

# Evaluation of Red Cell Transfusion Effects on Tissue Oxygenation, Based on Blood Lactate Levels As Sensitive Indicator of Tissue Oxygenation

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**Abstract:** ***Purpose:** Evaluation of red cell transfusion effects on tissue oxygenation, by measuring blood lactate levels before and after hemotransfusion. Blood lactate levels are suggested as sensitive parameter to evaluate tissue oxygenation. The aim of this study was to verify the efficiency of hemotransfusions that were performed on patients in intensive care based on lactate level. **Study Design:** Prospective observational. **Methods:** In this prospective observational study on (n- 59 patients) who considered that required red cell transfusion.(the patients more that 25 point according to APACHE II-score were excluded).We monitor vital signs (BP, HR) at admission and also was strictly observed lactate level and hemoglobin level at admission before red cell transfusion (pre T), two hours after transfusion (2h post T) and 24 hours after (24 h post T with or no any another red cell transfusion). At first the patients group based at hemoglobin level, Group Ia with Hb< 8g/dl and Group Iib with Hb ≥ 8g/dl. After that the patients group again based at lactate level, Group Ic lactat level ≥ 2, 4 and Group Iid lactate level <2, 4. **Results:** Comparison between group Ia and group Iib as belongs hemoglobin level demonstrate significance only at admission pre T and lost significance at 2h post T and 24h post T, at the other hand differences between group Ic and gropIid as belongs hemoglobin level stay significant at pre T, 2h post T and 24h post T. **Conclusions:** Statistical significant evaluation (p < 0, 05) between above mentioned groups shown that lactate level are very sensitive indicator in measurement of tissue oxygenation...Another important finding was significant high mortality and morbidity at patient group with lactate level ≥ 2, 5.*

**Keywords:** red cell transfusion, lactat level, hemoglobin level, oxygenation, anemia.

## 1. Introduction

Anemia is a common finding in patients admitted to the ICU.[25] Studies have shown that 77% of these patients present 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. In addition to blood loss provoked by evident bleedings, including 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 can also lead to a decrease in erythropoietin release, which causes a decreases 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 pretransfusion hemoglobin (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, alloimmunization, refractoriness to platelet transfusion, acute lung injury, and immunosuppression.[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 the use of blood-derived substances are lung edema due to hypervolemia, hypothermia, coagulopathies, and toxicity due to citrate. [9].

Thus, blood transfusion has poses a difficult problem in ICUs, and there are still many controversial aspects related to its benefits, as well as to the risks of keeping lower levels of Hb in patients. In a recent study, Hébert et al.[11] did not find benefits related to keeping Hb between 10 and 12 g/dL, when compared to a group with Hb between 7 and 9 g/dL, in ICU patients. However, when the subgroup of patients with previous heart disease was analyzed, the restrictive strategy was associated with an increased death risk in these patients.

For all above mentioned factor, we attempt in our study to find sensitive indicator, which can improve our judgment for indications of blood transfusions.

## 2. Material and Methods

A prospective observational analytic study was conducted in 15 ICU bed at University Hospital Center of Tirana "Mother Theresa" between January 2012-January 2014. (Study area). Throughout this period, consecutive patients aged > 18 years admitted to the polyvalent (medical and surgical) ICU were enrolled in this study. We excluded from the study: pregnant women, moribond patients, patients pointed >24 as APACHE II score. (Exclude criteria).

We recorded demographic variables (age sex), admission diagnosis, preexisting conditions as comorbidities: cardiac diseases, neurological diseases, pulmonary diseases, gastrointestinal diseases, endocrinological diseases, postoperative conditions and laboratory value. To determine the influence of severity of illness on the ICU mortality rates, we evaluated the severity of illness using the Acute Physiological and Chronic Health Evaluation (APACHE II) within the first 1 hours of ICU admission. Consciously we excluded the patients evaluated more than 24 point as APACHE score, because according to literature at the extreme cases, lactat level are missing somewhat accuracy as indicator of tissue oxygenation.

