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PROSPECTIVE STUDY ON THE IMPORTANCE OF BASE DEFICIT AND ARTERIAL LACTATE AS PROGNOSTIC MARKER IN CHEST AND ABDOMINAL TRAUMA AT A TERTIARY CARE CENTRE IN GORAKHPUR

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Abstract

Background: In India, trauma is the leading cause of death. Early recognition of hemorrhagic shock and prompt therapy can improve outcomes. Lactate and base deficit are used as signs of shock and resuscitation.
Objective: To determine the association of Base Deficit and lactate and its used to determine a patient's prognosis after trauma.
Methods: Total 146 subjects with poly/isolated trauma with the possibility of hemodynamic compromise were included in this prospective observational analysis. An arterial blood gas sample was obtained within one hour of admission to the surgical emergency department. Both arterial lactate and baseline deficit were noted. Patients were followed throughout their hospital stay.
Results: Patients in the index study had a mean baseline deficit and arterial lactate values of 5.071 mmol/L and 5.695 mmol/L, respectively. Overall, in chest and abdominal trauma patients in the current study, baseline deficit and arterial lactate levels at the time of admission were significant predictors of short-term outcomes such as the need for blood transfusion, length of hospital stay, and hospital mortality.
Conclusion: Serum lactate and base deficit could be used as additional prognostic indicators for patients with chest and abdominal trauma.

Keywords: Base deficit, lactate, trauma, blood transfusion, mortality

1. Introduction

In the last century, trauma has become one of the major causes of mortality and morbidity worldwide, along with industrialization, scientific and technological progress.[1] Currently, India is among the countries with the highest age-standardised injury mortality (0.15 million

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deaths per year).[2] Treatment of trauma victims requires rapid assessment and resuscitation, which can only be achieved by early recognition of hemorrhagic shock and immediate action.[3] In particular, thoracic and abdominal injuries have steadily increased with the increasing number of motor vehicles on the road. Together with urbanisation and industrialization, these traffic accidents have led to a noticeable increase in trauma.[4] According to projections from WHO (World Health Organisation), road traffic accidents will replace homicides as the second leading cause of preventable death worldwide by 2020.[5] After cancer and cardiovascular disease, chest trauma is the third leading cause of death and morbidity worldwide.[4,6] Chest injuries have been found to account for 1/4 to 1/5 of mortality in trauma patients.[7] Trauma experts believe that abdominal injuries are among the most common.[8] In addition, the abdomen has been found to be involved in one-fifth of traffic accident injuries.[9] Hemorrhagic shock, which accounts for 30% to 40% of all deaths in trauma patients, is a leading cause of death.

Oxygen delivery and consumption are in balance when the condition is stable. After haemorrhage, hypovolemic shock occurs, causing an imbalance in oxygen delivery. This results in an oxygen deficit that causes the cell to switch to anaerobic metabolism when tissue perfusion falls below the baseline level of required oxygen consumption. The base deficit (BD), a net metabolic acidosis resulting from the oxygen debt during this process, increases the total number of metabolic acids in plasma and increases arterial lactate. In some shock situations, lactate, an anaerobic metabolic byproduct, can serve as a marker of cellular hypoxia.[10] Currently available portable point-of-care testing (POCT) provides rapid measurement of arterial lactate. It remains controversial whether blood lactate monitoring should be used for risk assessment in critically ill patients. Arterial lactate monitoring is used as an indirect indicator of tissue hypoxia in the ICU.[11,12]

The goal of resuscitation in trauma patients with hypovolemic shock is to restore physiologic balance, as assessed by hemodynamic indicators (e.g., vital signs), biochemical markers (e.g., serum lactate, base excess), and coagulation factors. Trauma patients may arrive hemodynamically normal but still be at risk for deterioration due to occult damage. In patients who require massive transfusions (MT), early recognition of these patients may improve therapy. Currently, vital signs such as blood pressure (BP) and heart rate (HR) are used to determine the condition and treatment of trauma.[13] However, blood pressure changes are a late sign of hemodynamic instability because they do not occur until 30% to 40% or more of the circulatory volume has been lost.[3] In addition, tachycardia is not a good indicator of shock. Therefore, vital signs should be used only as surrogate indicators and not as precise indicators of oxygenation. Base deficit (BD) and lactate, which are true metabolic byproducts of tissue hypoperfusion, may serve as better indicators of the presence and extent of continuous haemorrhage. Current emergency risk assessment methods, such as the Injury Severity Score (ISS) and the Abbreviated Injury Score (AIS), are widely used but have limited utility for clinical decision making.[14] In addition, they are difficult to calculate. Numerous research efforts have attempted to find biochemical markers that can signal severity and mortality to circumvent this limitation.[15] In addition, research has shown that uptake BD is a valid indicator of the relative extent of volume deficit and a predictor of death after trauma.

