

## SERUM LACTATE AND SERUM SODIUM AS A MARKER IN PREDICTING THE SEVERITY AND PROGNOSIS IN NECROTIZING SOFT TISSUE INFECTION

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### Abstract

**Background:** NSTIs can be fatal and involve infections in the soft tissue compartment. The prognosis depends on a precise diagnosis and the prompt implementation of the necessary treatments. The lack of visible skin signs at the beginning of the illness makes the initial diagnosis challenging at the moment. Some studies indicated higher serum lactate levels and serum sodium levels as a marker of sepsis and severe infections. So this study is an attempt to determine the diagnostic accuracy of serum lactate and sodium levels in the prediction of NSTIs prognosis. **Materials and Methods:** A prospective observational study was carried out among 50 patients with NSTIs. Serum sodium and serum lactate levels were measured during admission to predict the prognosis of NSTIs. Data were analyzed using sensitivity, specificity and predictive values. **Result:** Serum lactate had 62.9% of sensitivity and 100% of specificity for the prediction of prognosis among NSTIs patients. The sensitivity was 65.22% and the specificity was 88.29% for serum sodium levels. The AUC curve value was 0.815 for serum lactate and 0.229 for serum sodium. **Conclusion:** Patients of NSTIs may be identified using a basic model that uses admission serum lactate and serum sodium levels for the prediction of prognosis. Serum lactate levels had a better predictive value than serum sodium levels.

## INTRODUCTION

Necrotizing soft-tissue infections (NSTIs) are uncommon infections that can be fatal. They can be characterized as infections that are linked to necrotizing alterations in any of the layers of the soft tissue compartment (dermis, subcutaneous tissue, superficial fascia, deep fascia, or muscle).<sup>[1]</sup> NSTIs are most likely to impact the deeper layers of adipose tissue and clinically, they are marked by a very rapid disease progression and severe local tissue loss, which is often brought on by toxin-producing bacteria.<sup>[2]</sup>

Jones originally documented these diseases in 1871, when they were known as "hospital gangrene." Since then, numerous definitions of NSTI have been published, and numerous terminologies, classifications, and categorizations have also been utilized. Wilson created the term "necrotizing fasciitis" in 1951 to describe a few of these illnesses.<sup>[1]</sup>

Worldwide, there are 0.30 to 15 instances of NF per 100,000 people. According to international research, gynecological treatments, cancer, overweight, alcoholism, trauma, immune-compromised hosts, and surgery are all risk factors for NF. Severe sepsis, serum creatinine levels below 2, age over 60, streptococcal toxic shock syndrome, clostridial infection, delays in surgery of more than 24 hours, and infections of the head, neck, thorax, or abdomen are all variables that contribute to mortality.<sup>[3]</sup>

The most prevalent microorganism worldwide, as well as in North America, Asia, the Middle East, and Africa, was *Staphylococcus aureus*, which was followed by *Streptococcus pyogenes* and *Escherichia coli*. 16% of necrotizing soft tissue infections worldwide were caused by methicillin-resistant *S. aureus*. The global mortality rate was 23.1%, and it has been declining over the past ten years. For mortality, there were no geographical variations.<sup>[4]</sup> Due to the absence of visible skin signs at the beginning of the infection, initial diagnosis is

frequently challenging. Crepitation, bullae, necrosis, and subcutaneous air on radiographs are examples of hard clinical symptoms that aid in making the diagnosis; nevertheless, these indications are frequently absent during the initial examination. In necrotizing fasciitis, laboratory findings are typically non-specific. Blood lactate levels are the earliest indicator of death in sepsis and can distinguish between survivors and non-survivors as early as 12 hours after admission.<sup>[5]</sup> Hyponatremia, hyperkalemia, and increased band cells in peripheral blood of patients may be helpful criteria in differentiating life-threatening necrotizing fasciitis, according to Espander R et al.<sup>[6]</sup>

If there is a positive correlation between hyponatremia and sepsis, measuring sodium concentration as a possible laboratory marker for sepsis could help doctors diagnose hyponatremic septic patients more quickly and give them better prognosis in patients, particularly in elderly patients who frequently lack classic infection symptoms.<sup>[7]</sup>

So this study is an opportunity to predict prognosis of Necrotizing soft tissue infections using serum lactate and serum sodium levels.