### Study Variables

We used two main outcome variables hemoglobin level and lactat level. Monitoring of this two variables was done at admission time, hemoglobin and lactate level pre hemotransfusion (pre T). Two hours after hemotransfusion (2h post T) and 24 hours after the first hemotransfusion (24h post T) notwithstanding the fact whether the patient was hemotransfused two or more times or anymore. Also we monitored some vital signs at admission time like systolic blood pressure SBP, heart rate HR, oxygen saturation SaO<sub>2</sub>, hematocrit level Hct, red cell number Rcn, base excess BE, also unit blood pack, infection, morbidity and mortality. Patients were grouped first based on hemoglobin level. Group Ia Hb < 8gr/dl and Group Ib Hb ≥ 8gr/dl and again patient regrouped based on lactate level, Group Ic lactat ≥ 2, 4mmol/l and Group Id lactat < 2, 4mmol/l. None strategy or protocol was used for hemotransfusion trigger. The hemotransfusion decision ruled from judgment of shift doctor. None discrimination was ruled as belongs diagnosis. **Table I** presents diagnosis of enrolled patients.

**Table I**

Diagnosis	Nr
Gastritis	6
Duoden Ulcus	14
Ventricular Ulcus	7
Esophagal varicose vein	8
Ventricular Neoforformation	8
Papilocarcinoma vesica urinaris	1
Hemophillae	2
Macroscopic Hematuria	2
Retroperitoneal Hematomae	2
Colon Neoforformation	1
Pancreatitis	1
Chronic renal failure	1
Chronic Anemia	2
Pancreas Neoforformation	1
Rectoraghia	3

Statistical analysis performed on above mentioned groups, gave as some important findings.

### 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 familiars who agreed to participate in the interviews.

## 3. Results

Total number of enrolled patients was 59. The mean age of respondents was 57, 05 (SD±18, 56) years, from which 20 were women and 39 men. As we mentioned above the evaluation of severity of illness was conducted, by using the APACHE II score within the first 1 hours 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<sub>2</sub> 95% (SD±0, 1), Hematocrit 23, 2% (SD±3, 4%), Red cell number (at admission time) 2, 69x10<sup>6</sup> (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 results 15, 30% and infections complication 15, 30%. (SIRS-Systemic inflammatory response syndrome).

**Table 2:** below show our statistical analysis.

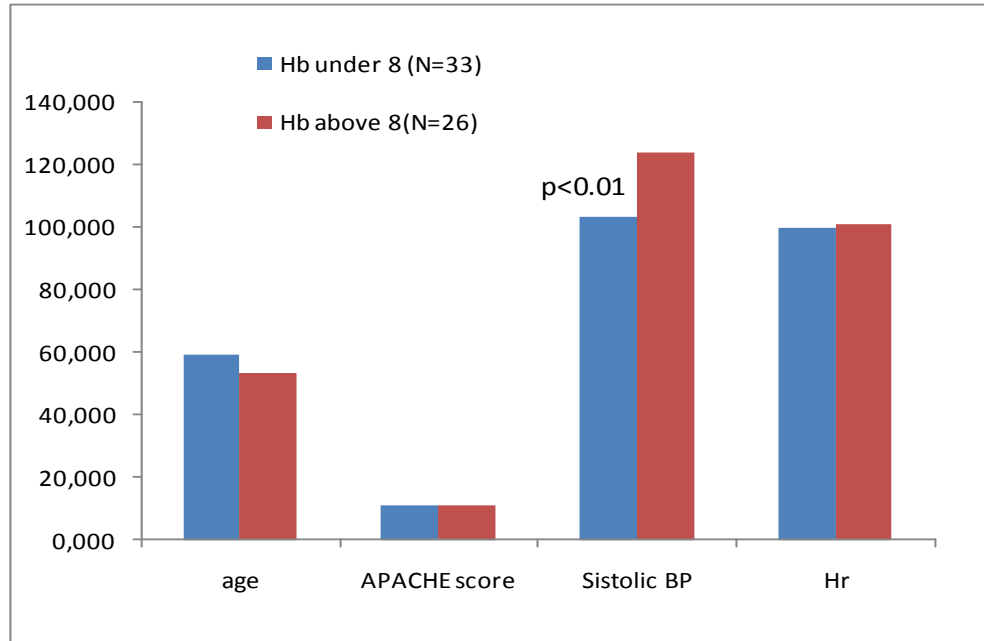
	mean	SD±
Age	57, 05	18, 56
Sex W/M	20	39
Apache II Score	11, 17	5, 10
SBP ad. T*	112, 78	29, 05
Hr ad.T	100, 54	19, 96
Hct ad.T	23, 2%	3, 4
SaO <sub>2</sub> ad.T	95%	0, 01
BE ad.T	-3, 32	3, 28
Blood pack	2, 05	1, 28
Hb pre HT*	7, 11	1, 10
Hb 2h post HT	7, 66	1, 06
Hb 24h post HT	8, 35	0, 65
Lactat pre 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- systolic blood presure at admission time, Hr- heart rate)