Biochemical markers at the point of care are increasingly used as prognostic indicators in trauma but have not been thoroughly studied in India. The use of arterial lactate to determine the dangerousness of critical trauma patients is still controversial. This is primarily due to the lack of clarity regarding the reference interval that determines whether a series of measurements is required or whether an initial baseline arterial lactate value can be predictive. In addition, there is still no agreement on how arterial lactate should be measured

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in arterial, venous, or capillary blood. The issue of single or serial sampling, limits, or timing of sampling has not been addressed in previous assessments.

In India, the emergency care system is still under development.[16] Studies examining trauma care and predictors of outcomes are lacking. The present study aims to show how arterial lactate and base deficit (BD) are used to determine a patient's prognosis after trauma.

2. Materials and methods

In this prospective observational study, 146 patients with poly/isolated trauma and the potential for hemodynamic compromise were admitted to the surgical emergency department of BRD Medical University, Gorakhpur. The institutional ethics committee gave its approval for the project. Patients with penetrating and blunt thoracic and abdominal trauma aged 18 to 65 years were included. Exclusion criteria included cerebral haemorrhage, blood transfusion before arrival, cardiac arrest before arrival, transfer after stabilisation, and resuscitation for patients with severe head injury (GCS 8 on arrival).

Patients who arrived at the surgical emergency department were evaluated for trauma to the chest or abdomen. All patients who met the inclusion criteria and had either abdominal or thoracic trauma or both gave informed consent. A sample of arterial blood gas was obtained within 1 hour of admission to the surgical emergency department. Baseline deficiency values and arterial lactate were recorded.

Patients were monitored throughout their hospital stay. The length of time patients remained in the hospital, whether they required blood transfusion during their stay, whether they were treated conservatively or surgically, and whether they died or were discharged were recorded.

Statistical analysis

Data were entered into Microsoft Excel. SPSS 26.0 was used for analysis. Frequencies and proportions were used to represent categorical variables. The Kolmogorov-Smirnov test was used to determine that continuous variables were not normally distributed. Spearman correlation was used to examine the relationship between continuous variables. ROC Curves were developed to examine the prognostic value of base deficit and arterial lactate for mortality, type of treatment, and need for blood transfusion. Statistical significance is defined as a p value of 0.05.

3. Results:

Majority of the patients in our study were in the age group of 21-30 years (26%), followed by 41-50 years (22.6%) and 31-40 years (19.9%). Majority of the patients in our study were males (91.1%), while 8.9% were females. Among the patients, majority had blunt trauma abdomen (57.5%), followed by chest injury (25.3%). 17.1% of the patients had penetrating injury of their abdomen.

Table 1: Baseline characteristics of the patients

		n	%
Gender	11-20 years	18	12.3
	21-30 years	38	26.0
	31-40 years	29	19.9
	41-50 years	33	22.6
	51-60 years	19	13.0
	61-70 years	9	6.2

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Gender	Male	133	91.1
	Female	13	8.9
Injury	Chest Injury	37	25.3
	Blunt Trauma Abdomen	84	57.5
	Penetrating Injury Abdomen	25	17.1

The mean age of patients in our study was 37.42±14.01 years. The median SBP and DBP of our patients were 88 and 53 mm Hg, respectively. The median pulse rate and SpO2 were 115 and 98%, respectively. The mean GCS was 15. The mean base deficit of the patients was 5.071±1.81, mean arterial lactate values were 5.695±1.55, and the median length of hospital stay of the patients was 10 days (Table 2).