## MATERIALS AND METHODS

**Study design:** Prospective observational study.

**Study area:** Department of Surgery, Trichy SRM Medical College Hospital & Research Centre, Irungalur, Thiruchirappalli, Tamil Nadu.

**Study duration:** One year (September 2021 – August 2022).

**Study population:** Patients with necrotizing soft tissue infections.

### Inclusion criteria

Patients with necrotizing soft tissue infections irrespective of age and gender.

Patients with necrotizing soft tissue infections along with soft tissue cellulitis.

### Exclusion criteria

Patients with dependent edema due to pathological causes.

Sampling technique

Purposive sampling.

### Sample size

Sample size was calculated by using formula  $4pq/d$  and using 48.3% of mortality rate among patients with serum lactate levels more than 2.9 the estimated sample size was 50. (80% power and 15% of absolute precision and 10% of non-response rate).

### Study instrument

A semi-structured questionnaire.

Laboratory records.

Operational definition

Serum lactate: A novel vital indicator of septic shock may be a blood lactate level of greater than 2 mmol/L<sup>8</sup>.

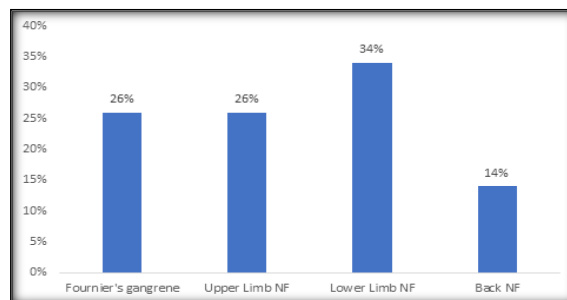
**Data collection:** Data was collected in the inpatient department of surgery among patients admitted with necrotizing soft tissue infections. A semi-structured

questionnaire was administered among them and a clinical examination was carried out with their informed written consent. The site of infection, depth of infection, and surrounding tissues were examined and their appropriate management schedule was followed up till their discharge. The laboratory examination like complete blood count, serum lactate and sodium levels were done. The patients have explained the prognosis (good/bad) of their disease. The prognosis was classified depending upon the extent of lesion, co morbid status, age group and abnormal blood indicators.

**Data analysis:** Data entered in Microsoft excel 2019 and analysed using descriptive and inferential statistics using SPSS software. The prediction of sodium and lactate levels was done by using sensitivity, specificity, positive and negative predictive value and diagnostic accuracy.

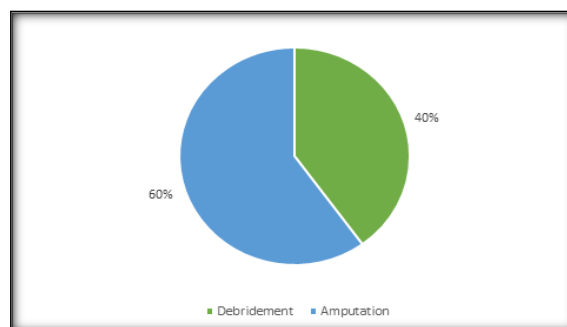
**Ethical issues:** Ethics clearance was obtained from Institutional Ethics Committee, Trichy SRM Medical College Hospital.

## RESULTS



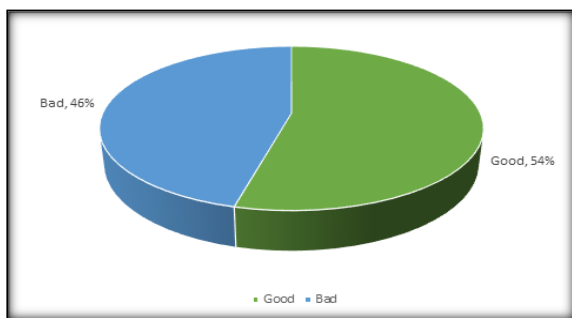
**Figure 1: Site of Necrotizing soft tissue infections**

40% patients undergone debridement and 60% of them undergone amputation.