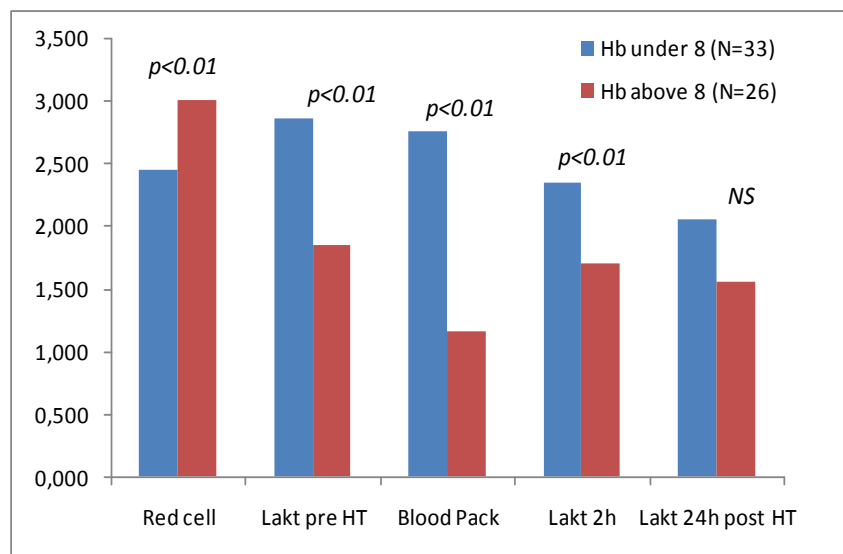
(\*Hb pre HT- hemoglobin level before hemotransfusion, Hb 2h post HT- 2 hours after hemotransfusion)

As mentioned above comparison was done between Group Ia Hb < 8 gr/dl and Group Iib Hb ≥ 8gr/dl where findings shown that Group Iib characterized from figures

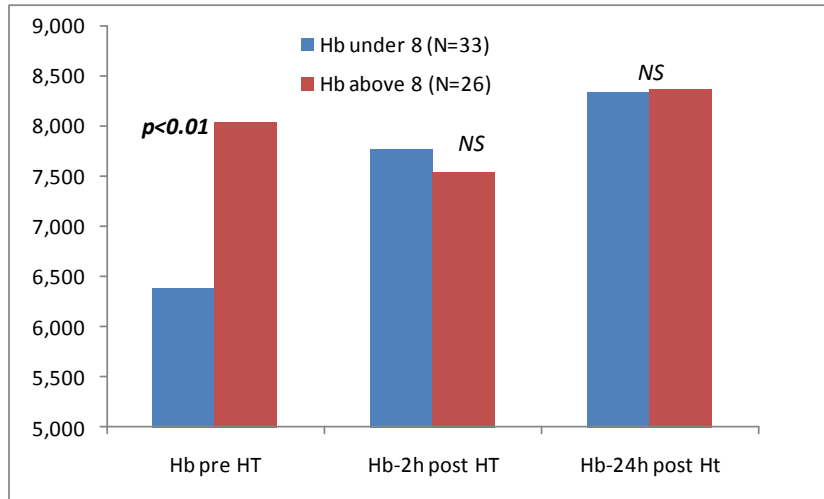
significantly higher on systolic blood pressure, hematocrit, red cell number meanwhile Group Ia characterized from level significantly higher on laktat level which made without significant only 24 hours after hem transfusion. Also differences have between the numbers of blood packet transfused. Following figures illustrate.



