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Serum lactate – useful analysis within emergency care

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Early identification and stratification of patients being treated within the emergency care chain are key components for medical safety and quality [1-4]. The aim is to provide a high level of safety in the emergency care chain and reduce lead times for diagnostics, decision making and measures at the emergency unit.

Most emergency rooms nowadays use some type of triage method. In Sweden, an increasing number of emergency units and ambulance organizations are now using validated decision support, which also contains recommendations for both measures and sampling [1-4], which most triage system do not include [5-8]. Previous studies have shown that the examination of the vital signs is important for predicting mortality [8-9], and various blood analysis methods have proven useful in the stratification of patients [10-13]. The major weakness from an emergency medical perspective is that most studies have been conducted on selected patients or diagnostic groups such as sepsis [14] and trauma [15] and that sampling took place in different phases of the emergency process reducing the possibility of using this information in an unselected patient population. Serum lactate (S-lactate) has been proposed for inclusion as a routine blood test in the emergency unit [16].

METTS (Medical Emergency Triage and Treatment System) is used at the emergency and accident unit at the Sahlgrenska University Hospital. This clinical decision making support includes three different blood sample sets depending on priority/emergency level and an algorithm provides support for re-prioritization, depending on the outcome of laboratory analyzes [1-4].

The primary purpose of this study was to investigate how the first assessment according to the METTS decision making support correlated with the S-lactate level upon arrival and the extent to which patients were re-prioritized due to high S-lactate levels.

Material and method

The study included 180 consecutive patients who were treated at the emergency and accident unit and who upon arrival had S-lactate levels >5.0 mmol/l. From the same period of time 180 consecutive patients were recruited to a control group, matched for age and with normal S-lactate levels (<1.8 mmol/l).

Approximately 49,000 patients receive medical care at the emergency unit every year and all undergo an initial examination, sampling and measures according to the METTS decision making tool [1-4]. The sample test results are handled in the METTS protocol according to a special algorithm (Fact 1) that can prioritize the patient to the next highest priority level where continuous monitoring is mandatory and medical assessment should take place without delay.

The METTS protocol has been validated regarding its sensitivity when predicting mortality, resource requirements and inter-individual variability [2, 4]. During the first examination patients who received red, orange or yellow priority levels are sampled according to METTS. Green priority patients are sampled only in those cases where the algorithm relating to the reason for contact recommends sampling. Venous blood gas measurements where S-lactate is included are used as a basic METTS analysis. We prefer venous blood gas measurements because they are simple and reliable. The analysis was performed using blood collected in heparin tubes and analyzed at our near-patient laboratory (Radiometer-ABL 825; Radiometer Copenhagen, Denmark). The procedure regarding first examinations according to METTS has been previously described [1-2].

All statistical analysis was performed using SPSS version 17.0 (SPSS Inc, Chicago, IL), and Student's t tests and ANOVA were used for analysis between groups.

Results

Basal data

In the group with high S-lactate levels the proportion of males was significantly (P <0.02) higher (62 %) than women, while the gender distribution in the normal S-lactate group was similar. The duration of care was significantly longer in the high S-lactate level group (Table I). There were no differences in age between the groups. The dispersion and distribution of S-lactate between the groups is shown in Figure 1. If the entire material is distributed according to METTS prioritizing which the patient received immediately upon arrival to the emergency unit, it shows that the highest priority group was significantly older, had higher S-lactate levels and longer hospital stays than in patients with lower degrees of priority. The mortality rate was higher for the higher priority level. Re-prioritization to “orange” occurred in 6 cases (15 %) with “green” priority and in 37 cases (29 %) of "yellow” priority, according to the algorithm for re-prioritization after laboratory results (Table II and Facts 1). The most common reasons for contact in the group with high S-lactate levels and which were re-prioritized were previous history of seizures, current alcohol abuse, poisoning and acute abdomens. The correlation between S-lactate levels and base excess was significant, r = 0.57 (P<0.001).

Vital signs

There was a correlation between vital signs and S-lactate level upon arrival. The group with high S-lactate levels had respiration that was significantly more affected with greater respiratory rates and lower POX percentages (oxygen saturation in the blood, as measured using pulse oximetry), higher heart rates and lower systolic and diastolic blood pressure levels. Even level of consciousness according to RLS varied significantly between the groups (Table III).

