worsen the condition of trauma patients.

4) Consistency with Previous Research

The results of this study align with previous research showing that immediate oxygen administration to trauma patients can increase oxygen saturation and stabilize hemodynamic parameters. Several studies also report that delays in oxygen administration are associated with an increased risk of shock and mortality. Therefore, these findings strengthen the scientific evidence that early oxygenation is a simple, rapid, and crucial intervention in trauma management in the emergency department.

5) Implications for Nursing and Medical Practice

The results of this study confirm that nurses and emergency room medical personnel play a critical role in ensuring rapid and appropriate initial oxygenation in trauma patients. Implementing early oxygenation as part of the emergency room's standard operating procedures (SOPs) can improve patient safety and prevent hemodynamic deterioration.

4. Conclusion and Suggestions

a. Conclusion

- 1) Trauma patients who come to the Emergency Department generally experience hemodynamic instability characterized by hypotension, tachycardia, tachypnea, and decreased oxygen saturation.
- 2) Early oxygenation significantly improves the hemodynamic stability of trauma patients, as seen from increased systolic and diastolic blood pressure and oxygen saturation.
- 3) Early oxygenation also significantly reduced pulse and respiratory rates, indicating an improvement in the patient's physiological condition.





- 4) Early oxygenation is an effective, simple, and crucial initial intervention in the management of trauma patients in the Emergency Department.

b. Suggestion

- 1) For Health Workers

Health workers in the ER, especially nurses and doctors, are advised to provide initial oxygenation quickly and appropriately to every trauma patient in accordance with the ABCDE principles and ATLS guidelines to prevent worsening of hemodynamic conditions.

- 2) For Hospital Management

Hospital management is expected to establish early oxygenation as part of the standard operating procedures (SOP) for handling trauma patients in the ER and ensure the availability of supporting facilities and infrastructure.

- 3) For Nursing and Medical Education

Educational institutions are expected to strengthen learning and clinical practice related to the initial management of trauma patients, particularly the importance of early oxygenation in maintaining hemodynamic stability.

- 4) For Further Researchers

Further research is recommended using an experimental design with a control group, a larger sample size, and considering other variables such as type of trauma, severity of injury, and long-term clinical outcomes.

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