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Comparison between Hemoglobin Levels and Lactate Blood Level as Predictor of HemotransfusionTriger

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Abstract: ***Introduction: To investigate the role of blood lactate level as an important indicator for indicating the starting of hemotransfusion. In this regard the blood lactate level was compared with hemoglobin levels. Blood lactate level is considered to be a sensitive indicator in monitoring tissue oxygenation. Therefore this study aimed to evaluate the extent of considering the blood lactate level in decision-making for initiation of hemotransfusion and compare the improvementof the clinical outcomes with the results when hemoglobin is used as hemotransfusion trigger.*** *Study design: Prospective observational.* ***Methods: In this prospective observing study were enrolled 59 patients undergoing hemotransfusion. Patients with APACHE score of above 24 were excluded from the study. Each patient at the time of admission was continuously monitored for vital parameters (i.e. systolic blood pressure, heart rate, etc) as well as for blood lactate levels and hemoglobin. Blood lactate and hemoglobin levels were measured also at 2 h after the first hemotransfusion and at 24h from the admission independently if the patient was hemotransfused again or not. The patients were first grouped in 2 groups according to the hemoglobin levels having as threshold the Hb level of 8gr/dl and then re-grouped again according to the blood lactate level having as threshold the blood lactate level of 2.4mol/L. Results: When patients are grouped based on hemoglobin levels (< or ≥8gr/dl) at the time of admission it was shown that there was no significant difference between the two groups for Hb levels at 2 h and 24 h after the initiation of the hemotransfusion. On the contrary, when patients are grouped based on blood lactate levels (< or ≥ 2,4 mmol/L) the significant difference between the two groups for blood lactate level values at the time of admission continued to remain significant even at 2 h and 24 h after the initiation of the hemotransfusion. Conclusions: Patients with high blood lactate level at admission required more blood packs transfused and had a poorer morbidity and mortality compared with patients with lower blood lactate level value. No significant difference was found on this regard between patients with lower Hb value at admission compared with those with higher Hb value. A negative correlation between Hb and blood lactate level at the time of admission was demonstrated. It was also shown that the progressive increase of Hb values was not associated with a progressive decrease of blood lactate levels. It was concluded that blood lactate level is a better indicator of patients in need for hemotransfusion.***

Keywords: red cell transfusion, lactate level, hemoglobin, oxygenation, anemia.

1. Introduction

Studies have shown that 77% of patients admitted to the ICU develops anemia during their hospital stay, and more than one third of them end up receiving a red blood cell transfusion. Anemia is secondary to multiple factors[25] such as: iatrogenic anemia, which is caused by collection of blood samples for exams, invasive procedures; nutrition failure; hemolytic; occult blood loss; and endocrine, renal or hepatic system alterations which can also lead to a decrease in erythropoietin release and a decrease in erythropoiesis.[1,2]

Thus, red blood cell transfusion has been often used on patients admitted to ICU. Two studies assessed the incidence of anemia and the use of blood transfusion in Europe and the United States. The European study has shown a transfusion rate of 37% during the ICU stay, whereas the American study shows that about 44% of ICU patients underwent transfusion. The mean pre-transfusionhemoglobin (Hb) values were 8.4 g/dL and 8.6 g/dL, respectively.

However, both studies show that transfusion was associated with a worse prognosis.[4,5] Moreover, blood transfusion has exhibited several adverse effects that must be assessed when deciding whether to use it. Complications are described in about 20% of transfusions[6] and can be classified as infectious and noninfectious. Among the infectious complications are the transmission of agents, such as hepatitis B and C virus, HIV, cytomegalovirus, and human T cell lymphotropic virus HTLV, as well as the risk of Chagas and syphilis transmission, among others.

The noninfectious complications are related to concomitant transfusions of leucocytes, such as fever, allo-immunization, refractoriness to platelet transfusion, acute lung injury, and immunossupression.[7,8] A retrospective study has shown that blood transfusion was related to a greater rate of hospital infection.[10] Other undesirable effects caused by lactate level having as threshold the blood lactate level of 2.4mol/L. No pre-established strategy or protocol was used for hemo-transfusion decision making. The decision for administering hemotransfusion was made from the ICU specialist in charge according to the clinical situation of the patient.

2. Data Analysis

The supervisors checked all patient file at the end of each data collection day to ensure the accuracy.Before starting the analysis,each variable was checked for abnormal values or different respondent rates.

The data were coded and analyzed using SPSS statistical software (SPSS 16.0 Chicago,Illinois,USA.) Summary statistics such as means, standard deviations (SD), frequencies and proportions, were used to summarize variables. Chi-square tests were used to identify associations between categorical variables with P –value less than 0.05 as the significance level. Logistic regression analysis was conducted to determine the significant predictors of outcomes.

