International Surgery Journal
Rudiman R et al. Int Surg J. 2017 May;4(5):1738-1742
http://www.ijsurgery.com
pISSN 2349-3305 | eISSN 2349-2902

DOI: http://dx.doi.org/10.18203/2349-2902.isj20171631

Original Research Article

Lactate clearance: its relationship with the success of non-operative management in patient with blunt abdominal trauma

Reno Rudiman*, Nova Saragih, Andriana Purnama

Department of Surgery, Division of Digestive Surgery, Hasan Sadikin Hospital/Faculty of Medicine, Padjadjaran University, Bandung, West Java Indonesia

Received: 01 March 2017
Accepted: 29 March 2017

***Correspondence:**
Dr. Reno Rudiman,
E-mail: rudiman@unpad.ac.id

ABSTRACT

Background: Occult ongoing bleeding has become the second highest cause of death in blunt abdominal trauma. Undetected abdominal injury has caused morbidity and mortality in patients at the early phases of trauma. Non-operative Management (NOM) in solid organ trauma is safe and effective, and this strategy has become widely used. Lactate clearance (LC) has important clinical benefits in patients with acute trauma that is superior to initial lactate examination.

Methods: This study was a prospective cohort study of patients with history of hemorrhagic shock caused by blunt abdominal trauma that came to emergency room of Hasan Sadikin Hospital Bandung from August 2015 to July 2016. The tests were including initial blood lactate, 2 hours, and 4 hours post-resuscitation and then calculation of LC. Analysis using SPSS with chi square for the significance of relationships and Spearman correlation to determine the strength of the relationship between variables. Comparison test between LC2 and LC4 were calculated using Mann-Whitney tests.

Results: During one year period, from August 2015 to July 2016, there were 34 patients. Age was in the range of 15-65 years, with a range of 15-25 years were 19 (55.8%), 25-50 years were 11 (32.4%), and >50 years as many as four (11.8%). By sex, there were 28 (82.4%) male gender and 6 (17.6%) women. Based on the type of trauma, there were 11 (32.4%) single trauma patients and 23 (67.6%) multiple trauma patients. Based on the results of statistical analysis with chi square, there was a significant correlation between lactate clearance 2 hours (LC2) and lactate clearance 4 hours (LC4) with the success of NOM ($p < 0.001$) with the Odds Ratio (OR) are 3.750 and 6.500 respectively. Based on non-parametric test (Mann Whitney) showed that there were no significant differences between the LC2 and LC4 in determining the successful of NOM ($p > 0.05$).

Conclusions: There was a significant relationship between lactate clearance 2 hours (LC2) and lactate clearance 4 hours (LC4) in determining the success of non-operative management (NOM) in patients with history of hemorrhagic shock caused by blunt abdominal trauma. In addition, there are no significant differences between the LC2 and LC4 in determining the success of the NOM, so that either LC2 or LC4 may be used in predicting the success of NOM, as LC4 is the first preference. The low level of lactate clearance may be used as one of indicators to terminate non-operative management and proceed with surgery right before all symptoms of hemorrhagic shock arise.

Keywords: Blunt abdominal trauma, Lactate clearance, Non-operative management

INTRODUCTION

Trauma is one of the major causes of death in the first four decades of life, and it has become a major health problem worldwide. Abdominal trauma is frequently handled in the emergency room with a majority (80%) were caused by blunt trauma that has caused high morbidity and mortality. The prevalence of intra-abdominal injury in patients with blunt abdominal trauma was 13%. The most commonly affected organs are liver and spleen, followed by other organs such as the pancreas, intestine, mesentery, bladder, diaphragm, and retroperitoneal organs (kidneys, abdominal aorta).[1] Occult bleeding in patients with blunt trauma has become the second highest cause of death. Undetected abdominal injury has caused morbidity and mortality in patients that can survive in the early phases of trauma.[2]

Management of blunt abdominal trauma has undergone significant changes in recent years. There are a lot of prospective and retrospective studies indicating that non-operative management (NOM) in solid organ trauma is safe and effective, and this strategy has become a widely used practice.[3,4] It is associated with low morbidity and mortality, decrease the length of stay, transfusion requirements, complications of bleeding, or injury associated with hollow viscous organ compared with the operative management. Lactate is a diagnostic and prognostic biomarker in patients with sepsis and trauma. Lactate is the result of anaerobic cellular metabolism, which increases in the state of hypoperfusion. In anaerobic condition, pyruvate cannot enter the Krebs cycle in the mitochondria and cannot undergo oxidative phosphorylation. Pyruvate is then converted to lactate via lactate dehydrogenase enzyme.