Care levels

In the high S-lactate group, the need for inpatient care was 75 % (n = 135) of which 60 % (n = 81) were initially treated at a monitored level of care (ICU, HIA, MAVA). In the group with normal S-lactate 42 % (n = 76) of patients were admitted for inpatient care, of which 45 % (n = 34) to the medical emergency department. No patients with normal S-lactate were cared for in intensive care

Mortality

In the entire material (n = 360) a total of 40 patients died (11.1 %) with 5 (1.4 %) in the emergency unit and 35 (9.7 %) during subsequent inpatient care. The mortality differed between the groups. The mortality rate was significantly higher in the group with high S-lactate (n = 35, 19.5 %). In the group with normal S-lactate mortality was 2.8 %, which is normally calculated on a full year for patients arriving via the emergency and accident unit (Table III).

If patients are allocated based on METTS protocol the mortality rate in the highest priority, "red", 37 % (n = 33), while in the second-highest priority, "orange", it was 8.5 % (n = 5). In the “yellow” priority group mortality was 2.4 % (n = 3) and the lowest priority group or “green” the mortality was zero (Table II).

Discussion

In this study we demonstrated a clear correlation between the S-lactate on arrival to the emergency room, the priority level of the METTS protocol and mortality in a consecutive patient material. Most triage protocols, official and validated, do not include systematic monitoring of vital signs, but rather the patients are primarily sorted based on symptoms and signs, often at a desk or reception area [5-7]. In other studies in which S-lactate was studied mainly selected emergency patients were studied [14-15]. It may therefore be difficult to make any general conclusions based on these studies.

In our study we examined a relatively large number of patients with different types of contact reasons, different degrees of emergency and with a systematic protocol which was the same for all patients. We also found a clinically relevant correlation between S-lactate and the patient's clinical condition regarding objective variables. Meanwhile S-lactate was taken at the same time as the patient was examined and received his priority level, which further strengthens the results clinical relevance. In other studies, S-lactate samples were taken at different phases of emergency process, which is likely to affect the outcome [19]. Sometimes there is criticism made against the use of venous blood for blood gas analysis and S-lactate analysis but several studies have shown a good correlation between arterial and venous samples regarding S-lactate [18-19].

Support for S-lactate sampling for general indications

At the Sahlgrenska University Hospital emergency and accident unit, primarily venous samples have been used for analysis of blood gas and S-lactate since 2005 as basic analysis depending on the priority level and the current algorithm in the METTS protocol. This basic analysis also includes Hb, P-glucose and electrolyte status.

Our experiences can also provide support for Vroonhofs and the contributing author's claims that S-lactate should be an analysis taken for relatively general indications at the emergency unit [16]. In order not to allow chance to dictate for who and when samples are taken, a structured protocol should be used. Venous blood gases with S-lactate is cheap, readily analyzed, safe and contains considerable information about the patient's metabolic, respiratory and circulatory conditions. Increased S-lactate can be seen in conjunction with a number of frequently occurring conditions where the patient does not exhibit clear signs of organ failure at the same time.

Most common in the emergency unit are patients with seizures, alcohol poisoning, acute abdomens, sepsis or local ischemia often with increased S-lactate. Blood gas is very good as a patient analysis because in the emergency services there is often a need for rapid analysis and measures. Our study also showed a certain correlation between the S-lactate level and base excess, which can be important information for those emergency units that do not have direct access to S-lactate analysis.

In this study, mortality was lower than in previous studies [13] with the same or lower S-lactate levels. It may be due to different patient populations, selection of patients or different sampling times compared with the previous studies. In our study we consecutively included all patients who satisfied the criteria that S-lactate was taken, which gives a specific selection of patients with lower priority because METTS does not normally recommend analysis of venous blood gas at the “green” priority level.

In this study, high S-lactate was found in a number of “green” and “yellow” priority patients. The reason for the high S-lactate was in many cases a history of seizures, alcohol abuse, poisoning or acute abdomen, the latter is a condition where the patient has often not consumed food or drink for a long period of time which can also cause moderate increases in S-lactate. According to the METTS protocol we should re-prioritize patients with S-lactate >5mmol/l to "orange” priority. Previously, a correlation has been found between hypoperfusion and high S-lactate levels, and in our study, in the "red” priority group there were clinical signs of hypoperfusion with increased heart rates and lower blood pressure.

