

# VETSCAN® VS2

Hospital Resource Guide





# Welcome

## to the VETSCAN® VS2 Hospital Resource Guide

This guide is designed to help make the VETSCAN VS2 Chemistry Analyzer indispensable for your veterinary clinic by covering the most common medical topics that are likely to arise in your practice. Throughout the chapters listed here, you will find links to supplemental resources to help address any questions you may have.

We hope you find this guide useful, and as always, contact Diagnostic Technical Support for further assistance at:

 (800) 822-2947

 [dxsupport@zoetis.com](mailto:dxsupport@zoetis.com)

### Need guidance on a treatment plan?

Confirm results and a path forward for complex cases with remote specialist consultations—at no additional charge.\*

 [ZoetisDx.com](https://zoetisdx.com)

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- > Sample Handling
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- > Profile Utilization Guide
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\*Requires the use of ZoetisDx.com, the VETSCAN® FUSE and at least one Zoetis Diagnostics instrument or service.

This guide is intended as an adjunct reference to the VETSCAN VS2 Operator's Manual and the VETSCAN VS2 Quick Reference Guide.





# How VETSCAN VS2 Works



## How VETSCAN® VS2 Works

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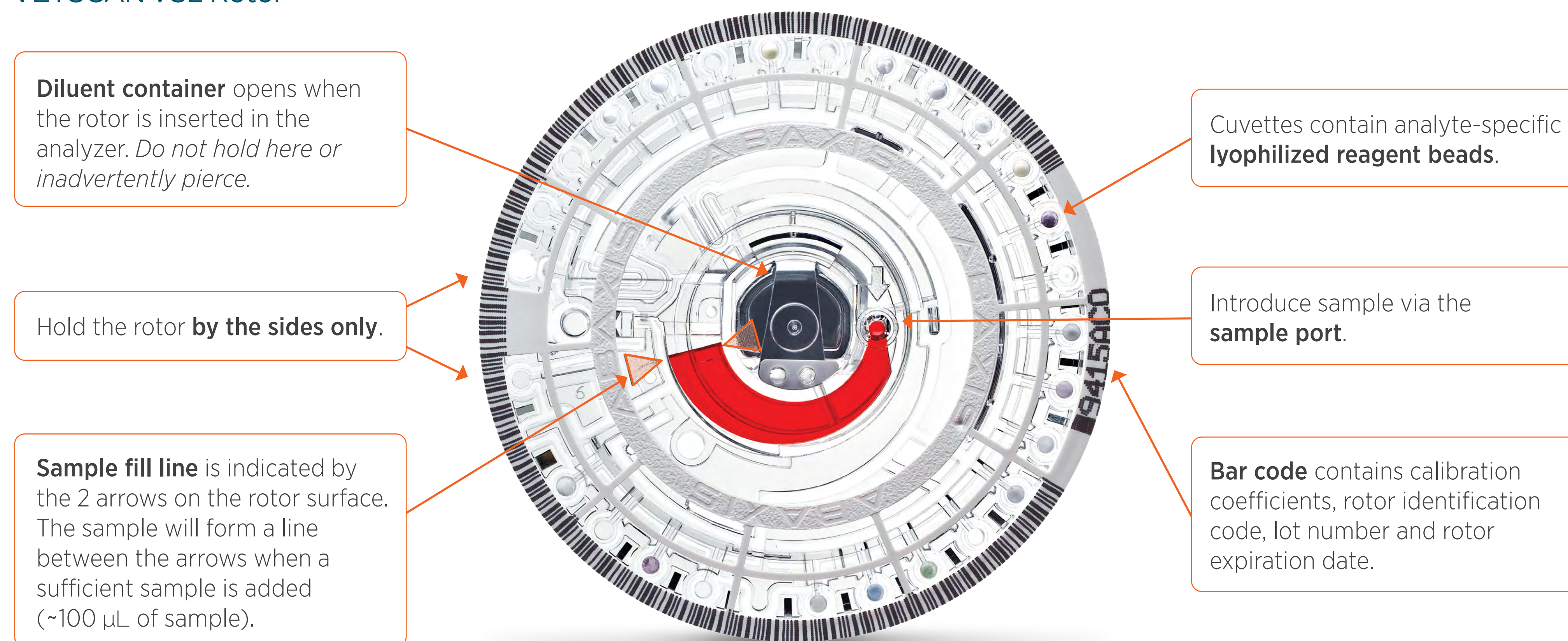
The VETSCAN VS2 Chemistry Analyzer is a state-of-the-art chemistry, electrolyte, immunoassay and acid-base analyzer that delivers uncompromising performance.<sup>1,2</sup> By using just 100 µL of whole blood, serum or plasma, the sophisticated Intelligent Quality Control (iQC) combines with proprietary algorithms to ensure dependable results during each run.\* This feature frees staff from having to perform routine quality controls or calibration.<sup>3†</sup>