Lactate clearance (LC) generally describes as the percentage decrease in lactate levels during resuscitation interval, which is associated with decreased in mortality, especially patients with sepsis and severe sepsis.[4] Several studies said that assessment of lactate clearance as therapeutic targets of resuscitation are superior to the oxygen derivatives variable. Biologically, lactate clearance reflects more about the homeostasis of the body in general and provides more meaningful data regarding the adequacy of the entire resuscitation process. Abramson et al stated that mortality was significantly decreased in patients with lactate levels were back to normal in the first 24 hours, but the concept is not very suitable in the early detection of hypoperfusion such as in trauma patients.[5-8]

Regnier et al concluded that lactate clearance has the important clinical benefits in patients with acute trauma. Firstly, lactate clearance provides important additional prognostic information, which is superior to initial lactate examination. It can also help the clinician to assess the adequacy of resuscitation process, assess the severity of ongoing injury, and the physiological response of interaction between the injury and its resuscitation. Secondly, this study supports the paradigm of evaluation of the lactate clearance in the early phase of trauma, emphasizing how quickly the body to detect and react to lactate production. Data shows that lactate clearance occurs in the first 2 hours after resuscitation, and then in the next 2-4 hours into a plateau condition. It is associated with decreased levels of lactate after resuscitation and increased hepatic clearance. Thirdly, lactate clearance threshold is required 20% per hour. This limit is associated with decreased of mortality, especially patients with initial lactate 2-10 millimoles/liter.[5]

METHODS

This study was a prospective observational cohort from August 2015 - July 2016 in Hasan Sadikin Hospital Bandung Indonesia. Inclusion criteria were patients with a history of hemorrhagic shock caused by blunt abdominal trauma and in hemodynamically stable after resuscitation, decided to proceed with non-operative management; age >14 years. Exclusion criteria were patients with severe head injury (GCS 3-8); patients with comorbidities, such as kidney failure, liver cirrhosis, malignancy, and diabetes mellitus with biguanide class treatment; pregnancy; or signs of coagulopathy, hypothermia, or metabolic acidosis. Dropout criteria was blunt abdominal trauma patients that was decided to do operative management in <4 hours due to signs of diffuse abdominal tenderness or transient response of resuscitation. Patients who met the inclusion criteria were observed for initial blood lactate, 2 hours and 4 hours post resuscitation, and then calculation of lactate clearance (LC2 and LC4). Lactate Clearance (LC) was defined as the percent change in lactate level after resuscitation from a baseline measurement. The formula was as can be seen at below equation. Statistical test used in this study were the Spearman correlation test and Mann Whitney comparison test.

$$\text{Lactate clearance} = \frac{\text{Initial lactate - Lactate Hour 2 or 4}}{\text{Initial lactate}} \text{ X } 100$$

RESULTS

During one year, from August 2015 to July 2016, there were 34 patients who went to the emergency room of Hasan Sadikin Hospital in Bandung that met the inclusion criteria.

The patients' characteristics are shown in Table 1.

Based on statistical analysis by t-test and Mann Whitney, there were significant relationship ($p<0.05$) between the pulse, systolic and LOS (length of stay) to the success of non-operative management (NOM) (Table 2).

The t-test study concluded that there was a strong relationship between lactate clearance 2 hours (LC2) and

4 hours (LC4) with NOM (p<0.001), the Odds Ratio (OR) were 3.750 and 6.500 respectively (Table 3 and Table 5).

Table 1: Patients' characteristics.

Variable	n=34 (%)
Age	
15-25	19 (55.8)
25-50	11 (32.4)
>50	4 (11.8)
Sex	
Male	28 (82.4)
Female	6 (17.6)
Trauma	
Single trauma	11(32.4)
Liver	5 (45.4)
Spleen	5 (45.4)
Renal	1 (9.2)
Multiple trauma	23 (67.6)
Initial blood lactate	
< 2 mmol/L	10 (29.4)
>2 mmol/L	24(70.6)
Mechanism of injury	
Vehicle	23 (67.6)
Pedestrian	5 (14.7)
Fall from height	4 (11.8)
Fighting	2 (5.9)

Table 2: Variables associated with success of NOM.

Variables	NOM	t/Z count	P- value (sig)
Age	NOM OM	-0.811	0.418
Onset	NOM OM	-0.056	0.956
Systole	NOM OM	3.896	<0.001
Pulse	NOM OM	-3.848	0.001
Initial lactate	NOM OM	-0.203	0.839
LOS	NOM OM	-2.331	0.020

NOM : non-operative management, OM: operative management (NOM failure).

Table 3: Correlation between LC2 with success of NOM.