Table 2: Mean, ±SD, median and IQR of age, SBP, DBP, pulse rate, SpO2 on room air, GCS, Base deficit, arterial lactate and hospital stay (days) of patients

	Mean	**±SD**	**Median**	**IQR**
Age	37.42	14.01	35.00	24-48
SBP	96.07	15.12	88.00	85-110
DBP	58.86	12.19	53.00	50-70
Pulse rate	109.54	18.89	115.50	88-128
Spo2 on room air	97.54	1.97	98.00	98-98
GCS	15.00	0.00	15.00	15-15
Base deficit	5.07	1.81	5.90	3.4-6.6
Arterial lactate	5.70	1.55	6.70	4.2-6.9
Hospital stay (days)	9.99	3.74	10.00	7-12

Overall, the majority of patients had a hospital stay of 6 to 10 days (44.5%), while 37.7% of patients had a stay of 11-15 days. 65.8% of patients required a blood transfusion. The majority of patients required two units of blood transfusion (53.4%). Only 6.8% needed more than two blood transfusions. 35.6% of patients did not need any blood transfusion (Table 3).

Table 3: Details of length of hospital stay, blood transfusion, and number of units of blood transfused

		n	%
Duration of hospital stay	1-5 days	19	13.0
	6-10 days	65	44.5
	11-15 days	55	37.7
	16-20 days	5	3.4
	>20 days	2	1.4
Blood transfusion	Yes	96	65.8
	No	50	34.2
No. of units of blood transfused	0	52	35.6
	1	6	4.1
	2	78	53.4
	3	10	6.8

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The most common patients treated conservatively had a chest injury (53.7%). The majority of surgically treated patients had blunt trauma to the abdomen (64.1%) and penetrating injury to the abdomen. The majority of patients were treated surgically (63%), while 37% were treated conservatively. The mortality rate was 2.7% of patients (Table 4).

Table 4: Distribution of patients after conservative treatment and surgical intervention for different injuries and final outcome

		n	%
Chest injury	Conservative management	29	78.4
	Operative intervention	8	21.6
Blunt Trauma Abdomen	Conservative management	25	46.1
	Operative intervention	59	64.1
Abdomen injury	Conservative management	25	22.9
	Operative intervention	84	77.1
Intervention	Conservative management	54	37.0
	Operative intervention	92	63.0
Final outcome	Discharged	142	97.3
	Expired	4	2.7

There was a significant positive and high correlation between base deficit (0.742), arterial lactate (0.782), and length of hospital stay (Table 5).

Table 5: Correlation of base deficit and arterial lactate with length of hospital stay

	Correlation coefficient	**P value**
Base deficit	0.742	<0.001
Arterial lactate	0.782	<0.001

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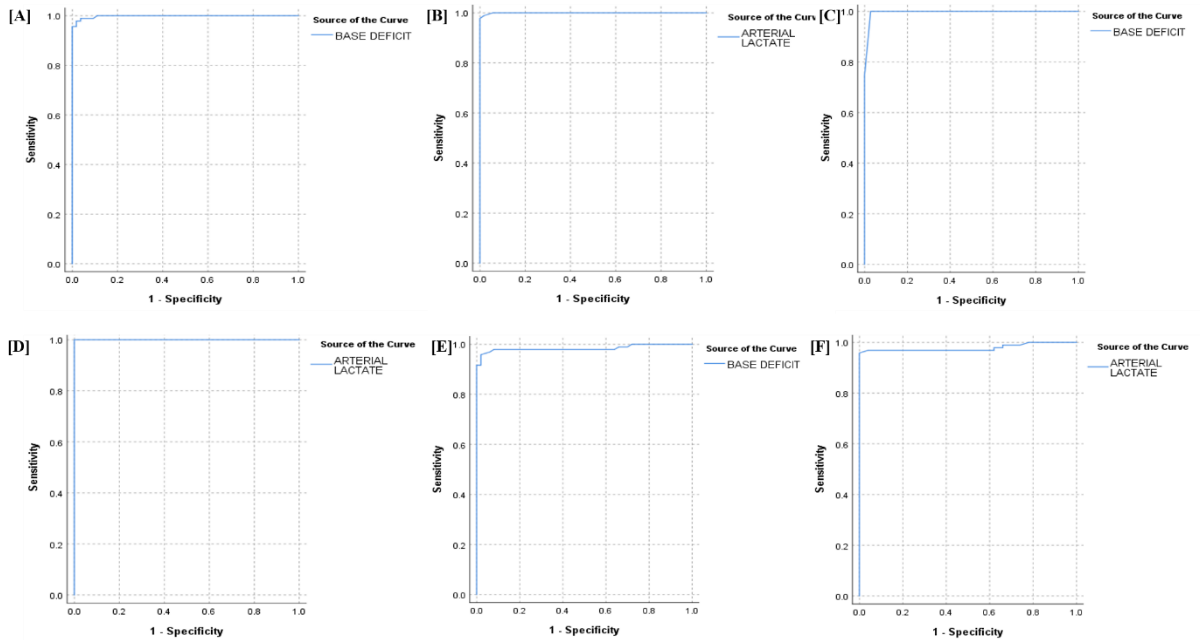