**Figure 2: Surgical approach of Necrotizing soft tissue infections**

54% of the patients had good prognosis and others had bad prognosis.



**Figure 3: Prognosis of necrotizing soft tissue infections**

This study recruited fifty patients with necrotizing soft tissue infections who were admitted to the Department of Surgery. The mean age of participants was  $56.38 \pm 12.623$  years ranged from 34 – 76 years. Most (38%) of the participants were belonged to 61 – 70 years age group. 70% of the patients were males

and 30% were females. 38% of them do not have existed co-morbid conditions but others do have co-morbid conditions like hypertension and Diabetes. Age ( $p = 0.506$ ), gender ( $p = 0.951$ ), co morbid status ( $p = 0.901$ ), and site of lesion ( $p = 0.756$ ), was not associated with prognosis of NSTIs.

34%, 26%, 26% and 14% of the patients had lower limb NSTIs, Fournier's gangrene, UL NSTIs and back region NSTIs respectively. [Table 1]

The mean serum sodium value was  $130.3 \pm 2.038$  ranged from 126.2 – 132.5. The mean serum lactate value was  $2.82 \pm 1.01$  ranged from 1.2 – 4.6. The mean value of serum lactate level was found to be high in patients with bad prognosis of NSTIs and this was statistically significant. The mean value of serum sodium level was found to be low in patients with bad prognosis of NSTIs and this was statistically significant.

**Table 1: Baseline characteristics of the patients (n = 50)**

S No	Variables	Frequency	Proportion (%)
1	Age group	31 – 40 years	12
		41 – 50 years	24
		51 – 60 years	14
		61 – 70 years	38
		71 – 80 years	12
2	Gender	Male	70
		Female	30
	Co morbid	Nil	38
		Hypertension	18
		Type II DM	20
		HT & Type II DM	24

**Table 2: Mean serum sodium values and prognosis (n = 50)**

S No	Values	Good prognosis	Bad prognosis	p-value
1	Serum sodium	$131.59 \pm 0.968$	$128.56 \pm 1.7$	0.001
2	Serum Lactate	$2.096 \pm 0.66$	$3.682 \pm 0.576$	0.001

A higher proportion of patients with bad prognosis of NSTI's had serum lactate levels  $\geq 2.9$  and this was significant statistically.

**Table 3: Cross tabs of serum lactate values and prognosis (n = 50)**

S No	Serum lactate	Good prognosis	Bad prognosis	Total	p value
1	$< 2.9$	17 (100%)	0 (0)	17	0.001
2	$\geq 2.9$	10 (30.3%)	23 (69.7%)	33	

A higher proportion of patients with bad prognosis of NSTI's had serum lactate levels  $\leq 130$  and this was significant statistically.

**Table 4: Cross tabs of serum lactate values and prognosis (n = 50)**

S No	Serum lactate	Good prognosis	Bad prognosis	Total	p value
1	$\leq 130$	3 (16.7%)	15 (83.3%)	18	0.001
2	$> 130$	24 (75%)	8 (25%)	32	

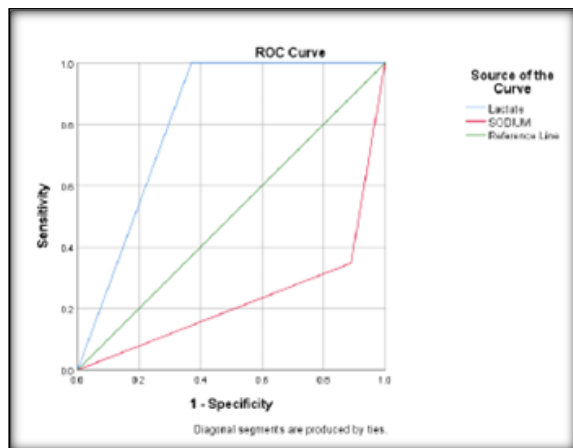
The serum lactate levels had better sensitivity and high specificity for the prediction of bad outcomes of NSTIs. Although the sensitivity of serum sodium was high compared with serum lactate, it had low specificity and predictive values.