LC 2		NOM		Total	X^2 = 20,597
		NOM	NOM failure		
High	f	19	0	19	df = 1
	%	82.6	0.0	55.9	χ^2_{tabel} = 3.841
Low	f	4	11	15	
	%	17.4	100.0	44.1	OR = 3.750
Total	f	23	11	34	p <0.001
	%	100.0	100.0	100.0	

The correlation between lactate clearance 2 hours (LC2) and 4 hours (LC4) with NOM showed a strong association category (C=0.614 and 0.660 respectively) based on the contingency coefficient (Table 4). There was no significant difference between Lactate Clearance 2 hours (LC2) and Lactate Clearance 4 hours (LC4) (p> 0.05) (Table 6).

Table 4: Correlation coefficient.

Criteria	Value
0.00-0.25	Weak
0.26-0.50	Strong enough
0.51-0.75	Strong
0.76-1.00	Very strong

Table 5: Correlation between LC4 with success of NOM.

LC 4		NOM		Total	X^2 = 20,268
		NOM	NOM failure		
High	F	21	0	21	df = 1
	%	91.3	0.0	61.8	χ^2_{tabel} = 3.841
Low	F	2	11	13	
	%	8.7	100.0	38.2	OR = 6.500
Total	F	23	11	34	p <0.001
	%	100.0	100.0	100.0	

Table 6: Difference between LC2 and LC4 in determining the success of NOM.

Category	NOM	t/Z count	P- value (sig)	Conclusion
Lactate Clearance	LC 2 LC 4	-0.866	0.386	No significant difference

DISCUSSION

There were significant relationship (p <0.05) between the pulse, systolic and LOS to the success of NOM. However, there were no significant relationships (p> 0.05) between age, onset, and lactate initials on the success of NOM. From patients' distribution we can see that patients managed by NOM came with hemorrhagic shock class II, meanwhile in the group of NOM failure, the average patient came with shock haemorrhage class III. It shows that the patient's hemodynamic condition at initial presentation can be a consideration whether we can do NOM or not. Selective NOM of blunt abdominal trauma to intra-abdominal solid organs has been established as an acceptable standard of care. The success rate of NOM ranges from 60-90%.[9] The benefits of NOM has been stated by Croce et al, who reported fewer blood transfusions and abdominal complications than operative management.[10] Moudoni et al and Robert et al in the light of severe blunt renal injuries, reported that operative

management was more likely to result in the loss of the injured kidney than in NOM.[11,12] However the benefits of succesful NOM should be weighed against the risk of delayed treatment, when a hollow viscus injury is missed. Therefore, a tool is needed to help surgeons in decision making on whether a patient should undergo operative management, or may continue with NOM. This is where lactate clearance is put into the focus of this study. Lactate clearance has previously been reported to be of value in monitoring several critically ill patients including sepsis and cardiac arrest.[8,13,14] With the present publication by Regnier et al we now have important evidence of the utility of lactate clearance in the acutely traumatized population.[5]

The results of this study concluded that there was a significant relationship between lactate clearance 2 hours (LC2) and lactate clearance 4 hours (LC4) in determining the success of non-operative management (NOM) in patients with history of hemorrhagic shock caused by blunt abdominal trauma. In addition, there were no significant differences between the LC2 and LC4 in determining the success of the NOM, so that either LC2 or LC4 may be used in predicting the success of NOM, but because of the odds ratio (OR) of LC4 was higher than LC2, so lactate clearance 4 hours (LC4) is preferred to be used as an indicator of treating patients with a non-operative management.

In clinical setting, the proper timing of measuring lactate clearance may give benefit in decision making on when to terminate NOM and send the patient to surgery. This will subsequently shorten hospital length of stay and possibly improve patients' outcome. How much time is the ideal duration of lactate clearance has not been studied extensively. For septic patients in the ICU, a lactate clearance-directed therapy in the first 6 hours appeared as efficient as ScvO2 measurement.[15] However no data are availabe for lactate-directed therapy for longer duration, nor on blunt abdominal trauma settings in the emergency room.

Up till now, there has been no similar study addressing to the timing of lactate clearance measurement specifically in blunt abdominal trauma. Regnier et al had studied the lactate clearance intensively at the trauma patients regardless their hemodynamic status at presentation.[5] The authors proposed on incorporating lactate clearance measurements on future decision schemes for the resuscitation of trauma patients. Odom et al studied 4,742 trauma patients who had an initial lactate measeured during a 10-year period.[16] They concluded that both initial lactate and lactate clearance at 6 hours independently predict death in trauma patients. The clinical importance of this study was further recited by Zane.[17]

This study served as an initial measurement method to assess whether lactate clearance is feasible as an indicator for decision making in patients with blunt abdominal trauma who managed by NOM. Further investigation is needed to fine-tune the correct cut-off point of LC in helping the decision making process. However, this is beyond the scope of this study.