Figure 1: ROC curve of base deficit predicting surgical intervention [A] Base deficit predicting need for surgical intervention, [B] arterial lactate predicting need for surgical intervention, [C] base deficit predicting mortality, [D] arterial lactate predicting mortality, [E] base deficit predicting need for blood transfusion, and [F] arterial lactate predicting need for blood transfusion

The AUC of the base deficit values was 0.998 ($p < 0.001$). Base deficit was a significant predictor of the need for surgical intervention. The ideal cutoff value for Base deficit to predict the need for surgical intervention is 4.75. A base deficit of > 4.75 can predict the need for surgical intervention with a sensitivity of 97.8% and a specificity of 98.1%. The AUC of arterial lactate was 0.999 ($p < 0.001$). Arterial lactate was a significant predictor of the need for surgical intervention. The ideal cutoff value for the Base deficit to predict the need for surgical intervention is 5.85. An arterial lactate value of > 5.85 can predict the need for surgical intervention with a sensitivity of 97.8% and a specificity of 100%. The AUC of the base deficit values was 0.996 ($p < 0.001$). Base deficit was a significant predictor of mortality. The ideal cutoff value for Base deficit to predict mortality is 6.85. A Base deficit value of > 6.85 can predict mortality with a sensitivity of 100% and a specificity of 97.2%. The AUC of arterial lactate levels was 1.000 ($p < 0.001$). Base deficit was a significant predictor of mortality. The ideal arterial lactate cut-off value to predict mortality is 7.2, and an arterial lactate value of > 7.2 can predict mortality with a sensitivity of 100% and a specificity of 100%. The AUC of the Base deficit values was 0.984 ($p < 0.001$). Base deficit was a significant predictor of the need for blood transfusion. The ideal cutoff value for Base deficit to predict the need for blood transfusion is 4.3. A Base deficit of > 4.3 can predict the need for blood transfusion with a sensitivity of 95.8% and a specificity of 98%. The AUC of arterial lactate was 0.979 ($p < 0.001$). Arterial lactate was a significant predictor of the need for blood transfusion. The ideal arterial lactate cutoff value for predicting the need for blood transfusion is 5.85. An arterial lactate value of > 5.85 can predict the need for blood transfusion with a sensitivity of 93.8% and a specificity of 100% [Figure 1].

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4. Discussion

In trauma patients who have sustained severe injuries and are at high risk of mortality, it is critical to determine the extent of damage as soon as possible to protect the patient and reduce the likelihood of adverse medical outcomes.[15,16] The results of such assessments and biomarkers are used to determine patient triage and treatment, with additional emphasis on minimising time spent at the scene or in the emergency department as much as possible, as well as ensuring rapid and adequate oxygen delivery and improving organ perfusion to increase the likelihood that the patient will survive the incident.[17] Thoracic trauma is an important cause of mortality and morbidity, ranking third worldwide after cancer and cardiovascular disease.[4,18] It has been stated that 20% to 25% of deaths in trauma patients are due to thoracic injuries.[7] It is reported that nearly one-third of all patients treated for trauma had abdominal injuries. Because surgical intervention is required in approximately 25% of these injuries, rigorous and accurate biomarkers are needed to determine the best course of treatment and, therefore, outcomes.[19] Therefore, it is necessary to examine in detail the prognostic signs in individuals who have sustained abdominal and thoracic trauma. The present study was conducted in 146 trauma patients with thoracic and abdominal injuries to assess the prognostic significance of baseline deficit and arterial scores at a tertiary institute in Gorakhpur, India.
In a similar study from Patna, India, Jyoti et al evaluated the ability of lactate levels and base deficit to predict mortality in polytrauma patients.[17] In another study from India, Javali et al evaluated arterial and base deficit outcomes in trauma patients.[20] Odom et al evaluated the role of lactate clearance in predicting mortality in trauma patients from Boston, USA.[21] Similar studies examining the prognostic value of base deficit and/or lactate level on outcomes in trauma patients have been conducted in Germany (Rixen et al., Mutschler et al.), Iran (Mofidi et al.), the United States (Brooke et al., Davis et al.), Brazil (Freitas et al.), France (Raux et al.), and Egypt (Saad et al.).[22-29]

