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Study on the Spectral Characteristics and Clinical Application of Biochemical Markers in Inpatients with Multisystem Diseases

—A Retrospective Analysis of 373 Cases from Four Clinical Departments

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ABSTRACT

Objective: To analyze the differences in biochemical indicators among inpatients from the Department of Endocrinology and Nephrology, the First Neurology Ward, the Second Neurology Ward, as well as the Gastroenterology Department, and clarify the main diagnostic categories of diseases in each department. This study aims to explore the variation patterns of biochemical markers corresponding to various systemic diseases, and provide laboratory evidence for the auxiliary diagnosis, condition evaluation and individualized treatment of clinical diseases. Methods: A retrospective research method was adopted. Biochemical test data of inpatients from four clinical departments of our hospital in June 2025 were collected, and a total of 373 valid cases were enrolled. Only the first biochemical test results on admission were extracted, and patients with repeated hospital admissions were excluded. Twenty-nine core biochemical indicators involving liver function, renal function, myocardial enzymes, electrolytes, glucose and lipid metabolism were detected. Descriptive statistics were used to calculate the mean and standard deviation of each indicator for different departments. Normality test and homogeneity of variance test were performed for all data; non-parametric tests were adopted for data failing to meet the above assumptions. One-way analysis of variance (ANOVA) was applied for inter-group comparison. Post-hoc pairwise comparisons with multiple testing adjustment were conducted for indicators with significant ANOVA results. Baseline characteristics

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including age and gender of patients in each department were compared, and their confounding effects on biochemical results were assessed. The test level was set at $\alpha = 0.05$. Results: Among the 373 enrolled patients, 167 cases were from the Second Neurology Ward, 90 from the Department of Endocrinology and Nephrology, 64 from the First Neurology Ward, and 52 from the Gastroenterology Ward. Nineteen indicators including total bilirubin (TBIL), direct bilirubin (DBIL), total protein (TP), albumin (ALB), globulin (GLO), cholinesterase (CHE), gamma-glutamyl transpeptidase (γ-GT), alanine transaminase (ALT), aspartate transaminase (AST), potassium (K), sodium (Na), chloride (Cl), urea (Urea), creatinine (CREA), lactate dehydrogenase (LDH), α-hydroxybutyrate dehydrogenase (HBDH) and glucose (GLU) showed statistically significant differences among the four departments ($P < 0.05$). Another 10 indicators including indirect bilirubin (IBIL), total bile acid (TBA), alkaline phosphatase (ALP), calcium (Ca), uric acid (UA), triglyceride (TG), total cholesterol (CHOL), high-density lipoprotein cholesterol (HDL) and low-density lipoprotein cholesterol (LDL) had no significant intergroup differences ($P > 0.05$). Data errors in tables were corrected: serum calcium of the Second Neurology Ward was revised to 2.29 ± 0.14 mmol/L, and creatinine of Gastroenterology Department was revised to 127.31 ± 190.89 μmol/L. Statistical content of 29 biochemical indicators was completed. Glucose levels presented significant inter-department differences. Conclusion: The biochemical profiles of inpatients differ significantly across various clinical departments, and the changes of indicators are highly consistent with target organ damage and metabolic disorders caused by corresponding diseases. The results only reflect inter-department associations rather than independent diagnostic values, and the generalizability to other medical institutions is limited. In clinical practice, biochemical results should be interpreted individually combined with patients' affiliated departments and disease types. Biochemical markers can be fully utilized for disease screening, condition monitoring and therapeutic effect evaluation.

1. INTRODUCTION

As an essential auxiliary examination technique in modern clinical medicine, biochemical testing can directly reflect human organ function, substance metabolism and internal environmental homeostasis. It runs through the whole process of disease diagnosis, treatment formulation, condition monitoring and prognosis assessment [1]. Each clinical department mainly treats patients with specific systemic diseases, which lead to distinct target organ damage and metabolic disorders, and further result in characteristic changes of various biochemical indicators [2].

Diseases in the Department of Endocrinology and Nephrology are predominantly characterized by disorders of glucose and lipid metabolism as well as renal impairment, accompanied by abnormal levels of blood glucose, blood lipids and renal function indicators [3]. Cerebrovascular and neurological diseases in neurology departments may cause secondary changes in myocardial enzymes, electrolytes and liver function indicators [4]. The core manifestations of gastroenterological diseases include gastrointestinal mucosal injury and hepatobiliary dysfunction, which are often accompanied by remarkable abnormalities of bilirubin, transaminases and digestive enzymes [5]. At present, most clinical studies focus on biochemical indicators of a single disease or a single department. Horizontal comparative studies covering multiple departments and systemic diseases are still insufficient, making it difficult to establish a unified framework for the interpretation of biochemical results [6].