**Figure 1**



**Figure 2**

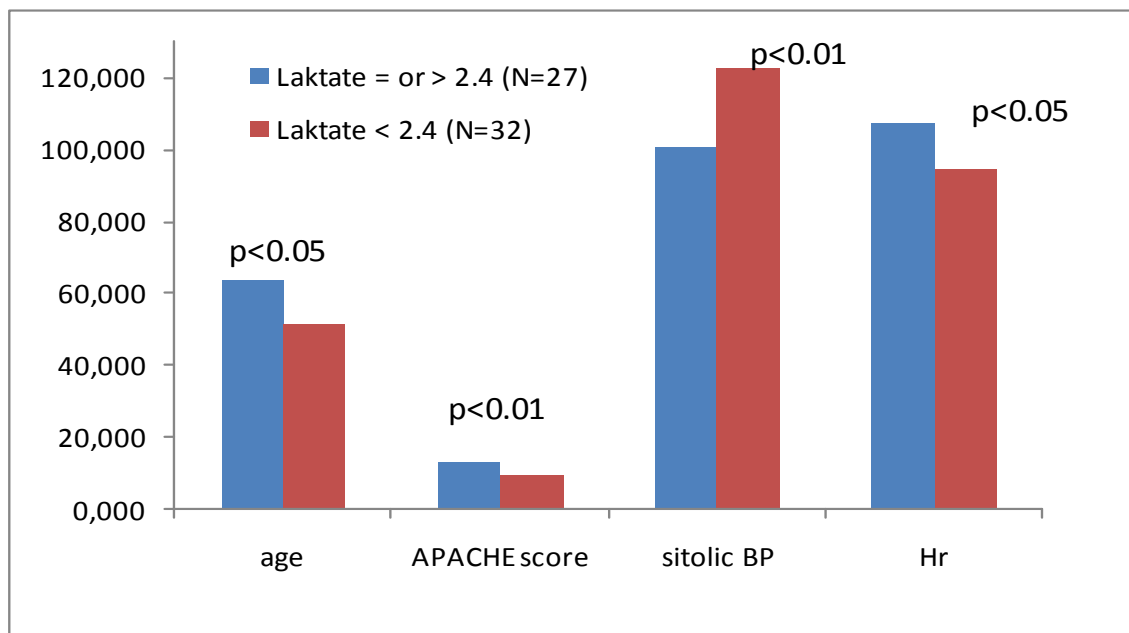


**Figure 3**

No differences were found between two groups as regards age, APACHE score, heart rate and no significant difference in indwelling. The significant differences in hemoglobin level at admission time (Hb pre HT) were lost 2 hours after hemotransfusion and of course also after 24 hours (Hb 2h post HT and Hb 24h post HT). Mortality: 3 patients (9%) in Group Ia versus 6 patients (23%) in Group IIb ( $p=0.14$ ) showed differences in percentage but not on statistical analysis.

On the other hand, statistical analysis between Group Ib lactate level  $\geq 2,4$  mmol/l and Group IIc lactate level shows that Group Ib is characterized by a significantly higher

value on age, APACHE score, heart rate and lower values of systolic blood pressure, hematocrit, base excess, red cell number at admission time. Number of blood packs at first group was significantly higher compared with Group IIc. At Group Ic, lactate level stayed again significant 2 hours and 24 hours after hemotransfusion, the same thing we can say also for differences in hemoglobin level 2 and 24 hours after hemotransfusion. Indwelling was significantly higher in Group Ic. Changing Group Ia and Group IIb at Group Ib vs. Group IIc, mortality was significantly higher in Group Ic. Following figures illustrate our results.