Ethical considerations

The Albanian Ethical Committee reviewed and approved the study protocol. Following ethical approval, permission to conduct data collection was obtained from the District Public Health Directories of Tirana. Informed verbal consents were obtained from all patients or family members who agreed to participate in the interviews.

3. Results

Total number of enrolled patients was 59.*Table 1* presents the diagnosis of enrolled patients.

Table 1: Patient's diagnosis at admission

Diagnosis	Nr
Gastritis	6
DuodenUlcus	14
Ventricular Ulcus	7
Esophagal varicose vein	8
Ventricular Neoformation	8
Papilocarcinomavesicaurinaris	1
Hemophillae	2
Macroscopic Hematuria	2
Retroperitoneal Hematomae	2
Colon Neoformation	1
Pancreatitis	1
Chronic renal failure	1
Chronic Anemia	2
Pancreas Neoformation	1
Rectoraghia	3

The mean age of respondents was 57,05 years (SD±18,56 ,from which 20 were women and 39 men. As mentioned above the evaluation of severity of illness was conducted, by using the APACHE II score within the first 1 hour of ICU admission and the average score was 11,17(SD±5,10). Statistical analysis performed on some vital signs at admission time showed the below results: systolic blood pressure 112,78(SD±29,05), heart rate 100,54(SD±19,96), $SaO^2$95%(SD±0,1),Hematocrit23,2%(SD±3,4%), red cell number(at admission time)2,69x10^6(SD±0,49). The number of blood pack used for patient during this study was 2,05 (SD±1,28) with average indwelling at ICU 3,83 (SD±2,46). Also the calculation of mortality resulted at 15,30% and infections complication 15,30 % (*Table 2*) .

Table 2: Values of variables measured

	mean	SD±
Age	57,05	18,56
Sex W/M	20	39
Apache II Score	11,17	5,10
SBP ad. T*	112,78	29,05
Hrad.T	100,54	19,96
Hctad.T	23,2%	3,4
SaO^2ad.T	95%	0,01
BE ad.T	-3,32	3,28
Blood pack	2,05	1,28
Hb pre HT*	7,11	1,10
Hb 2h post HT	7,66	1,06
Hb 24h post HT	8,35	0,65
Lactat pre HT	2,41	1,40
Lactat 2h post HT	2,06	1,22
Lactat 24h post HT	1,83	1,08
Infection	9 from 59	15.30%
Morbidity	3,83	2,46
Mortality	9 from 59	15.30%

*(*SBP ad T- sistolic blood presure at admission time,Hr-heart rate)*

*(*Hb pre HT- hemoglobin level before hemotransfusion, Hb 2h post HT- 2 hours after hemotransfusion)*

The comparison between patient's Group with Hb< 8 gr/dl and Group with Hb≥8gr/dl showed that patients with higher Hb values had significant higher values of systolic blood pressure and red cell number while those with lower Hbvalues had significantly higher values of number of blood packs used and blood lactate level in the 1st and 2d hour from hemotransfusion (Figure 1 and 3). This difference between groups in lactate levels loses significance only at 24h from hemotransfusion (Figure 2).

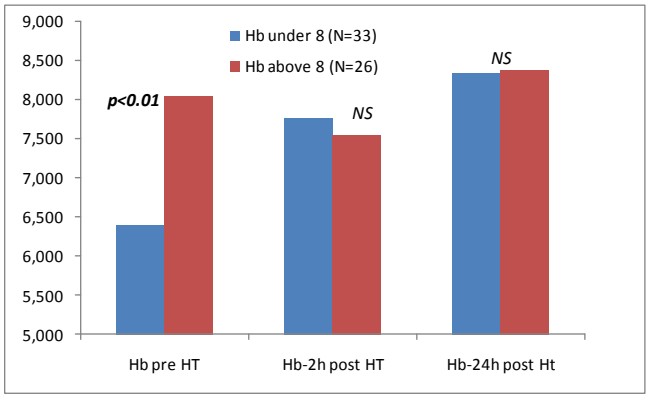

Figure 1: Hb values differences between patients groups with Hb<8 gr/dl or Hb≥8gr/dl

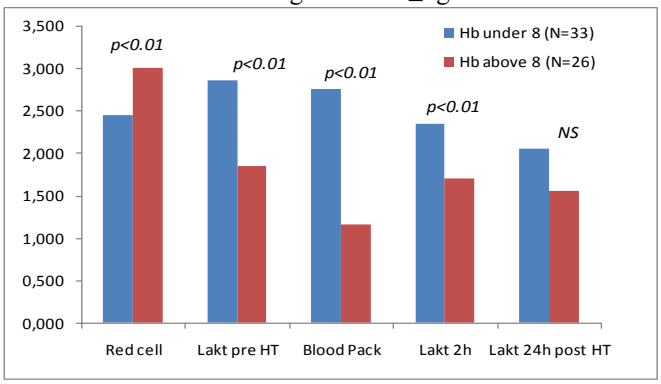

Figure 2: Variables values differences between patients groups with Hb<8 gr/dl or Hb≥8gr/dl