In our study the majority of patients were male (91.1%). Similar studies in the past have also found a preponderance of males in trauma cases. In previous study, Jyoti et al. found 86% of patients were male,[21] in Odom et al. 62-68%,[24] and in Rixen et al. 70%.[17]
The mean age of patients in our study was 37.42 years, similar to previous studies, in which reported that the mean age of the patients were 38.9 to 39.5 years.[22,24] Another study included slightly younger patients (mean=34.8 years).[25] The mean age of survivors and nonsurvivors was 37.36 years and 39.50 years, respectively, which was similar in our study. This was similar to the age in the study of Jyoti et al (mean=34.11 and 36.73 years, respectively).[17] However, in a study, the mean age of patients who died (67.89 years) was higher than that of survivors (48.20 years).[21] The majority of patients in our study were in the age group of 21-30 years (26%). Similarly, the majority of patients were in the age group of 20-29 years, but the proportion was higher than in our study (41.1%).[17]

In this study the mean SBP and DBP of patients were 88 and 53 mm Hg, respectively. A previous study reported that the mean SBP of 118 and a DBP of 68 mm Hg.[25] The mean pulse rate and SpO2 were 115 and 98%, respectively. The patients had a mean pulse rate of 91.5 per minute.[25]
In present study the mean GCS score on admission was 15 in both discharged and deceased patients. In contrast, previous study reported a significantly lower GCS score on admission in deceased patients (7.8) than in surviving patients (13.8).[21]

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In the present study, patients were found to have a mean base deficit of 5.071 mmol/L. This was high compared with the base deficit at admission (3.5 mmol/L).[24] The survivors had a mean base deficit of 5.013 and the nonsurvivors of 7.150. Another study reported a higher base deficit (7) in the deceased patients than in the surviving patients (4).[28]

In our study the mean arterial lactate values were 5.695. The survivors had a mean base deficit of 5.640, whereas the nonsurvivors had a base deficit of 7.650. A study reported higher arterial lactate values in the deceased patients (3.8) than in the survivors (2.5), but the values were lower than in our study.[24] Another study also reported higher lactate values (mean=5.4) in deceased than in surviving patients (mean=3.6).[28]

In the present study, 65.8% of patients required one blood transfusion. The majority of patients required two blood transfusions (53.4%). In our study, base deficit was found to be a significant predictor of the need for blood transfusion at a cut-off value of 4.3. A study reported that at a cut-off value of 8 mEq/L, base deficit was a significant predictor of blood transfusion in trauma patients.[20] This is consistent with the findings of various previous study, in which reported that the increased need for blood transfusion when base deficit worsened.[24,27] Another study found that base deficit was a significant predictor of intra-abdominal haemorrhage and transfusion requirements, with significant accuracy at a cut-off value of 6.[25] The base deficit was significantly associated with the need for blood transfusion, and it was a better predictor than lactate levels.[28]

A base deficit of > 4.3 can predict the need for blood transfusion with a sensitivity of 95.8% and a specificity of 98% in our study, whereas Mofidi et al reported a sensitivity and specificity of 88.2% and 95.2% at a cut-off value of 6.[25]

The AUC of arterial lactate levels in our patients was 0.979, whereas Brooke et al reported an AUC of 0.71 for transfusion.[22] In our study, arterial lactate was a significant predictor of the need for blood transfusion, similar to Brooke et al.[22] The ideal cutoff value for arterial lactate to predict the need for blood transfusion is 5.85, whereas Brooke et al reported a value of 4 mmol/L.[22] Javali et al reported that arterial lactate at a cutoff value of 2.9 mmol/L is a significant predictor of transfusion in trauma patients.[20] An arterial lactate value of > 5.85 can predict the need for blood transfusion with a sensitivity of 93.8% and a specificity of 100%. Davis et al found that lactate level was significantly associated with the need for blood transfusion.[28]

In our study there was a significant positive and high correlation between base deficit (0.742), arterial lactate (0.782), and length of hospital stay. Lactate levels were found to be associated with longer duration of hospitalisation.[30]

In this study the mortality rate in our study was 2.7%, whereas a study reported a higher mortality rate of 17%.[17] The difference in mortality between studies could be due to the inclusion of other trauma (including head injury) as well as the treatment protocol and facilities available in each study setting.

