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COMPREHENSIVE BLOOD PANEL: APPROACH FOR VAGUE CLINICAL SIGNS

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Introduction

Blood biochemical testing is a very important initial approach for dogs and cats with vague clinical symptoms. Blood biochemical testing is less likely to overlook a disease and more likely to lead to a diagnosis by using a blood biochemical screening panel (**Table 1**) that assesses multiple parameters together, rather than a single parameter, to evaluate individual organs. How to interpret blood test results will be explained using three actual cases.

Table 1. Blood biochemical screening panel and organ-specific parameters used at Veterinary Specialists Emergency Center

Screening panel of blood biochemical test at Veterinary Specialists Emergency Center		GLU	BUN	CRE	P	Ca	TP	ALB	GLB	NH_3	T-CHO	TG	T-BIL	ALP	ALT	AST	CPK	GGT	Na/K/Cl
Parameters related to organs	Liver	●	●				●	●	●	●	●	●	●	●	●	●		●	
	Muscle														●	●	●		
	Kidney		●	●	●	●	●	●	●		●								●
	GI						●	●	●		●								●
	Endocrine	●			●	●	●	●	●		●	●		●			●		●

Case 1. A 7-year-old castrated male Chihuahua

Course: Anorexia (50% to 80%) and weight loss (4.3 kg to 3.8 kg) over the past 2-3 months
Physical findings: Normal TPR, moderately decreased muscle mass, and no other special notes

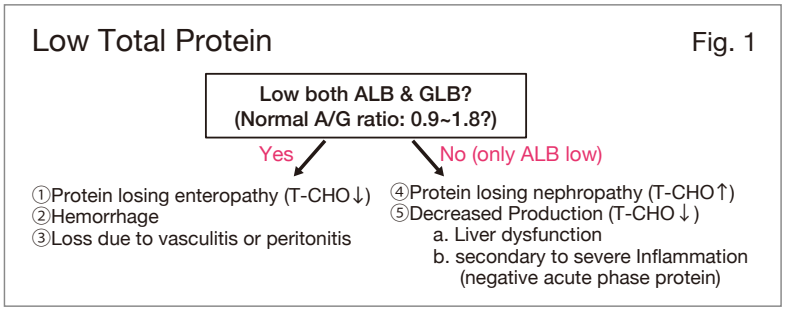
Blood tests:

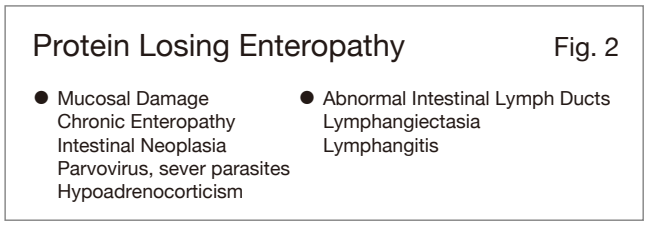
	Case		Ref range
Ht	38	%	37~55
Neu	8.1	$x10^3/\mu L$	3~11.5
Lym	3.0	$x10^3/\mu L$	1~4.8
PLT	210	$x10^3/\mu L$	200~500
TP	4.5	g/dL	5.0~7.2
ALB	2.5	g/dL	2.6~4.0
GLB	2.0	g/dL	1.6~3.7
GLU	81	g/dL	75~128
BUN	29	mg/dL	9.2~29.2
CRE	0.9	mg/dL	0.4~1.4
T-BIL	0.1	mg/dL	0.1~0.5

	Case		Ref range
ALT	81	U/L	17~78
ALP	120	U/L	47~254
GGT	1	U/L	5~14
T-CHO	101	mg/dL	111~312
TG	82	mg/dL	30~133
CPK	76	U/L	49~166
Ca	10.4	mg/dL	9.3~12.1
P	3.8	mg/dL	1.9~5.0
Na	146	mEq/L	141~152
K	4.6	mEq/L	3.8~5.0
Cl	108	mEq/L	102~117
CRP	0.8	mg/dL	~0.7

Interpretation of blood test results: Parameters of interest are shown in red. When hypoproteinemia is observed, loss of ALB alone or loss of both ALB and GLB should be considered. The ALB/GLB ratio (A/G) in this case was calculated to be 1.25 (normal range, 0.9 to 1.8), indicating that both ALB and GLB, rather than ALB alone, were lost (**Fig. 1**). In addition, given no findings suggestive of elevated liver enzymes or impaired liver function as well as the decrease in T-CHO, protein-losing enteropathy was very likely to be responsible for hypoproteinemia. A representative differential diagnosis of protein-losing enteropathy is shown in **Fig. 2**. In the complete blood count (CBC), moreover, the lymphocyte count was 3,000/μL, showing the absence of stress patterns. In diseased dogs, which are usually stressed, a stress pattern (decreased lymphocyte count) is expected as a change in white blood cells due to the secretion of the stress hormone cortisol. In the present case, however, the absence of stress patterns (normal to increased lymphocyte count) suggested impaired cortisol secretion.