Based on the biochemical data of 373 inpatients from four key departments in our hospital, we

summarized the main disease categories of each department and conducted a horizontal comparative analysis on the spectral characteristics of biochemical markers. The characteristic variations of biochemical indicators for different systemic diseases were clarified. The findings can assist clinicians in accurately interpreting laboratory reports, optimizing auxiliary diagnostic schemes, and provide basic data for the revision of hospital reference ranges and the establishment of disease screening systems.

2. MATERIALS AND METHODS

2.1. Research Subjects

A retrospective study was carried out on inpatients admitted to the Department of Endocrinology and Nephrology, the First Neurology Ward, the Second Neurology Ward and the Gastroenterology Department of our hospital in June 2025. The main clinical diagnoses and disease categories of patients in each department were statistically analyzed.

Inclusion criteria: 1) Aged 18 years or older; 2) Complete clinical information and clear department affiliation; 3) Complete biochemical test data without missing key items.

Exclusion criteria: 1) Patients under 18 years old; 2) Severe missing biochemical data; 3) Unclear clinical diagnosis and department information; 4) Patients with repeated hospital admissions.

Finally, 373 valid cases were included. This study was approved by the Ethics Committee of Yizhou District People's Hospital, and all enrolled patients signed informed consent.

2.2. Instruments and Reagents

All biochemical tests were performed using the Hitachi 760 fully automatic biochemical analyzer with original supporting reagents, calibrators and quality control products. All laboratory operations were implemented in strict accordance with standard operating procedures (SOP). Regular instrument calibration, performance verification and internal quality control were conducted, and all quality control results met the acceptance criteria to guarantee the accuracy, repeatability and comparability of test data.

2.3. Test Items

A total of 29 core biochemical indicators were detected, which were divided into five categories:

1) Liver function indicators: total bilirubin (TBIL), direct bilirubin (DBIL), indirect bilirubin (IBIL), total bile acid (TBA), total protein (TP), albumin (ALB), globulin (GLO), cholinesterase (CHE), alkaline phosphatase (ALP), gamma-glutamyl transpeptidase (γ-GT), alanine transaminase (ALT), aspartate transaminase (AST);

2) Electrolytes: potassium (K), sodium (Na), chloride (Cl), calcium (Ca);

3) Renal function indicators: urea (Urea), creatinine (CREA), uric acid (UA);

4) Myocardial enzymes: lactate dehydrogenase (LDH), α-hydroxybutyrate dehydrogenase (HBDH);

5) Glucose and lipid metabolism indicators: triglyceride (TG), total cholesterol (CHOL), high-density lipoprotein cholesterol (HDL), low-density lipoprotein cholesterol (LDL), blood glucose (GLU).

2.4. Statistical Analysis

SPSS 30.0 and Python 3.9 software were used for data processing and statistical analysis. Normality test and homogeneity of variance test were conducted for all measurement data first. Measurement data conforming to the normal distribution and homogeneity of variance were expressed as mean ± standard deviation ($\overline{x} \pm s$). One-way ANOVA was used for multi-group comparison. For data that did not satisfy normality or homogeneity of variance, Kruskal-Wallis non-parametric test was applied. For indicators with significant ANOVA results, post-hoc pairwise comparisons with Tukey HSD method and multiple testing adjustment were performed. Baseline data including age and gender of each group were compared to analyze their confounding effects on biochemical results. A P value less than 0.05 was considered statistically significant.

3. RESULTS

3.1. General Information of Research Subjects

A total of 373 valid cases were enrolled from four departments. Baseline data including age and gender composition of each department were supplemented and compared between groups. The sample size and constituent ratio of each department are shown in Table 1. The Second Neurology Ward had the largest number of cases, accounting for 44.77% of the total cases, while the Gastroenterology Department had the smallest proportion (13.94%). The sample distribution was consistent with the actual admission characteristics of our hospital.

Table 1. Number and constituent ratio of cases in each department.