In the index study, baseline deficit was found to be a significant predictor of mortality (6.85), similar to the findings of Javali et al.[20] whereas Rixen et al reported an increase in mortality with a low baseline deficit in trauma patients.[21] Saad et al reported that a baseline deficit of > -5.6 predicted mortality in polytrauma patients with a sensitivity and specificity of 64% and 93%, respectively.[26] A study found that baseline deficit was significantly associated with mortality, and it was a better predictor than lactate levels.[21] In contrast, a study reported that

baseline deficit on admission was not a significant predictor of mortality in trauma patients, but 24-hour higher baseline deficit values were predictive of mortality.[17]
In our study, we found that arterial lactate was a significant predictor of mortality, with a diagnostic ability of 100% sensitivity and specificity at a cut-off value of 7.2. Previous study found that arterial lactate was a significant predictor, with a cut-off value of 4 mol/L.[20] Another study reported in their study that arterial lactate levels at the time of admission were a significant prognostic factor for mortality, with a cut-off value of > 2.5.[21] Similarly previous studies reported a lactate value of > 2.6 with a sensitivity and specificity of 92% and 42% to predict mortality.[26] However, caution should be exercised in interpreting our results because the sample size was smaller. Also, Arslan et al reported that lactate at the time of admission was one of the strongest predictors of mortality in trauma patients from New York.[31] In contrast, previous studies reported, that arterial lactate on admission was not a significant predictor of mortality in trauma patients, but 12-hour higher arterial lactate levels were predictive of mortality.[17,29] Serum lactate has also been reported to predict injury severity in trauma patients.[32] Previous studies found that both baseline deficit and lactate levels were significant predictors of 72-hour and 48-hour mortality, respectively, in polytrauma patients.[16,33] It has also been reported that the predictive power of baseline deficit and arterial lactate for clinical outcomes in trauma patients is not attenuated by drugs or alcohol, which are commonly present in trauma patients.[34]

Limitations

Because the study was conducted in patients from a single institution, external validity is limited. The descriptive nature of the study design limits the determination of a causal relationship between base deficit, arterial lactate, and outcomes. Serial measurements of base deficit and lactate clearance could have identified potential predictors of outcomes. Associated diseases could influence outcomes, which was not investigated.

5. Conclusion

We concluded that chest and abdominal trauma were responsible for a significant proportion of morbidity and mortality among trauma patients. The mean base deficit and arterial lactate values of the patients in the index study were 5.071 mmol/L and 5.695 mmol/L, respectively. Overall, base deficit and arterial lactate levels at the time of admission are significant predictors of short-term outcomes such as the need for blood transfusion, length of hospital stay, and in-hospital mortality in the chest and abdominal trauma patients in the present study. Serum lactate and base deficit can be used as additional prognostic factors for outcomes in chest and abdominal trauma patients. Biomarkers that predict the prognosis of patients with thoracic and abdominal injuries could help in early intervention and treatment, which in turn would reduce morbidity and mortality. Further prospective studies with sufficient power should be conducted in our setting to verify the results.

6. Reference

1. Krug EG, Mercy JA, Dahlberg LL, Zwi AB. The world report on violence and health. Lancet. 2002 Oct;360(9339):1083-8. doi: 10.1016/S0140-6736(02)11133-0, PMID 12384003.
2. Ram B, Thakur R. Measuring the burden of accidental injuries in India: a cross-sectional analysis of the National Sample Survey (2017-18). Humanit Soc Sci Commun. 2022;9(1):363. doi: 10.1057/s41599-022-01369-0.