With the abnormalities suggestive of protein-losing enteropathy and the absence of stress patterns, the blood screening test showed that this case was strongly suspected to be hypoadrenocorticism. Additional testing showed a basal cortisol level of <1.0 μg/dL and a post-ACTH stimulation cortisol level of <1.0 μg/dL, leading to a diagnosis of hypoadrenocorticism without electrolyte abnormalities.





Case 2. A 5-year-old sterilized female miniature Dachshund

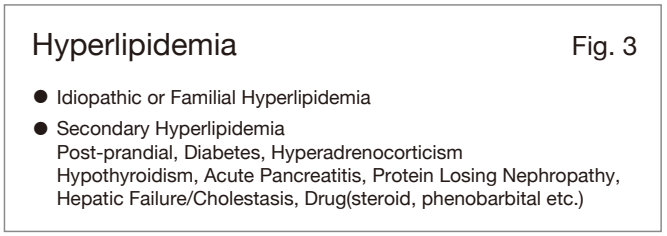
Course: Anorexia (80%) and decreased activity (50%) over the past 1-2 months
Physical findings: normal TPR, BCS 7/9, weight 9.3 kg (8.9 kg half a year ago)

Blood tests:

	Case		Ref range
Ht	40	%	37~55
Neu	8.1	x10³/μL	3~11.5
Lym	0.8	x10³/μL	1~4.8
PLT	250	x10³/μL	200~500
TP	6.2	g/dL	5.0~7.2
ALB	3.6	g/dL	2.6~4.0
GLB	2.6	g/dL	1.6~3.7
GLU	131	g/dL	75~128
BUN	30	mg/dL	9.2~29.2
CRE	1.1	mg/dL	0.4~1.4
T-BIL	0.1	mg/dL	0.1~0.5

	Case		Ref range
AST	102	U/L	17~44
ALT	81	U/L	17~78
ALP	120	U/L	47~254
GGT	3	U/L	5~14
T-CHO	330	mg/dL	111~312
TG	221	mg/dL	30~133
CPK	232	U/L	49~166
Ca	10.4	mg/dL	9.3~12.1
P	3.8	mg/dL	1.9~5.0
Na	146	mEq/L	141~152
K	4.6	mEq/L	3.8~5.0
Cl	108	mEq/L	102~117

Interpretation of blood test results: Parameters of interest are shown in red. A representative differential diagnosis of fasting hyperlipidemia is shown in **Fig. 3**. Increased weight despite decreased appetite, together with hyperlipidemia, suggested decreased metabolism, and decreased activity raised the suspicion of hypothyroidism.



Fasting hyperglycemia and elevated AST and CPK, which are usually of little interest when changes are mild, are also known to occur in hypothyroidism. In hypothyroidism, which induces insulin resistance, it has been reported that hyperglycemia and elevated fructosamine were observed in nearly 50% of cases (Dixon RM et al., Vet Rec 1999). In addition, elevated CPK and AST were observed due to myopathy associated with hypothyroidism in some cases (Dixon RM et al., Vet Rec 1999). Accordingly, all abnormalities detected by the blood biochemical test panel in the present case were suggestive of hypothyroidism.
Ht is also of interest. While a Ht value of 40% is usually within the normal range, dog species should be taken into consideration when determining whether it is actually within the normal range. It has been reported that a mean Ht of 52% in healthy Dachshund dogs is higher than in mongrel dogs (Torres AR et al., Vet Clin Pathol 2014). Accordingly, the Ht value of 40% may be low for a miniature Dachshund. In fact, this value was clearly lower than a Ht value of 54% in a blood test performed in the present case 1 year ago. Anemia is known to occur in approximately 30% to 40% of cases of hypothyroidism and may have occurred in this case, given the dog species. Therefore, T4 and TSH were subsequently measured, and a T4 level of as low as 0.7 µg/dL and a TSH level of as high as 1.2 ng/mL led to a diagnosis of hypothyroidism.