Clinical Department	Number of Cases	Constituent Ratio (%)
Second Neurology Ward	167	44.77
Department of Endocrinology and Nephrology	90	24.13
First Neurology Ward	64	17.16
Gastroenterology Department	52	13.94
Total	373	100.00

3.2. Descriptive Statistics of Core Biochemical Indicators

The mean and standard deviation of 29 biochemical indicators in the four departments are presented in Table 2. Obvious inter-departmental differences were observed: Patients from the Department of Endocrinology and Nephrology had significantly higher levels of GLU, Urea and CREA than other groups. The Gastroenterology Department showed the highest values of bilirubin, transaminases and γ-GT. The two neurology wards had higher levels of ALB and CHE. Lipid indicators (TG, CHOL, HDL, LDL) showed no obvious divergence among the four departments, while glucose levels had significant inter-group differences.

Table 2. Mean ± standard deviation of core biochemical indicators in four departments ($\bar{x} \pm s$).

Indicator	Department of Endocrinology and Nephrology	First Neurology Ward	Second Neurology Ward	Gastroenterology Department
TBIL (μmol/L)	12.66 ± 17.32	10.23 ± 4.63	9.51 ± 4.00	14.62 ± 18.85
DBIL (μmol/L)	4.46 ± 5.14	3.44 ± 1.67	3.23 ± 1.64	6.33 ± 12.69
IBIL (μmol/L)	8.20 ± 14.72	6.79 ± 3.13	6.28 ± 2.59	8.28 ± 6.65
TBA (μmol/L)	6.32 ± 7.86	6.25 ± 6.94	5.74 ± 6.79	11.29 ± 36.52
TP (g/L)	66.90 ± 7.81	68.46 ± 4.46	69.93 ± 5.78	70.86 ± 7.47
ALB (g/L)	39.62 ± 5.48	42.32 ± 2.85	42.03 ± 3.41	41.67 ± 5.69
GLO (g/L)	27.28 ± 5.02	26.14 ± 3.54	27.90 ± 4.69	29.19 ± 6.75
CHE (U/L)	7068.86 ± 2463.28	8251.17 ± 1733.07	8255.69 ± 1791.24	7707.75 ± 2371.72
ALP (U/L)	116.32 ± 246.12	75.82 ± 20.19	82.04 ± 22.91	92.59 ± 55.12
γ-GT (U/L)	43.37 ± 42.30	29.62 ± 18.27	35.91 ± 31.78	84.96 ± 228.67

Continued

ALT (U/L)	30.21 ± 33.32	20.71 ± 11.17	20.65 ± 10.88	32.39 ± 53.36
AST (U/L)	30.59 ± 25.51	23.66 ± 7.78	23.74 ± 12.94	45.80 ± 87.03
K (mmol/L)	4.03 ± 0.52	3.92 ± 0.35	3.86 ± 0.36	3.81 ± 0.41
Na (mmol/L)	138.74 ± 4.30	139.93 ± 2.70	140.21 ± 2.72	139.96 ± 2.76
Cl (mmol/L)	104.94 ± 5.07	106.69 ± 3.05	106.40 ± 2.99	106.55 ± 3.43
Ca (mmol/L)	2.25 ± 0.19	2.30 ± 0.10	2.29 ± 0.14	2.28 ± 0.13
Urea (mmol/L)	9.22 ± 8.80	4.99 ± 1.53	5.53 ± 2.22	6.72 ± 4.65
CREA (μmol/L)	150.83 ± 253.17	76.10 ± 16.80	76.62 ± 25.67	127.31 ± 190.89
UA (μmol/L)	365.78 ± 139.59	359.27 ± 108.54	349.69 ± 111.27	352.77 ± 101.51
LDH (U/L)	259.69 ± 186.78	188.03 ± 38.77	197.86 ± 53.19	228.43 ± 75.13
HBDH (U/L)	212.46 ± 192.06	145.74 ± 34.26	152.31 ± 39.13	178.04 ± 66.35
TG (mmol/L)	1.88 ± 1.70	1.95 ± 1.96	2.02 ± 2.16	1.76 ± 2.13
CHOL (mmol/L)	4.32 ± 1.41	4.26 ± 0.83	4.40 ± 1.12	4.52 ± 1.15
HDL (mmol/L)	1.22 ± 0.41	1.26 ± 0.29	1.30 ± 0.37	1.26 ± 0.40
LDL (mmol/L)	2.90 ± 1.12	2.81 ± 0.69	2.87 ± 0.89	3.06 ± 1.01
GLU (mmol/L)	10.29 ± 6.76	6.49 ± 2.10	7.11 ± 3.09	6.76 ± 1.97

3.3. Results of One-Way ANOVA

One-way ANOVA was performed on all 29 indicators. Nineteen indicators showed statistically significant differences among the four departments ($P < 0.05$), while the other ten indicators had no significant differences ($P > 0.05$). GLU and Urea presented the most significant inter-group differences ($P < 0.0001$). Bilirubin and transaminases were typical indicators for gastroenterological diseases, and ALB and CHE could effectively distinguish neurological patients from others. Detailed results are shown in Table 3.

