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THE CORRELATION BETWEEN SERUM INDICES AND CERTAIN CHARACTERISTICS OF PATIENT SAMPLES AT CAN THO UNIVERSITY OF MEDICINE AND PHARMACY HOSPITAL

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ABSTRACT

Background: *The presence of serum indices is a concern for most laboratories, and their distribution can be influenced by various factors such as age, gender, pathology.* ***Objective:*** *To determine the correlation between the distribution of serum indices and the characteristics of patient samples at Can Tho University of Medicine and Pharmacy Hospital.* ***Materials and methods:*** *A cross-sectional descriptive study was conducted on 1299 patient samples to determine the correlation between the distribution of serum indices with the characteristics of the patient samples.* ***Results:*** *The icterus index (3.16%) had a significant relationship with clinical department, age group, gender, type of test, and patient type. The lipemia index (0.92%) was related to gender, but there were no differences with other characteristics. Overall, 8.78% of specimens exhibited serum indices, primarily related to the clinical department (Outpatient 47.4%, Emergency 19.3%), type of test (routine 80.7%, emergency 19.3%), and patient type (outpatient 58.8%, inpatient 41.2%).* ***Conclusion:*** *Evaluating the correlation between serum indices and sample characteristics helps improve test quality, reduce errors, and optimize patient treatment processes.*

Keywords: *Serum indices, HIL indices, hemolysis index, icterus index, lipemia index.*

I. INTRODUCTION

The hemolysis index (H), the icteric index due to increased bilirubin (I), and the lipemic index due to increased lipid levels (L) have become of great interest in the field of laboratory testing. These are common pre-analytical issues that affect patients' clinical test results and may lead to erroneous outcomes [1] In fact, more than 70% of clinical decisions made by physicians are based on laboratory test results [2]. These pre-analytical sample characteristics can be detected either visually or by automated laboratory systems [3]. However, visual assessment is time-consuming, highly subjective, and lacks standardization [3]. Therefore, serum index testing is performed using automated systems to provide fast, timely, accurate, and objective results, which include the three parameters: H, I, and L [3]. The distribution of serum indices is often related to factors such as gender, age group, clinical departments, type of tests, among others [4]. Therefore, our research team undertakes this study with the objective: To determining the relationship between serum indices and certain characteristics of samples at Can Tho University of Medicine and Pharmacy Hospital.

II. MATERIALS AND METHODS

2.1. Materials

Serum samples (silica particle tube serum) with a minimum volume of 2 mL per tube at Can Tho University of Medicine and Pharmacy Hospital.

- **Inclusion criteria:** All serum samples were ordered for testing at the Laboratory Department of the Can Tho University of Medicine and Pharmacy Hospital.

- **Exclusion criteria:** Samples with signs of breakage or leakage; Samples with abnormal color will be excluded, except for colors related to the indices under investigation: samples with noticeably turbid or yellow plasma will be recorded, samples with significant hemolysis or the presence of clots will be excluded.

- **Research location and period:**

+ Location: Laboratory Department, Can Tho University of Medicine and Pharmacy Hospital.

+ Period: From June 12 to August 12 2024.

2.2. Methods

- **Sample size:** 1299 serum samples that met the inclusion criteria were collected.

- **Research method:** The study was designed as a cross-sectional descriptive study.

- **Research content:** Serum index testing was conducted on all samples using the Abbott Architect Ci8200 system. Hemolysis (H), icterus (I), and lipemia (L) indices were analyzed per the manufacturer's guidelines. Serum indices were considered to impact test results (+) at H: ≥ 30 mg/dL, I: ≥ 2.0 mg/dL, and L: ≥ 50 mg/dL; values below these were negative (−). This classification helped assess sample characteristics and their relationship with patient factors like age, gender, clinical department, test type, and category.

- **Data processing:** Data were analyzed using SPSS 27.0. Qualitative variables are presented as frequencies and percentages, while quantitative variables are reported as mean ± standard deviation (normal distribution) or median, maximum, and minimum values (non-normal distribution). The chi-square test was used to determine relationships, with $p<0.05$ indicating statistical significance.

- **Ethics in research:** The study was approved by the Ethics Committee of the Can Tho University of Medicine and Pharmacy (code 24.005.SV/PCT-HĐĐĐ).