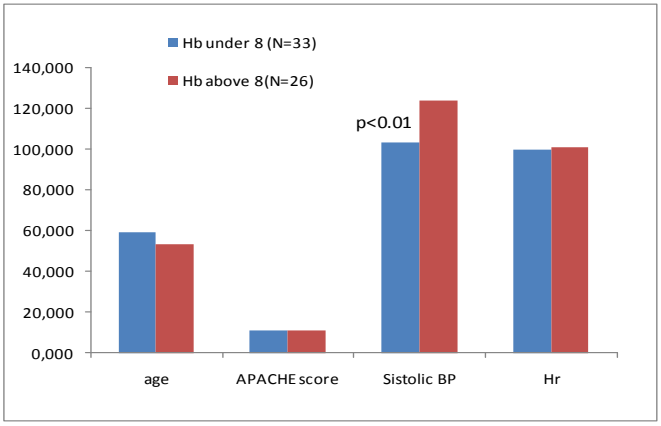

Figure 3: Variables values differences between patients groups with Hb<8 gr/dl or Hb≥8gr/dl

When comparing the Group with Lactate level ≥ 2.4 mmol/L with the Group of patients with Lactate level < 2.4 mmol/L resulted that patients with high blood lactate level had very low Hb values with the difference reduced at 2^{d} and 24thhours from hemotransfusion though remaining statistically important (Figure 1). The patients of this group resulted to have a lower systolic blood pressure and being in the need for getting administered a higher number of blood pack. Most importantly the difference between the mean values of blood lactate levels in patients of these patient's groups though significantly reduced with time from the starting of hemotransfusion remained strongly statistically important even at 24h from hemotransfusion (p<0.01). (Figure 2 and 3). Patients with high values of blood lactate levels at admission resulted to have a higher rate of infection complications during the stay at ICU service as well as a higher morbidity expressed as duration of stay at ICU service in terms of days.

4. Discussion

Oxygen delivery to the peripheral tissues is proportionally dependent on three factors: cardiac output, arterial hemoglobin concentration, and arterial O_2 saturation. This relationship defers a central role to the concentration of red blood cells in the plasma, since under physiological conditions almost all hemoglobin molecules are located inside the red blood cells. When the concentration of red blood cells is too low to allow enough O_2 to be transported to satisfy the needs of the individual organs, and the physiological compensation to anemia is exhausted, anemic hypoxia will supervene.

This will eventually lead to metabolic derangement, alterations of cell function, and finally cell damage. There is no common critical threshold value of hemoglobin concentration at which anemic hypoxia develops. Rather, the critical hemoglobin concentration is dependent on several factors including age, co-morbidity, and the rapidity of blood loss. Therefore, the definition of a global transfusion trigger is obsolete, and RBC transfusion decisions should be made by considering each individuals risk-benefit relationship [31].

All benefits of hemotransfusion are directly or indirectly related to improved O_2 transport capacity. Transfusion risks include adverse reactions such as fever and hemolysis, viral infections, immunosuppression, post-transfusion sepsis, and microvascular plugging due to storage lesions of aged red blood cells. Because of these risks, and since the resources for human RBC preparations are limited, efforts to develop hemoglobin based oxygen carriers (HBOCs) have been expanded in recent years. 1996, the American Society of Anesthesiologists Task Force on Blood Component Therapy published transfusion recommendations on the basis of an evidence-based evaluation of the literature.

It was concluded that transfusion is rarely indicated when the hemoglobin concentration exceeds 10 g/dl and is almost always indicated when it is less than 6 g/dl (particularly when the anemia is acute**)** [31].Truly the major number of intensives doctor'sin Albania trigger hemotransfusion mainly based on hemoglobin level and vital signs. Traditional vital signs at triage are used as surrogate markers by their ability to indirectly measure blood lose volume. In our study Figure 1. Show that between Groups there is a statistically significant difference regarding theHb level at admission time and lose immediately significance since 2 hoursafter hemotransfusion. This means that after the first RBC transfusion or shortly later the Hb level has alreadyit's guiding role in hemotransfusion treatment decisions.

Meanwhile the differences between blood lactatelevelremain significant between two respective groups at 2 hours after hemotransfusion while losing significance at 24h after Figure 5. Other factors as vital signs(age, apache score,Hr) on admission time (pre HT) seems to have low sensitivity and have not statistical difference except systolic BP Figure 3 and 6.