**Figure 4**

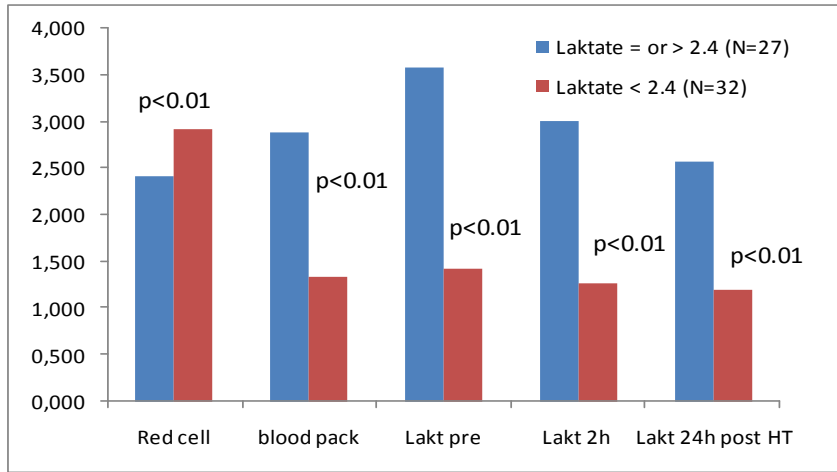


Figure 5

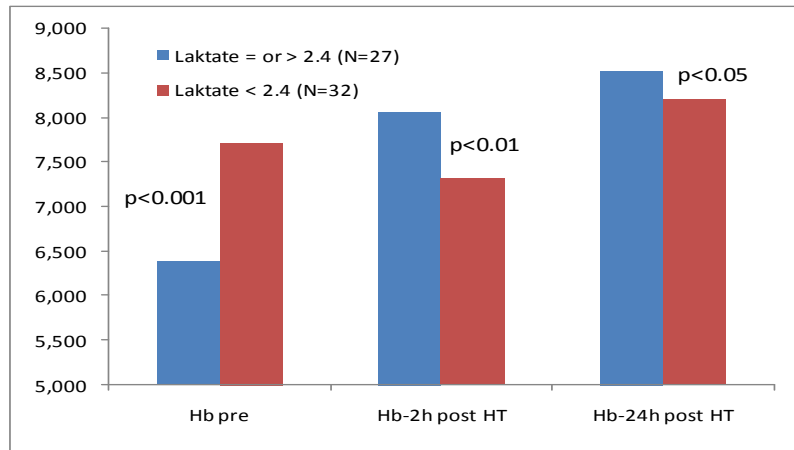


Figure 6

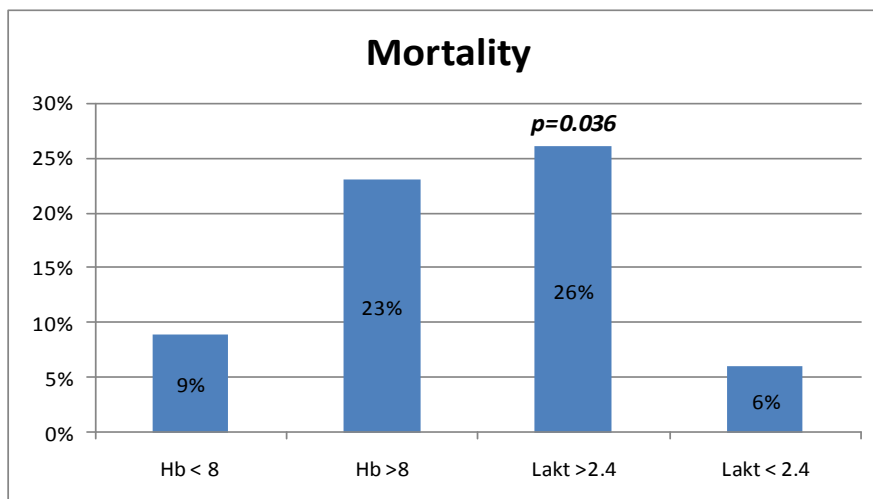


Figure 7

#### 4. Discussion

From almost 200 years we have started to use blood transfusion. Today we have the ability to know the big number of complications infectious on noninfectious related with blood transfusion. But, why we continuing to use it, with such big risk of undesirable adverse effects? The simple response is, we need an oxygen transporter with final target improving tissue oxygenation, but until today no other compound can performed it. A numerous studies promote

restrictive strategy on blood transfusion with aim not only avoiding complications but also announce, that liberal strategy can not improve outcomes and surviving rate. Hébert et al.[11] reported that a restrictive strategy in terms of blood transfusions was adequate, with a mortality rate lower than that observed in the group that received more transfusions. In this line, our study attempts to elaborate the accuracy of lactate level on tissue oxygenation.

Truly the major number of intensives doctors in 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 Group Ia vs. Group IIb at admission time has not significant difference on vital signs as age, heart rate, apache score but only systolic BP. So we can conclude that some vital signs has low sensitivity on evaluation of blood lose or tissue oxygenation. At similar study Paladino at al[26] shows superiority of lactat level vs vital sings in differentiating major from minor injury in trauma patients with normal vital signs. Meanwhile statistical changes based on lactat level appear significant between two groups not only at admission time but also 2 hours after hemotransfusion and lose importance only 24 hours after hemotransfusion. On the other hand important changes between above mentioned groups linked with hemoglobine level are significant only at admission time and no more.

But, what happen when we regroup those patient base on lactat level? As we can see Figure 4 shows that exist significant difference between Group Ic vs Group IId as belong vital signs like age, apache score, systolic blood pressure and heart rate. Conclusions could be that, when we evaluate tissue oxygenation primarily based on lactat level the sensitivity of vital signs is also higher.