The VETSCAN VS2 provides dependable results with a sample integrity report, so you have all the information needed to make the best clinical decisions for your patients.

### VETSCAN VS2 Profiles

The reagent profiles are specially designed to perform all the steps required to convert just 100 µL of blood into a panel of test results.† The VETSCAN VS2 rotor spins, separating the whole blood sample into plasma and cells. Precisely measured quantities of plasma or serum and diluent are mixed and delivered to the reaction cuvettes along the rotor perimeter. The diluted plasma dissolves the reagent beads, initiating the chemical reactions, which are monitored photometrically. The bar code printed on the rotor bar code ring provides calibration data that are specific for the chemistries in the rotor, ensuring accurate results.<sup>3</sup>

### VETSCAN VS2 Rotor



\*Always fill sample tube to the manufacturer's sample fill line.

†The routine use of quality controls is not required for optimal analyzer performance. Quality control material is available for the VETSCAN VS2 at the recommendation of Diagnostic Technical Support or upon request from Customer Service.





# Sample Handling



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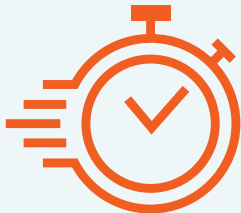
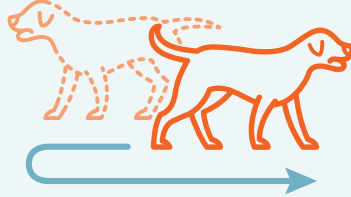
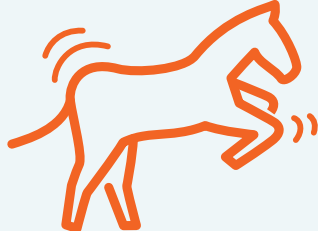


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## Patient preparation

These recommendations apply to all labs and instruments—whether at the point of care (POC) or in an external lab.

	Before the appointment	Rationale
	<ul style="list-style-type: none"><li>• Avoid feeding patients for 10 to 12 hours prior to an appointment unless it is contraindicated</li><li>• In horses and ruminants, fasting prior to chemistry analysis is not required</li></ul>	<ul style="list-style-type: none"><li>• A postprandial sample may cause lipemic interference</li><li>• Food consumption can affect biochemistry analytes—particularly glucose, urea and creatinine<sup>4,5</sup></li></ul>
	<ul style="list-style-type: none"><li>• Consider timing requirements for proper test interpretation</li><li>• Understand that certain medications may impact test results</li></ul>	<p>Confirm timing of medication dosing and testing:</p> <ul style="list-style-type: none"><li>• Total thyroxine [T4] and phenobarbital monitoring</li><li>• Feeding around postprandial bile acid [BA] testing</li></ul> <p>Phenobarbital may decrease T4 concentration; glucocorticoids and phenobarbital may increase liver enzymes</p>
	<ul style="list-style-type: none"><li>• Avoid exercise and minimize any excitement/fear prior to the appointment</li></ul>	<p>Can cause:</p> <ul style="list-style-type: none"><li>• Physiological leukocytosis<sup>4</sup></li><li>• Transient hyperglycemia in cats<sup>6</sup></li></ul>
	At the clinic	Rationale
	<ul style="list-style-type: none"><li>• Minimize any excitement/fear during the appointment</li><li>• Consider the use of sedation and anxiety medication to help decrease stress for anxious animals and enable safer and gentler restraint, when appropriate</li></ul>	<p>Can cause:</p> <ul style="list-style-type: none"><li>• Physiological leukocytosis<sup>4</sup></li><li>• Transient hyperglycemia in cats<sup>6</sup></li></ul>
	<ul style="list-style-type: none"><li>• For dehydrated or very sick patients, consider centrifuging the sample prior to testing, and run the test using plasma (vs whole blood)</li></ul>	<ul style="list-style-type: none"><li>• Visual assessment of the sample preanalysis can highlight abnormalities (eg, hemolysis can indicate poor sample quality) or may indicate the presence of disease (eg, lipemia in pancreatitis/diabetes mellitus/hypothyroidism, icterus in hemolytic anemia, hepatic disease or cholestasis)</li></ul>
	<ul style="list-style-type: none"><li>• Abnormal findings on other diagnostic tests may correlate with abnormal analyte values in certain disease states</li></ul>	<ul style="list-style-type: none"><li>• When a urinalysis identifies a glucosuria, expect blood glucose levels to be elevated</li></ul>
	At time of sampling	Rationale
	<ul style="list-style-type: none"><li>• Good sample collection technique is critical (clean needle puncture of the vein, minimal suction, steadily paced drawback)</li></ul>	<ul style="list-style-type: none"><li>• Lack of good technique leads to an increased risk of clotting or hemolysis</li></ul>