Case 3. An 8-year-old castrated male Welsh corgi

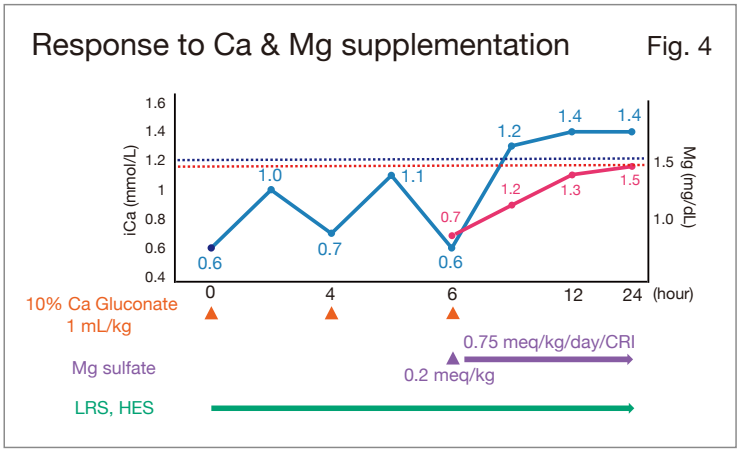
Course: Loose stools over the past month, but normal appetite and activity. He presented to the emergency department with seizures this morning.

Blood tests:

	Case		Ref range
Ht	34	%	37~55
Neu	16.6	x10³/µL	3~11.5
Lym	0.5	x10³/µL	1~4.8
PLT	212	x10³/µL	200~500
TP	3.2	g/dL	5.0~7.2
ALB	1.5	g/dL	2.6~4.0
GLB	1.7	g/dL	1.6~3.7
GLU	108	g/dL	75~128
BUN	14	mg/dL	9.2~29.2
CRE	0.6	mg/dL	0.4~1.4
T-BIL	0.1	mg/dL	0.1~0.5

	Case		Ref range
NH_3	62	µg/dL	16~75
ALT	151	U/L	17~78
ALP	98	U/L	47~254
GGT	5	U/L	5~14
T-CHO	71	mg/dL	111~312
Ca	5.6	mg/dL	9.3~12.1
iCa	0.6	mmol/L	1.16~1.4
P	3.9	mg/dL	1.9~5.0
Na	139	mEq/L	141~152
K	3.9	mEq/L	3.8~5.0
Cl	111	mEq/L	102~117

Interpretation of blood test results: Parameters of interest are shown in red. GLU, NH_3, CRE, and Ca (iCa) were measured to rule out convulsive metabolic disorders, and hypoglycemia, hepatic encephalopathy, and uremia were excluded, but severe hypo-ionized calcemia was identified and may be responsible for seizures. As in Case 1, hypoalbuminemia with normal AG ratio and low T-CHO were observed, indicating that protein-losing enteropathy was suspected to be responsible for low iCa. Since a stress pattern was observed, hypoadrenocorticism was unlikely to be responsible for protein-losing enteropathy, raising the suspicion of primary gastrointestinal diseases such as chronic enteropathy or intestinal lymphangiectasia. An intravenous infusion and treatment with calcium gluconate were initiated to deal with hypocalcemia (**Fig. 4**). However, the ionized calcium increased temporarily, but decreased within hours and remained unstable. Subsequently, blood Mg was measured, and hypomagnesemia was detected, leading to the initiation of Mg



supplementation and subsequent stabilization of blood Ca. Later, ultrasonography and gastrointestinal endoscopic biopsy were performed, leading to a diagnosis of protein-losing enteropathy due to intestinal lymphangiectasia.
It is known that hypo-ionized calcemia and hypomagnesemia occur in protein-losing enteropathy, and protein-losing enteropathy may be detected in dogs that present to hospital with seizures, as in this case, although relatively rarely. A blood screening test for metabolic disorders in cases of seizures is very important. In addition, blood Mg measurement is important in cases of refractory hypo-ionized calcemia. Hypomagnesemia is known to cause secondary hypoparathyroidism, which results in PTH secretion and dysfunction, causing hypocalcemia. In such cases, Ca supplementation alone may be insufficient to increase or stabilize Ca levels, as in the present case; therefore, Mg measurement is important in protein-losing enteropathy and refractory hypocalcemia.

Conclusion

In blood biochemical tests, it is important to assess multiple parameters comprehensively, rather than a single parameter, with the organ to be evaluated kept in mind. When the clinical symptoms are vague, as in the cases presented here, a wide range of blood biochemical tests and appropriate assessments can lead to subsequent tests and a definitive diagnosis.

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