S-lactate can provide additional information

Our data also indicates that in patients given high priority in METTS, S-lactate can contribute additional information about the patient's clinical condition than is the case if only the S-lactate is used [20]. High sensitivity in a decision making tool such as METTS should provide some level of "overtriage” meaning that some patients receive a priority level that is too high. Even in these patients, analysis of venous blood gas can be important as a complement to the physician's assessment of how acutely ill the patient actually is.

Conclusion

Our clinical experience in analyzing S-lactate already upon arrival at the emergency unit is, in some cases, an important addition to the decision making tool in order to increase the sensitivity and precision of care and also contribute to increased patient safety at the emergency unit.

Facts 1. Part of algoritm 70 in METTS.

Reprioritisation performed based on laboratory evaluations. Below is stated the priority (orange) that the patient receives when one or more test results are consistent with these values. Please note that the reference values may differ between hospitals and laboratories.

- Hb <70 µg/l
- S-Na <125 mmol/l
- S-K >5.5 or <2.7 mmol/l
- P-glucose <3.5 or >25 mmol/l

- S-lactate >5.0 mmol/l
- CRP >200 mg/l
- PK-INR >3.0
- Troponin I >0.15 µg/l
- Troponin I >0.10–0.15 □g/l + chest pain
- Paracetamol >reference for antidote treatment

SUMMARY

In the emergency care chain the time to correct diagnosis and measure is usually important. In addition to a validated decision support tool additional analyzes are often needed as a basis for decisions on re-prioritization, diagnosis and treatment, preferably in close proximity to the first medical assessment.

At the emergency and accident unit the correlation between priority and outcome in patients with high S-lactate levels and how S-lactate affects reprioritization was studied.

The group with high S-lactate levels had a higher priority according to METTS, longer hospital stays and a higher hospital death rate. They also exhibited greater impact on vital signs upon arrival at the hospital.

S-lactate is a variable used in METTS decision making, and at the level of >5 mmol/L a reprioritization takes place to a higher priority level.

Our conclusion is that S-lactate taken upon arrival provides additional and useful information which can be an additional decision making tool in the acute phase of processing.

Table I. Distribution of sex, age and length of stay in the groups with high respective normal S-lactate levels.

	High S-lactate n = 180	Normal S-lactate n = 180	P
Men, number (percent)	112 (62)	82 (46)	
Women, number (percent)	68 (38)	98 (54)	
Age, years	62 ±19	62 ±19	ns
S-lactate, mmol/l	7.5 ±2.9	1.5 ±0.3	<0.0001
Duration of care, days	4.6 ±6.9	3.3 ±3.9	<0.03

Number High Low

0.0 5.0 10.0 15.0 20.0 0.0 5.0 10.0 15.0 20.0

Lactate, mmol/l

Figure 1. Distribution in the two study groups with high and low serum lactate

Table II. Distribution of age, S-lactate, length of stay and mortality in each priority group according to METT-S.

	Green n = 39	Yellow n = 126	Orange n = 106	Red n = 89
Age, years	55 ±19	63 ±19	59 ±17	70 ±18***
Lactate, mmol/l	2.3 ±2.2	3.1 ±2.8	5.1 ±3.7	6.9 ±3.8***
Normal lactate, Number of patients	33	89	41	17
High lactate, Number of patients	6	37	65	72
Duration of care, days	2.4 ±2.9	3.4 ±4.4	3.6 ±3.6	5.7 ±8.9**
Dead at ER, number (percent)	0	0	1 (0.9)	4 (4.5)
Dead during care period, number (percent)	0	3 (2.4)	7 (6.6)	25 (28.1)

** significant <0.01 *** significant <0.001

Table III. Vital signs and mortality in the group with high respective normal S-lactate. POX-percent = oxygen saturation in the blood measured using pulse oximetry. SBT = systolic blood pressure. DBT = diastolic blood pressure. RLS = reaction level scale.

	High lactate n = 180	Normal lactate n = 180	P
Respiratory rate/min	22 ±9	18 ±8	<0.001
Oxygen saturation, POX-percent	91 ±8	96 ±4	<0.001
Heart rate, beats/min	99 ±26	86 ±25	<0.001
SBT, mm Hg	132 ±33	146 ±29	<0.001
DBT, mm Hg	77 ±23	83 ±17	<0.001
RLS	1.6 ±1.5	1.1 ±0.5	<0.001
Dead at ER, number (percent)	4 (2.2)	1 (0.5)	
Dead during care period, number (percent)	31 (17.2)	4 (2.2)	

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Possible competing and conflicts of interest: None stipulated

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