III. RESEARCH RESULTS

3.1. The correlation between each serum index and sample characteristics

Table 1. Correlation between hemolysis index and sample characteristics

Sample Characteristics		Hemolysis Index (+)	Hemolysis Index (-)
		% (n) 4.9 (64)	% (n) 95.1 (1235)
Clinical Department	Obstetrics	0.0 (0)	100.0 (9)
	Oncology	6.7 (2)	93.3 (28)
	AIC	10.0 (1)	90.0 (9)
	Outpatient	4.2 (36)	95.8 (827)
	IC - Neurology	9.0 (7)	91.0 (71)
	Emergency - ICU	7.7 (9)	92.3 (108)
	Internal Medicine	4.5 (5)	95.5 (106)
	General Surgery	6.4 (3)	93.6 (44)
	Orthopedic Surgery	2.9 (1)	97.1 (33)

Sample Characteristics		Hemolysis Index (+)	Hemolysis Index (-)
		% (n) 4.9 (64)	% (n) 95.1 (1235)
$\chi^2 = 7.044$; p = 0.490			
Gender	Male	4.4 (25)	95.6 (539)
	Female	5.3 (39)	94.7 (696)
$\chi^2 = 0.520$; p = 0.471			
Age Group	< 19	0.0 (0)	100.0 (24)
	19 - 40	4.7 (13)	95.3 (264)
	41 - 65	5.2 (31)	94.8 (562)
	> 65	4.9 (20)	95.1 (385)
$\chi^2 = 1.391$; p = 0.708			
Test Type	Emergency	7.7 (9)	92.3 (108)
	Routine	4.7 (55)	95.3 (1127)
$\chi^2 = 2.099$; p = 0.147			
Patient Type	Outpatient	4.4 (42)	95.6 (921)
	Inpatient	6.5 (22)	93.5 (314)
$\chi^2 = 2.542$; p = 0.111			

The proportion of specimens positive for hemolysis index (H) was highest in the Department of Anesthesiology and Intensive Care at 10% (1/9) and lowest in the Department of Obstetrics at 0.0% (0/9). Females had a higher positive rate than males (5.3% vs. 4.4%). The age group of 41–65 years had the highest rate of positivity at 5.2% (31/562), while the group under 19 years of age had no positive cases, 0% (0/24). Emergency tests showed a higher positivity rate than routine tests (7.7% vs. 4.7%). Inpatients had a higher rate compared to outpatients (6.5% vs. 4.4%). However, the differences among these characteristics were not statistically significant (p>0.05).

Table 2. The correlation between icteric index and specimen characteristics

Sample Characteristics		Lipemic Index (+)	Lipemic Index (-)
		% (n) 0.9 (12)	% (n) 99.1 (1287)
Clinical Department	Obstetrics	0.0 (0)	100.0 (9)
	Oncology	0.0 (0)	100.0 (30)
	AIC	0.0 (0)	100.0 (10)
	Outpatient	1.2 (10)	98.8 (853)
	IC - Neurology	0.0 (0)	100.0 (78)
	Emergency - ICU	0.9 (1)	99.1 (9)
	Internal Medicine	0.0 (0)	100.0 (111)
	General Surgery	2.1 (1)	97.9 (46)
	Orthopedic Surgery	0.0 (0)	100.0 (34)
$\chi^2 = 3.807$; p = 0.874			
Gender	Male	1.6 (9)	98.4 (555)
	Female	0.4 (3)	99.6 (732)
$\chi^2 = 4.917$; p = 0.027			
Age Group	< 19	0.0 (0)	100.0 (24)
	19 - 40	2.2 (6)	97.8 (271)
	41 - 65	0.5 (3)	99.5 (590)
	> 65	0.7 (3)	99.3 (402)
$\chi^2 = 6.174$; p = 0.103			
Test Type	Emergency	0.9 (1)	99.1 (116)

Sample Characteristics		Lipemic Index (+)	Lipemic Index (-)
		% (n) 0.9 (12)	% (n) 99.1 (1287)
	Routine	0.9 (11)	99.1 (1171)
$\chi^2 = 0.007$; p = 0.935			
Patient Type	Outpatient	1.0 (10)	99.0 (953)
	Inpatient	0.6 (2)	99.4 (334)
$\chi^2 = 0.535$; p = 0.465			

The Emergency and Intensive Care Department had the highest positivity rate at 12.0% (14/117), while the Obstetrics and Gynecology Department and the Anesthesiology Department had the lowest rate at 0.0% (p<0.001). Males had a higher positivity rate compared to females (4.3% vs 2.3%) (p=0.047). The age group over 65 years had the highest positivity rate at 5.9%, with the lowest rate in the 19–40 age group at 0.7% (p<0.01). Emergency tests had a higher positivity rate compared to routine tests (12.0% vs. 2.3%) (p<0.01). Inpatients had a higher positivity rate than outpatients (7.4% vs 1.7%) (p<0.01). The differences among these characteristics were statistically significant.