Several limitations should be considered when interpreting this study results. First, this was an observational analysis which results support an association and not necesarily showing causation. Second, data come from a single center and may have influenced the present results. Nonetheless, the results may serve a source of information, should a large scale study is proposed elsewhere.

CONCLUSION

In conclusion, lactate clearance 2 hours (LC2) and lactate clearance 4 hours (LC4) can be measured on all patients who present with a history of hemorrhagic shock due to blunt abdominal trauma and decided to do NOM. Lactate clearance 4 hours (LC4) is preferred due to its higher odds ratio compared to LC2. The low level of lactate clearance can be used as one of indicators to terminate non-operative management and proceed with surgery right before all symptoms of hemorrhagic shock arise.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Nishijima DK, Simel DL, Wisner DH, Holmes JF. Does this adult patient have a blunt intra-abdominal injury? JAMA. 2012;307:1517.
2. Gilroy D. Deaths from blunt trauma, after arrival at hospital. Injury. 2005;36:47-50.
3. Velmahos GC, Toutouzas KG, Radin R, Chan L, Demetriades D. Non-operative management of blunt injury to solid abdominal organs: a prospective study. Arch Surg. 2003;138:844-51.
4. Stein DM, Scalea TM. Non-operative management of spleen and liver injuries. J Intensive Care Med. 2006;21:296-304.
5. Regnier MA, Raus M, Le Manach Y, Asencio Y, Gaillard J, Devillers C, et al. Prognostic significance of blood lactate and lactate clearance in trauma patients. Anesthesiology. 2012;117(6):1276-88.
6. Abramson D, Scalea TM, Hitchcock R, Trooskin SZ, Henry SM, Greenspan J: Lactate clearance and survival following injury. J Trauma. 1993;35:584-8.
7. Jarquin AM, Lagunas IL, Gasca CS, Lagunas LL, Cano EG, Conde EG, et al. Lactate clearance is a prognostic factor in patients on shock state. Eur J Gen Med. 2012;9(2):98-103.
8. Jones AE, Shapiro NI, Trzeciak S, Arnold RC, Claremont HA, Kline JA, Emergency Medicine Shock Research Network (EMShockNet) Investigators. Lactate clearance vs central venous

oxygen saturation as goals of early sepsis therapy: A randomized clinical trial. JAMA. 2010;303:739-46.
9. Demetriades D, Hadjizaharia P, Constantinou C, Brown C, Inaba K, Rhee P, et al. Selective nonoperative management of penetrating abdominal solid organ injuries. Ann Surg. 2006;244(4):620-8.
10. Croce MO, Fabian TC, Menke PG, Waddle-Smith L, Minard G, Kudsk KA, et al. Non-operative management of blunt hepatic trauma is the treatment of choice for hemodynamically stable patients: results of a prospective trial. Ann Surg. 1995;221:744-53.
11. Moudouni SM, Hadj S, Manunta A, Patard JJ, Guiraud PH, Guille F, et al. Management of major blunt renal lacerations: is a non-operative approach indicated? Eur Urol. 2001;40:409-14.
12. Robert M, Drianno N, Muir G, Delbos O, Guiter J. Management of major blunt renal lacerations: surgical or non-operative approach? Eur Urol. 1996;30:335-9.
13. Bakker J, Coffernils M, Leon M, Gris P, Vincent J-L. Blood lactate levels are superior to oxygen-derived variables in predicting outcome in human septic shock. Chest. 1991;99:956-62.
14. Donnino MW, Miller J, Goyal N, Loomba M, Sankey SS, Dolcourt B, et al. Effective lactate clearance is associated with improved outcome in post-cardiac arrest patients. Resuscitation. 2007;75:229-34.
15. Marty P, Roquilly A, Vallee F, Luzi A, Ferre F, Fourcade O, et al. Lactate clearance for death prediction in severe sepsis or septic shock patients during the first 24 hours in Intensive Care Unit: an observational study. Ann Intensive Care. 2013;3(3): 1-7.
16. 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;74(4):999-1004.
17. Zane RD. Lactate and poor lactate clearance predict mortality in trauma patients. Available at http://www.jwatch.org/em201304260000003/2013/04/26/lactate-and-poor-lactate-clearance-predict. Accessed 6 March 2017.

Cite this article as: Rudiman R, Saragih N, Purnama A. Lactate clearance: its relationship with the success of non-operative management in patient with blunt abdominal trauma. Int Surg J 2017;4:1738-42.