ISSN: 0975-3583,0976-2833 VOL14, ISSUE6**, 2023**

3. Brasel KJ. Advanced trauma life support (ATLS®). 9th ed. J Trauma Acute Care Surg. 2013 May;74(5):1363-6.
4. Khan IA, Ghaffar S, Asif S, Zia-ur-Rehman S, Asad S, Ahmed E, et al. Management of thoracic trauma: experience at Ayub Teaching Hospital, Abbottabad. J Ayub Med Coll Abbottabad. 2009;21(1):152-4. PMID 20364767.
5. Krug EG, Sharma GK, Lozano R. The global burden of injuries. Am J Public Health. 2000;90(4):523-6. doi: 10.2105/ajph.90.4.523, PMID 10754963.
6. Hemmati H, Kazemnezhad-Leili E, Mohtasham-Amiri Z, Darzi AA, Davoudi-Kiakalayeh A, Dehnadi-Moghaddam A, et al. Evaluation of chest and abdominal injuries in trauma patients hospitalized in the surgery ward of Poursina teaching hospital, Guilan, Iran. Arch Trauma Res. 2013 Feb;1(4):161-5. doi: 10.5812/atr.7672, PMID 24396771.
7. Veysi VT, Nikolaou VS, Paliobeis C, Efstathopoulos N, Giannoudis PV. Prevalence of chest trauma, associated injuries and mortality: A level I trauma centre experience. Int Orthop. 2009 Oct;33(5):1425-33. doi: 10.1007/s00264-009-0746-9, PMID 19266199.
8. Sah D, Sinha SP. Pattern of abdominal injuries in A tertiary Care Center in western U.P. Ann int Med. Dent Res. 2016 Oct;2(6).
9. Motie M, Behnampour N, Alinezhad H. Epidemiology of blunt abdominal trauma in Gorgan–Iran (2001-05). J Gorgan Univ Med Sci. 2009.
10. Mizock BA, Falk JL. Lactic acidosis in critical illness. Crit Care Med. 1992;20(1):80-93. doi: 10.1097/00003246-199201000-00020, PMID 1309494.
11. Jansen TC, Van Bommel J, Bakker J. Blood lactate monitoring in critically ill patients: a systematic health technology assessment. Crit Care Med. 2009;37(10):2827-39. doi: 10.1097/CCM.0b013e3181a98899, PMID 19707124.
12. Shapiro NI, Howell MD, Talmor D, Nathanson LA, Lisbon A, Wolfe RE, et al. Serum lactate as a predictor of mortality in emergency department patients with infection. Ann Emerg Med. 2005;45(5):524-8. doi: 10.1016/j.annemergmed.2004.12.006, PMID 15855951.
13. Paladino L, Sinert R, Wallace D, Anderson T, Yadav K, Zehtabchi S. The utility of base deficit and arterial lactate in differentiating major from minor injury in trauma patients with normal vital signs. Resuscitation. 2008;77(3):363-8. doi: 10.1016/j.resuscitation.2008.01.022, PMID 18367305.
14. MacKenzie EJ. Injury severity scales: overview and directions for future research. Am J Emerg Med. 1984;2(6):537-49. doi: 10.1016/0735-6757(84)90081-0, PMID 6442155.
15. James SL, Abate D, Abate KH, Abay SM, Abbafati C, Abbasi N. Global, regional, and national incidence, prevalence, and years lived with disability for 354 Diseases and Injuries for 195 countries and territories, 1990-2017: A systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2018 Nov;392(10159):1789-858. doi: 10.1016/S0140-6736(18)32279-7, PMID 30496104.
16. Qi J, Bao L, Yang P, Chen D. Comparison of base excess, lactate and pH predicting 72-h mortality of multiple trauma. BMC Emerg Med. 2021;21(1):80. doi: 10.1186/s12873-021-00465-9, PMID 34233612.
17. Jyoti D, Kumar A, Halim T, Hai AA. The association between serum lactate concentration, base deficit, and mortality in polytrauma patients as a prognostic factor: an observational study. Cureus. 2022 Aug 20;14(8):e28200. doi: 10.7759/cureus.28200, PMID 36158397.