Table 3. The correlation between lipemic index and specimen characteristics

Sample Characteristics		Lipemic Index (+)	Lipemic Index (-)
		% (n) 0.9 (12)	% (n) 99.1 (1287)
Clinical Department	Obstetrics	0.0 (0)	100.0 (9)
	Oncology	0.0 (0)	100.0 (30)
	AIC	0.0 (0)	100.0 (10)
	Outpatient	1.2 (10)	98.8 (853)
	IC - Neurology	0.0 (0)	100.0 (78)
	Emergency - ICU	0.9 (1)	99.1 (9)
	Internal Medicine	0.0 (0)	100.0 (111)
	General Surgery	2.1 (1)	97.9 (46)
	Orthopedic Surgery	0.0 (0)	100.0 (34)
$\chi^2 = 3.807$; p = 0.874			
Gender	Male	1.6 (9)	98.4 (555)
	Female	0.4 (3)	99.6 (732)
$\chi^2 = 4.917$; p = 0.027			
Age Group	< 19	0.0 (0)	100.0 (24)
	19 - 40	2.2 (6)	97.8 (271)
	41 - 65	0.5 (3)	99.5 (590)
	> 65	0.7 (3)	99.3 (402)
$\chi^2 = 6.174$; p = 0.103			
Test Type	Emergency	0.9 (1)	99.1 (116)
	Routine	0.9 (11)	99.1 (1171)
$\chi^2 = 0.007$; p = 0.935			
Patient Type	Outpatient	1.0 (10)	99.0 (953)
	Inpatient	0.6 (2)	99.4 (334)
$\chi^2 = 0.535$; p = 0.465			

The proportion of specimens positive for the lipemic index was highest in the General Surgery Department at 2.1% (1/47), while no positive cases were found in the Obstetrics, Oncology, Anesthesiology and Intensive Care, Interventional Cardiology-Neurology, Internal Medicine, and Orthopedic Surgery Departments. Males had a higher

positivity rate compared to females (1.6% vs. 0.4%). The 19-40 age group had the highest positivity rate at 2.2% (6/277), followed by the over-65 and 41-65 age groups at 0.7% and 0.5%, respectively, while the under-19 age group had no positive cases. Emergency and routine tests showed an equivalent lipemic index positivity rate of 0.9%. Outpatients had a higher positivity rate compared to inpatients (1.0% vs 0.6%).

Gender was significantly associated with the lipemic index (p=0.027), whereas other factors such as clinical department, age group, test type, and patient type showed no statistically significant differences.

3.2. The correlation between serum index presence and sample characteristics

Table 4. Relationship between serum index and sample characteristics

Sample Characteristics		Presence of serum index (+)	Absence of serum index (-)
		% (n) 8.8 (114)	% (n) 91.2 (1185)
Clinical Department	Obstetrics	0.0 (0)	100.0 (9)
	Oncology	13.3 (4)	86.7 (26)
	AIC	10 (1)	90.0 (9)
	Outpatient	6.3 (54)	93.7 (809)
	IC - Neurology	10 .3 (8)	89.7 (70)
	Emergency - ICU	18.8 (22)	81.2 (95)
	Internal Medicine	16.2 (18)	83.8 (93)
	General Surgery	10.6 (5)	89.4 (42)
	Orthopedic Surgery	5.9 (2)	94.1 (32)
$\chi^2 = 31.644$; $p < 0.001$			
Gender	Male	9.9 (56)	90.1 (508)
	Female	7.9 (58)	92.1 (677)
$\chi^2 = 1.655$; $p = 0.198$			
Age Group	< 19	4.2 (1)	95.8 (23)
	19 - 40	7.2 (20)	92.8 (257)
	41 - 65	8.1 (48)	91.9 (545)
	> 65	11.1 (45)	88.9 (360)
$\chi^2 = 4.577$; $p = 0.206$			
Test Type	Emergency	18.8 (22)	81.2 (95)
	Routine	7.8 (92)	92.2 (1090)
$\chi^2 = 16.149$; $p < 0.001$			
Patient Type	Outpatient	7.0 (67)	93.0 (896)
	Inpatient	14.0 (47)	86.0 (289)
$\chi^2 = 15.380$; $p < 0.001$			

Among clinical departments, the Emergency Department had the highest serum index occurrence rate at 18.8% (22/117), while the Obstetrics Department had no cases of serum index occurrence. By gender, males showed a slightly higher serum index occurrence rate compared to females (9.9% vs. 7.9%). Regarding age groups, individuals aged >65 years had the highest occurrence rate of 11.1%, and the under-19 group with a very low rate of 4.2%. For test types, emergency tests had a higher serum index occurrence rate (18.8%) compared to routine tests (7.9%). By patient type, inpatients exhibited a higher rate of serum index occurrence at 14.0% compared to outpatients at 7.0%. The differences in clinical department, test type, and patient type were statistically significant (p<0.001), indicating a

notable impact on the occurrence of the serum index. However, gender and age group showed no significant differences in the occurrence of a positive serum index ($p>0.05$).