[Get more sample handling best practices](#) ↗

[Refresh your sample handling knowledge](#) ↗





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## Sample collection

The quality of the sample analyzed is directly related to the quality of the result.

### Keys to success

Avoid vein collapse when drawing samples	<ul style="list-style-type: none"><li>Minimize suction on the syringe and do not draw back too quickly</li></ul>
Prevent hemolysis	<ul style="list-style-type: none"><li>Use the largest vein and needle appropriate for blood collection</li><li>Avoid using 23 gauge or smaller needles for most species. Certain exotic species may require a smaller needle</li><li>Use minimal alcohol on fur/skin</li><li>Remove the needle from the syringe before dispensing into the blood tube unless using a closed vacuum blood collection system</li></ul>
Ensure the correct ratio of anticoagulant to blood	<ul style="list-style-type: none"><li>Fill lithium heparin tube to manufacturer's sample fill line</li><li>Immediately after filling the blood tube, replace the cap and invert 10-15 times to sufficiently mix with the anticoagulant</li></ul>
Ensure appropriate tube use	<div><div><ul style="list-style-type: none"><li>Select blood tubes based on the testing requirements and size of the patient (Microtainer® 1.3 mL, 3 mL, 5 mL)</li><li>Ensure the blood tubes have not expired</li><li>Always fill blood tubes in the correct order to avoid contamination<ul style="list-style-type: none"><li>EDTA contamination of chemistry samples may affect electrolyte results and cause a falsely low Ca and falsely high K<sup>+</sup></li></ul></li><li>If improper tube-filling order occurs, the sample should be redrawn and dispensed in the appropriate order and the rotor rerun</li></ul></div><div><p><b>Blood tube fill order</b></p><div><div>1</div><div>SODIUM CITRATE anticoagulant for coagulation testing</div></div><div><div>2</div><div>NO ANTICOAGULANT for chemistry</div></div><div><div>3</div><div>LITHIUM HEPARIN anticoagulant for chemistry</div></div><div><div>4</div><div>EDTA anticoagulant for hematology</div></div></div></div>
Prevent unwanted blood clotting	<ul style="list-style-type: none"><li>Do not raise the vein for more than a few seconds before venipuncture</li><li>For feline samples collected from the medial saphenous vein, a vacuum blood collection system is recommended instead of a syringe</li></ul>
Do not allow samples to degrade	<ul style="list-style-type: none"><li>Run the sample as soon as possible after drawing</li><li>Lithium heparin whole blood samples at room temperature must be run within 1 hour<sup>4</sup></li><li>Serum and plasma samples may be stored refrigerated for up to 48 hours<sup>4</sup></li></ul>

Ca=calcium; K<sup>+</sup>=potassium.