Patients on extreme conditions often can suffer from oxygen imbalance between supply and demand[28]. The comparison between Figure 2 and 3 versus Figure 5 and 6 tell us, despite the fact of hemoglobin level increase, improving of tissue oxygen was not going parallel with hemoglobin increasing. Lorente at al[29] reported that sistemic oxygen content (VO<sub>2</sub>) has no increasing, at septic patients with noninvasive oxygenation despite the hemotransfusions increased the hemoglobin level from 9, 6gr/dl to 11, 6gr/dl. The same results was reported from similar studies [30].

At last our analysis about mortality at four groups Figure 7 shows the highest mortality rate at Group Ic with 26% mortality and the best survival rate Group IId only with 6% mortality. Meanwhile Group Ia mortality rate 9% and Group IIb 23%. Statistical significance was seen only at Group Ic (p=0, 036). Those findings allow us to say that high level of hemoglobin or liberal strategy of hemotransfusion, do not improve the survivance rate, on the other hand lactat level are not only best marker of tissue oxygenation but also are a good predictor of survival prognosis.

## 5. Conclusion

The results of our study demonstrated that lactat levels are sensitive and accurate marker of tissue oxygenation. Amission lactat level and serial lactat measurements should be used to quickly identify tissue hipooxygenation. This strong parameter will improve our judgment on hemotransfusion trigger. Restrictive strategy will be more logical and justified than unnecessary hemotransfusions that will expose patients in front of numerous risks. Also in this prospective observial study lactat level shows to be a good predictor of survival.

## 6. Acknowledgement

Not available.

## 7. Conflict of Interest Disclosure

The authors have no conflict of interest.

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## Author Profile



**Lordian Nunci** graduated as physician in Medicine Faculty of Tirana University on 1997. During 1998-2002 he stayed as resident near Department of Anesthesiology and Intensive Care. After, he continued working at Intensive Care Unit. In this time he was tried to improve our experience in some fields such as mechanical ventilation, pulmonary care and blood transfusion by followed course in some qualified European centers.