IV. DISCUSSION

Our study of 1,299 patient samples found no statistically significant association between the hemolysis index positivity rate and sample characteristics. Our findings align with the study by Atakan Erkal (2019), which reported a higher hemolysis rate in females compared to males (65.6% vs. 35.4%), potentially due to differences in vascular structure and physiological factors [5]. Similarly, the study by Lim *et al*. (2017) observed higher hemolysis rates in middle-aged and elderly groups, consistent with our results, where the 41-65 age group showed the highest hemolysis rate (5.2%) [6]. Additionally, the study by Nguyen Thi Ngoc Lan (2018) indicated that samples from the Emergency Department had a significantly higher hemolysis rate, which is consistent with our findings, as emergency samples had a higher rate than routine ones (7.7% vs 4.9%) [7]. Therefore, standardizing the assessment and management of hemolyzed samples is crucial.

In our study, the positive rate of serum bilirubin was clearly associated with several clinical factors, including the department, gender, age group, type of test, and patient type. The results showed the highest positive rate in the Emergency - Intensive Care Department (12%) and the lowest in the Obstetrics and Anesthesia Intensive Care Departments ($p < 0.001$), reflecting the severity of the patients, especially those with septicemia or hemolysis, leading to increased bilirubin levels [8]. When analyzed by gender, males had a higher positive rate than females (4.3% vs. 2.3%) ($p = 0.047$), which could be due to the higher prevalence of liver diseases in men. Regarding age, the group over 65 years old had the highest positive rate (5.9%) due to liver function decline and aging processes that reduce the ability to metabolize bilirubin. For the type of test, the positive rate in the emergency test group was higher than in the routine test group (12% vs. 2.3%) ($p < 0.001$), similar to the study by Gang Tian *et al*. (2022), where inpatient patients had a significantly higher positive rate than outpatient patients [4].

In our study, the positivity rate for lipid turbidity index showed uneven distribution across clinical departments and different groups. However, the difference may be random. Regarding gender, males had a higher positivity rate than females (1.6% vs 0.4%), with the chi-square result ($p<0.05$), indicating a significant relationship between gender and lipid turbidity rate. This result may be explained by lifestyle factors such as diet, smoking, and alcohol consumption, which are more common in men and may increase blood lipid levels. These results suggest that gender is the only factor significantly related to the positivity rate of lipid turbidity. Males are at higher risk, consistent with previous studies showing that men are more likely to suffer from conditions associated with increased blood lipids than women. Additionally, the high positivity rate in the Surgery department may be due to non-compliance with the fasting requirements before surgery, which is also common among outpatient patients [9]. However, due to the lack of statistical difference between clinical departments, the department factor may not have a clear association with lipid turbidity.

The results of our study show that the positivity rate for serum indices varies across factors such as clinical departments, test types, patient types, gender, and age groups. Specifically, the Emergency – Intensive Care Unit department has the highest positivity rate (18.8%), while the Obstetrics department has no positive cases. With the chi-square result ($p<0.001$), indicating that the clinical department significantly influences the likelihood of

positive serum indices. Regarding gender, males have a higher positivity rate than females (9.9% vs. 7.9%), but the difference is not statistically significant ($p = 0.198$), which contradicts some studies suggesting that gender can affect test results [10]. When comparing test types, the positivity rate is higher in emergency samples (18.8%) compared to routine samples (7.9%), with the chi-square test ($p < 0.001$) showing that test type affects serum indices. Furthermore, inpatients have a higher positivity rate than outpatients (14% vs. 7%), with a statistically significant difference ($p < 0.001$), indicating that inpatients are at higher risk for issues related to serum bilirubin, due to factors such as the severity of illness and sample handling procedures [4], [7], [11] .These results suggest that clinical department, test type, and patient type have a significant impact on positivity rates, while gender and age do not show strong associations. To minimize the impact of interfering factors such as hemolysis, serum bilirubin, or lipid turbidity, improvements in sample collection and storage procedures are needed, particularly for difficult-to-sample groups such as infants, elderly patients, or critically ill individuals.

V. CONCLUSION

In this study, the positive rate of the hemolysis index (H+) showed no statistically significant association with the characteristics of the patient samples. The positivity rate of the bilirubin index (I+) was significantly associated with clinical departments, age groups, gender, test type, and patient type ($p<0.05$). The positivity rate of the lipid turbidity index (L+) was associated with gender ($p<0.05$) but showed no significance with the other characteristics of the patient samples. Overall, the presence of serum indices was related to clinical departments, test types, and patient types.

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