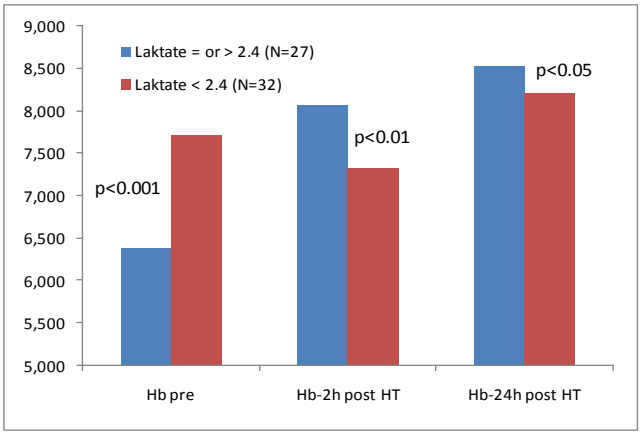

Figure 4: Hb values differences between patient groups with Lactate<2.4mmol/L or Lactate≥2.4mmolL

But,what happen when we regroup those patient base on lactat level? As we can see on Figure 4 shows a significant difference atHb level between the group of patients with low lactate levels and those with high lactate levels,that consists not only after 2 hours but also after 24 hours. Significant differences between these 2 groups was found also regarding vital signs and other variables monitored like age, apache score, systolic blood pressure and heart rate. It seems that when we evaluate tissue oxygenation level primarily based on blood lactate level rather than Hb values, the sensitivity of vital signs is also higher. Figure 5 and 6.

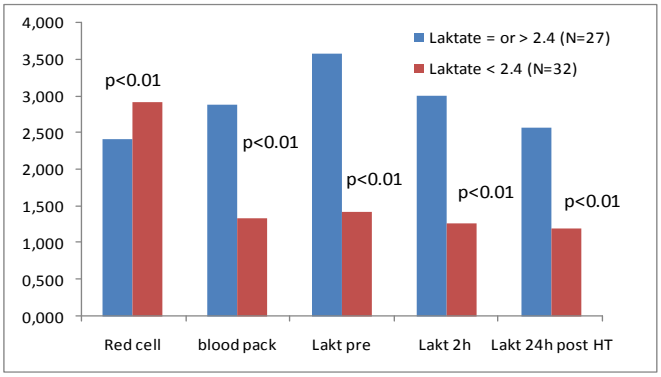

Figure 5: Variables values differences between groups with Lactate<2.4mmol/L or Lactate≥2.4mmolL

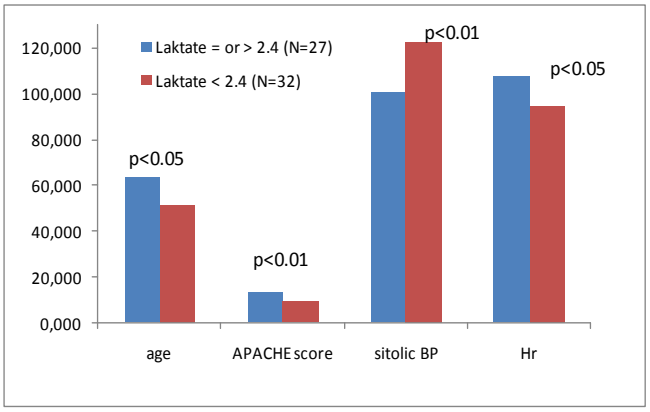

Figure 6: Variables values differences between groups with Lactate<2.4mmol/L or Lactate≥2.4mmolL

Patients on extreme conditions suffer often from oxygen imbalance between supply and demand[28]. The data reported in our study demonstrate that despite the fact of hemoglobin level increases with hemotransfusion, the improving of tissue oxygenation was not going parallel with hemoglobin increase, instead it correlated significantly with changes in blood lactate level. Lorente at al[29] reported that systemic oxygen content (VO_2) has not increased, at septic patients with noninvasive oxygenation despite the hemotransfusions increased the hemoglobin level from 9,6gr/dl to 11,6gr/dl. The same results were reported from other similar studies[30].

5. Conclusion

In conclusion,adding lactate level to hemoglobin level and traditional vital signs increase the ability to distinguish patients on demand for red cell transfusion and estimate the level od such need.There would surely be needed the case by case evaluation of hemotransfusion needs and that might not be possible predict with accuracy if hemotransfusion is needed but considering blood lactate level in such decision making can help avoiding a numerous of cases where red cell transfusion and the exposing of the patient against many potential related risks might be unnecessary.

6. Acknowledgement

Not available.

7. Conflict of Interest Disclosure

The authors have no conflict of interest.

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Author Profile

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