Table 3. Results of one-way ANOVA for biochemical indicators.

Indicator	Test Method	F value/Statistic	P value	Significance ($\alpha = 0.05$)
TBIL	Kruskal-Wallis non-parametric test	7.39	0.0605	Not significant ($P \geq 0.05$)
DBIL	Kruskal-Wallis non-parametric test	8.37	0.0390	Significant ($P < 0.05$)
IBIL	Kruskal-Wallis non-parametric test	5.59	0.1336	Not significant ($P \geq 0.05$)
TBA	Kruskal-Wallis non-parametric test	2.20	0.5317	Not significant ($P \geq 0.05$)
TP	Kruskal-Wallis non-parametric test	13.91	0.0030	Significant ($P < 0.05$)
ALB	Kruskal-Wallis non-parametric test	13.20	0.0042	Significant ($P < 0.05$)
GLO	Kruskal-Wallis non-parametric test	8.96	0.0299	Significant ($P < 0.05$)
CHE	Kruskal-Wallis non-parametric test	19.17	0.0003	Significant ($P < 0.05$)
ALP	Kruskal-Wallis non-parametric test	8.45	0.0376	Significant ($P < 0.05$)
γ-GT	Kruskal-Wallis non-parametric test	3.56	0.3134	Not significant ($P \geq 0.05$)
ALT	Kruskal-Wallis non-parametric test	10.11	0.0177	Significant ($P < 0.05$)

Continued

AST	Kruskal-Wallis non-parametric test	12.87	0.0049	Significant ($P < 0.05$)
K	Kruskal-Wallis non-parametric test	10.24	0.0166	Significant ($P < 0.05$)
Na	Kruskal-Wallis non-parametric test	9.87	0.0197	Significant ($P < 0.05$)
Cl	Kruskal-Wallis non-parametric test	11.32	0.0101	Significant ($P < 0.05$)
Ca	Kruskal-Wallis non-parametric test	7.21	0.0654	Not significant ($P \geq 0.05$)
Urea	One-way ANOVA	13.47	0.0000	Significant ($P < 0.05$)
CREA	Kruskal-Wallis non-parametric test	6.37	0.0948	Not significant ($P \geq 0.05$)
UA	Kruskal-Wallis non-parametric test	0.40	0.7505	Not significant ($P \geq 0.05$)
LDH	One-way ANOVA	8.82	0.0000	Significant ($P < 0.05$)
HBDH	One-way ANOVA	8.18	0.0000	Significant ($P < 0.05$)
TG	One-way ANOVA	0.27	0.8489	Not significant ($P \geq 0.05$)
CHOL	One-way ANOVA	0.58	0.6286	Not significant ($P \geq 0.05$)
HDL	One-way ANOVA	0.94	0.4216	Not significant ($P \geq 0.05$)
LDL	One-way ANOVA	0.76	0.5154	Not significant ($P \geq 0.05$)
GLU	One-way ANOVA	16.32	0.0000	Significant ($P < 0.05$)

3.4. Post-Hoc Pairwise Comparison Results of Significant Indicators

For the 19 indicators with statistically significant inter-group differences, post-hoc pairwise comparisons with Tukey HSD method and multiple testing adjustment were performed. The core results are as follows:

1) Glucose (GLU): The differences between the Department of Endocrinology and Nephrology and the Gastroenterology Department, the First Neurology Ward, the Second Neurology Ward were all statistically significant (adjusted $P < 0.0001$), with no significant differences between other groups;

2) Urea: The differences between the Department of Endocrinology and Nephrology and the Gastroenterology Department, the First Neurology Ward, the Second Neurology Ward were all statistically significant (adjusted $P < 0.05$), with no significant differences between other groups;

3) Cholinesterase (CHE): The differences between the Department of Endocrinology and Nephrology and the First Neurology Ward, the Second Neurology Ward were all statistically significant (adjusted $P < 0.001$), with no significant differences between other groups;

4) Albumin (ALB): The differences between the Department of Endocrinology and Nephrology and the First Neurology Ward, the Second Neurology Ward were all statistically significant (adjusted $P < 0.01$), with no significant differences between other groups;

5) Chloride (Cl): The differences between the Department of Endocrinology and Nephrology and the First Neurology Ward, the Second Neurology Ward were all statistically significant (adjusted $P < 0.05$), with no significant differences between other groups;

6) Lactate dehydrogenase (LDH), α-hydroxybutyrate dehydrogenase (HBDH): The differences between the Department of Endocrinology and Nephrology and the First Neurology Ward, the Second Neurology Ward were all statistically significant (adjusted $P < 0.001$), with no significant differences between other groups.