**Table 5: Diagnostic accuracy of serum lactate and sodium levels**

S No	Diagnostic prediction	Serum lactate	Serum sodium
1	Sensitivity	62.9%	65.22%
2	Specificity	100%	88.89%
3	Positive predictive value	100%	83.33%
4	Negative predictive value	69.7%	75%
5	Diagnostic accuracy	80%	78%

**Table 6: Area under curve of serum lactate and sodium levels**

S No	Diagnostic prediction	Area under curve	p value	95% CI
1	Serum lactate	0.815	0.001	0.693 – 0.937
2	Serum sodium	0.229	0.001	0.091 – 0.368

**Figure 4: ROC curves of serum lactate and sodium levels**

The area under curve of serum lactate was 0.815 which was good to predict prognosis and this value was statistically significant. The area under curve of serum sodium was 0.229 which was not that much good to predict prognosis and this value was statistically significant.

## DISCUSSION

This study was conducted among 50 patients of NSTIs who admitted for management. Their serum lactate and serum sodium levels were collected at the time of admission and they were followed up to discharge. Their prognosis was predicted using these blood values. This study shows serum lactate had 80% of diagnostic accuracy and serum sodium had 78% of diagnostic accuracy for the prediction of NSTI's prognosis.

Colak E et al,<sup>[9]</sup> in Turkey and Yaghoubian et al,<sup>[10]</sup> in United states, revealed no association of mortality of NF with age and gender which was similar to our study results.

The necrotizing fasciitis cohort's mean (standard deviation) serum lactate levels were 4.1 mmol/l (1.62) in a study by Murphy G. et al,<sup>[11]</sup> in a hospital-based study in the United Kingdom. For necrotizing fasciitis in this cohort, a lactate level of 2.0 mmol/l yielded a sensitivity of 1, specificity of 0.76, positive predictive value of 0.82, negative predictive value of 1, and accuracy of 0.89. This study shows near contrast results might be due to cut off values of serum lactate of two.

Smith et al,<sup>[12]</sup> research in United Kingdom also revealed the area under curve was 0.78 for serum lactate for predicting prognosis of intensive care unit patients which was similar to our study results.

According to studies by Yaghoubian et al in United states, admission serum lactate and sodium levels

were 100% sensitive, 28% specific, 23% positive predictive, and 100% negative predictors of NSTI mortality. This study result also signifies admission serum lactate and sodium levels could be the predictors of prognosis which was same compared with Yaghoubian et al.<sup>[10]</sup>

Among patients with Fournier's gangrene, the rise in serum lactate at the time of admission was also found to be a significant predictor of a fatal outcome ( $p = 0.01$ ). based on a study conducted by Martinschek et al,<sup>[13]</sup> in Germany which was similar to our study results.

Jabbour et al,<sup>[14]</sup> in Qatar compared survivors and non survivors of NF and found that the serum sodium levels had non-significant value ( $p=0.442$ ) for prediction of mortality in multivariate analysis. This result was varied with our results might be due to increased sample size ( $n = 331$ ).

Sudhir S et al,<sup>[5]</sup> in Karnataka described that the statistically significant area under the curve for serum lactate at the time of admission in predicting death was 0.740. For predicting mortality, serum lactate demonstrated diagnostic accuracy of 78%, positive predictive value of 48.28%, negative predictive value of 90.14%, and sensitivity of 66.67% which was similar to our study results.