18. Mefire AC, Pagbe JJ, Fokou M, Nguimbous JF, Guifo ML, Bahebeck J. Analysis of epidemiology, lesions, treatment and outcome of 354 consecutive cases of blunt and penetrating trauma to the chest in an African setting. S Afr J Surg. 2010 Jul;48(3):90-3. PMID 21924001.
19. Ntundu SH, Herman AM, Kishe A, Babu H, Jahanpour OF, Msuya D, et al. Patterns and outcomes of patients with abdominal trauma on operative management from northern Tanzania: a prospective single centre observational study. BMC Surg. 2019;19(1):69. doi: 10.1186/s12893-019-0530-8, PMID 31242883.
20. Javali RH, Ravindra P, Patil A, Srinivasarangan M, Mundada H, Adarsh SB, et al. A clinical study on the initial assessment of arterial lactate and base deficit as predictors of outcome in trauma patients. Indian J Crit Care Med. 2017 Nov;21(11):719-25. doi: 10.4103/ijccm.IJCCM_218_17, PMID 29279631.
21. Odom SR, Howell MD, Silva GS, Nielsen VM, Gupta A, Shapiro NI, et al. Lactate clearance as a predictor of mortality in trauma patients. J Trauma Acute Care Surg. 2013 Apr;74(4):999-1004. doi: 10.1097/TA.0b013e3182858a3e, PMID 23511137.
22. Brooke M, Yeung L, Miraflor E, Garcia A, Victorino GP. Lactate predicts massive transfusion in hemodynamically normal patients. J Surg Res. 2016 Jul;204(1):139-44. doi: 10.1016/j.jss.2016.04.015, PMID 27451880.
23. Raux M, Le Manach Y, Gauss T, Baumgarten R, Hamada S, Harrois A, et al. Comparison of the prognostic significance of initial blood lactate and base deficit in trauma patients. Anesthesiology. 2017 Mar;126(3):522-33. doi: 10.1097/ALN.0000000000001490, PMID 28059838.
24. Rixen D, Raum M, Bouillon B, Lefering R, Neugebauer E, Arbeitsgemeinschaft "Polytrauma" of the Deutsche Gesellschaft fur Unfallchirurgie. Base deficit development and its prognostic significance in posttrauma critical illness: an analysis by the trauma registry of the Deutsche Gesellschaft für unfallchirurgie. Shock. 2001;15(2):83-9. doi: 10.1097/00024382-200115020-00001, PMID 11220646.
25. Mofidi M, Hasani A, Kianmehr N. Determining the accuracy of base deficit in diagnosis of intra-abdominal injury in patients with blunt abdominal trauma. Am J Emerg Med. 2010;28(8):933-6. doi: 10.1016/j.ajem.2009.06.002, PMID 20825927.
26. Saad S, Mohamed N, Moghazy A, Ellabban G, El-Kamash S. Venous glucose, serum lactate and base deficit as biochemical predictors of mortality in patients with polytrauma. Ulus Travma Acil Cerrahi Derg. 2016;22(1):29-33. doi: 10.5505/tjtes.2015.96832, PMID 27135075.
27. Mutschler M, Nienaber U, Brockamp T, Wafaisade A, Fabian T, Paffrath T, et al. Renaissance of base deficit for the initial assessment of trauma patients: a base deficit-based classification for hypovolemic shock developed on data from 16,305 patients derived from the TraumaRegister DGU®. Crit Care. 2013 Mar;17(2):R42. doi: 10.1186/cc12555, PMID 23497602.
28. Davis JW, Dirks RC, Kaups KL, Tran P. Base deficit is superior to lactate in trauma. Am J Surg. 2018 Apr;215(4):682-5. doi: 10.1016/j.amjsurg.2018.01.025, PMID 29409590.
29. Freitas AD, Franzon O. Lactate as predictor of mortality in polytrauma. Arq Bras Cir Dig. 2015;28(3):163-6. doi: 10.1590/S0102-67202015000300004, PMID 26537138.

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30. Lavery RF, Livingston DH, Tortella BJ, Sambol JT, Slomovitz BM, Siegel JH. The utility of venous lactate to triage injured patients in the trauma center. J Am Coll Surg. 2000 Jun;190(6):656-64. doi: 10.1016/s1072-7515(00)00271-4, PMID 10873000.
31. Arslan A, Flax L, Fraser R, Kanter M, Simon R, Caputo ND. Twenty-four-hour packed red blood cell requirement is the strongest independent prognostic marker of mortality in ED trauma patients. Am J Emerg Med. 2016 Jun;34(6):1121-4. doi: 10.1016/j.ajem.2016.03.036, PMID 27066932.
32. Okello M, Makobore P, Wangoda R, Upoki A, Galukande M. Serum lactate as a predictor of early outcomes among trauma patients in Uganda. Int J Emerg Med. 2014 Jul;7(1):20. doi: 10.1186/s12245-014-0020-9, PMID 25097669.
33. Laverde Sabogal CE, Correa Rivera AF, Joya Higuera AY. Lactate and base deficit in trauma: prognostic value. Colomb J Anesthesiol. 2014;42(1):60-4. doi: 10.1016/j.rcae.2013.09.002.
34. Dunne JR, Tracy JK, Scalea TM, Napolitano LM. Lactate and base deficit in trauma: does alcohol or drug use impair their predictive accuracy? J Trauma. 2005 May;58(5):959-66. doi: 10.1097/01.ta.0000158508.84009.49, PMID 15920409.