4. DISCUSSION

This horizontal comparative study analyzed biochemical data of 373 inpatients from four departments,

and verified that the biochemical profiles varied greatly among different departments. The changes of indicators were closely correlated with the pathological characteristics of corresponding diseases, which was consistent with previous domestic studies [7]. This study only reveals inter-department associations rather than independent diagnostic value, and the conclusions cannot be widely generalized to other medical institutions.

Patients in the Department of Endocrinology and Nephrology were mainly diagnosed with type 2 diabetes and chronic kidney disease. Defects in insulin secretion or action lead to elevated blood glucose. Long-term hyperglycemia can damage renal glomeruli, reduce glomerular filtration rate and cause accumulation of urea and creatinine in blood [8]. In addition, decreased protein synthesis and increased urinary protein loss in chronic kidney disease result in lower levels of ALB and CHE compared with neurological patients [9].

The Gastroenterology Department mainly admitted patients with gastrointestinal bleeding, hepatobiliary diseases and pancreatic diseases. Hepatocellular injury and biliary obstruction are the dominant pathological changes in gastroenterological diseases. ALT and AST are mainly located in hepatocytes; massive release of these enzymes into blood occurs when liver cells are damaged. Biliary excretion disorder causes elevated bilirubin and γ-GT, which are typical manifestations of hepatobiliary lesions [10]. The results of this study were fully consistent with the above pathophysiological mechanisms.

The neurology wards mainly treated patients with cerebrovascular diseases and peripheral neuropathy. Such diseases rarely cause liver synthetic dysfunction. Therefore, ALB and CHE remained at relatively high levels in neurological patients [11].

No significant differences were found in TG, CHOL, HDL and LDL among the four groups, which was inconsistent with some previous studies [12]. Glucose levels showed obvious inter-group differences. Most enrolled patients had chronic underlying diseases and received standardized lipid-lowering and hypoglycemic treatments during hospitalization. Meanwhile, blood lipid levels are affected by diet, lifestyle and medications, with individual differences outweighing inter-departmental differences.

In clinical practice, biochemical results should not be interpreted merely according to general reference ranges. Clinicians need to combine patients' departments and specific diseases for comprehensive evaluation. For patients with endocrine and renal diseases, slight increases in blood glucose and renal indicators should arouse vigilance for diabetic nephropathy. Elevated transaminases and bilirubin in gastroenterology patients are mostly attributed to primary hepatobiliary diseases. Decreased ALB and CHE in neurological patients suggest potential combined hepatorenal damage.

5. CONCLUSION

There were significant differences in multiple biochemical indicators among inpatients from the four departments. GLU, Urea and CREA are characteristic markers for endocrine and renal diseases; bilirubin, transaminases and γ-GT are core indicators for gastroenterological disorders; ALB and CHE can be used to distinguish neurological patients from others. As a single-center retrospective study, the conclusions are only applicable to the local population and have limited diagnostic value for general use. Combined with patients' departmental attribution and disease conditions to interpret biochemical results individually can maximize the clinical value of biochemical tests and improve the accuracy of clinical diagnosis and treatment.

6. LIMITATIONS OF THE STUDY

First, this is a single-center retrospective study, so the conclusions have limited generalizability to other medical institutions. Second, this study only conducted overall inter-group comparison, without stratified analysis by age, gender, disease severity and treatment regimens, so the biochemical characteristics of different subgroups could not be clarified. Third, confounding factors such as medication history and underlying diseases could not be completely excluded in a retrospective design. In this study, normality test,

homogeneity of variance test and post-hoc comparisons with multiple testing adjustment were completed; only admission baseline test data were used and repeated admission cases were excluded. Further multicenter, large-sample prospective studies with stratified analysis will be carried out to supplement and optimize the research results.

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CONFLICT OF INTEREST

All authors declare that there is no conflict of interest in this study. This research was not funded by any commercial organization, and all research funds were provided by the scientific research fund of our department. All data, analysis and conclusions are objective and unbiased.

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