## CONCLUSION

Serum sodium and serum lactate levels at the time of admission was helpful to predict the prognosis of patients with NSTIs. But serum lactate levels had higher diagnostic accuracy compared with serum sodium levels for the prediction of prognosis. It will helpful to categorize the patients for Intensive care and management. The serum lactate levels at the time of admission should be mandatory for the earliest prediction of NSTIs prognosis.

## REFERENCES

1. Goldstein EJC, Anaya DA, Dellinger EP. Necrotizing Soft-Tissue Infection: Diagnosis and Management. *Clin Infect Dis*. 2007 Mar 1;44(5):705–10.
2. Hakkarainen TW, Kopari NM, Pham TN, Evans HL. Necrotizing soft tissue infections: Review and current concepts in treatment, systems of care, and outcomes. *Curr Probl Surg*. 2014 Aug;51(8):344–62.
3. Tantirat P, Rattanathumsakul T, Praekunatham H, Pachanee K, Suphanchaimat R. Epidemiological Situation of Necrotizing Fasciitis and Factors in Thailand and Factors Associated with Its Morbidity and Mortality, 2014-2018. *Risk Manag Healthc Policy*. 2020;13:1613–24.
4. Dhanasekara CS, Marschke B, Morris E, Kahathuduwa CN, Dissanaik S. Global patterns of necrotizing soft tissue infections: A systematic review and meta-analysis. *Surgery*. 2021 Dec;170(6):1718–26.

5. S S, Arora R. Use of serum lactate and serum sodium at admission to predict mortality in necrotising fasciitis. *Int Surg J*. 2018 Nov 28;5(12):4040–6.
6. Espandar R, Sibdari SY, Rafiee E, Yazdanian S. Necrotizing fasciitis of the extremities: a prospective study. *Strateg Trauma Limb Reconstr*. 2011 Nov;6(3):121–5.
7. De Freitas G, Gudur A, Vela-Ortiz M, Jodelka J, Livert D, Krishnamurthy M. Where there is sodium there may be sepsis. *J Community Hosp Intern Med Perspect*. 2019 Sep 5;9(4):296–9.
8. Lee SM, An WS. New clinical criteria for septic shock: serum lactate level as new emerging vital sign. *J Thorac Dis*. 2016 Jul;8(7):1388–90.
9. Colak E, Ozlem N, Kucuk GO, Aktimur R, Kesmer S. Laboratory Risk Indicators for Necrotizing Fasciitis and Associations with Mortality. *Turk J Emerg Med*. 2014 Mar;14(1):15–9.
10. A Y, C de V, C D, Rj L, M L. Use of admission serum lactate and sodium levels to predict mortality in necrotizing soft-tissue infections. *Arch Surg Chic Ill 1960 [Internet]*. 2007 Sep [cited 2022 Aug 27];142(9). Available from: <https://pubmed.ncbi.nlm.nih.gov/17875838/>
11. Murphy G, Markeson D, Choa R, Armstrong A. Raised serum lactate: a marker of necrotizing fasciitis? *J Plast Reconstr Aesthetic Surg JPRAS*. 2013 Dec;66(12):1712–6.
12. Smith I, Kumar P, Molloy S, Rhodes A, Newman PJ, Grounds RM, et al. Base excess and lactate as prognostic indicators for patients admitted to intensive care. *Intensive Care Med*. 2001 Jan;27(1):74–83.
13. Martinschek A, Evers B, Lampl L, Gerngroß H, Schmidt R, Sparwasser C. Prognostic aspects, survival rate, and predisposing risk factors in patients with Fournier's gangrene and necrotizing soft tissue infections: evaluation of clinical outcome of 55 patients. *Urol Int*. 2012;89(2):173–9.
14. (PDF) Pattern and predictors of mortality in necrotizing fasciitis patients in a single tertiary hospital [Internet]. [cited 2022 Aug 29].
15. Sudhir S., Rachit Arora. Use of serum lactate and serum sodium at admission to predict mortality in necrotising fasciitis. *Int Surg J*. 2018 Dec;5(12):4040-4046.