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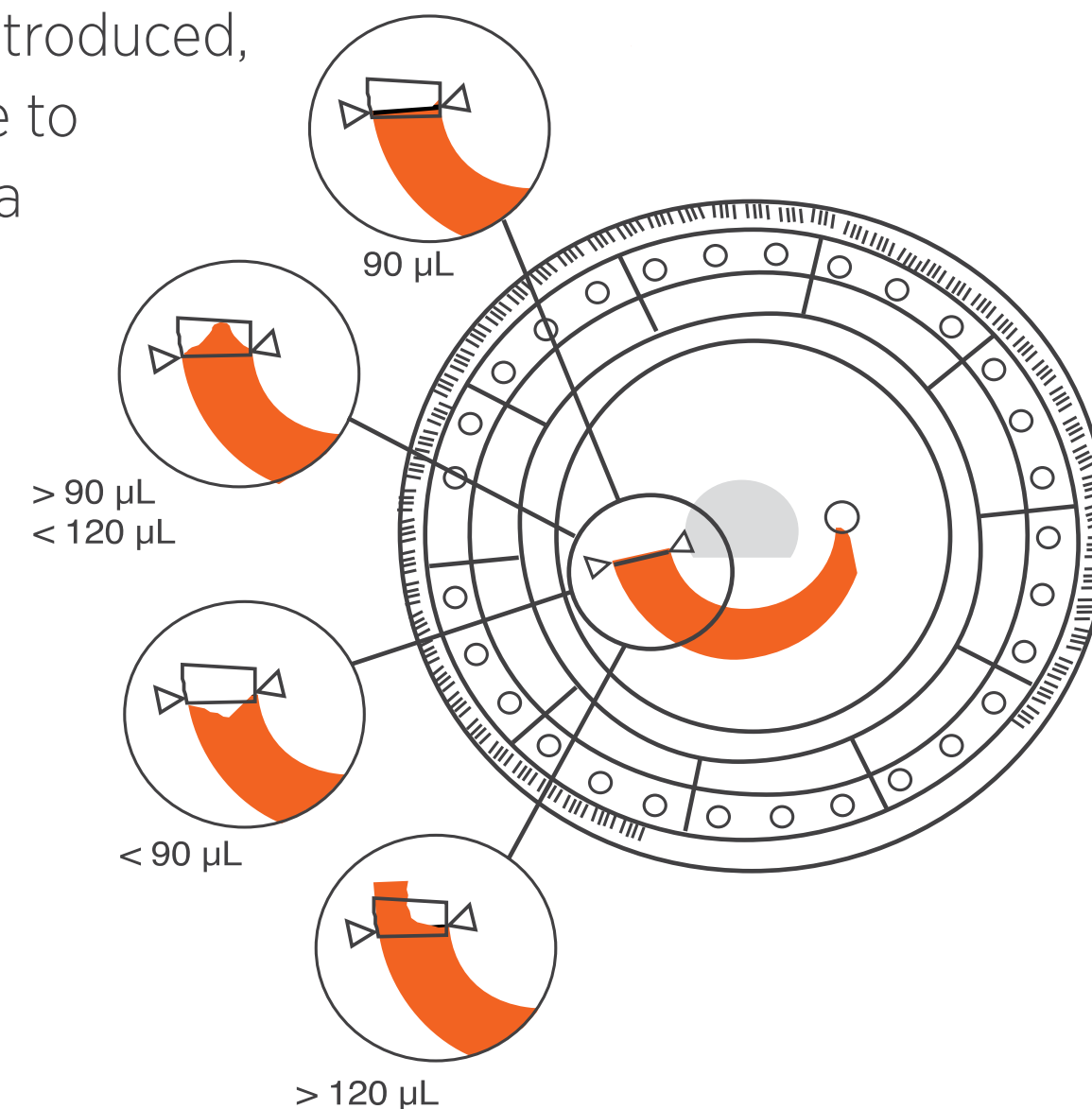
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## Running a sample: adding a sample to a VETSCAN VS2 profile<sup>3</sup>

### DO's

- Remove rotor pouch from the refrigerator immediately before testing—there is no warm-up time
- Use a fixed 100  $\mu\text{L}$  volume pipette
- Hold the rotors by the sides only, without touching the bar code or the central diluent container
- Keep the rotor in a flat position when loading in the VETSCAN VS2
- Avoid introducing air bubbles in the sample port
  - If an air bubble is introduced, add enough sample to fill the overflow area by 1/3 to 1/2, as shown here



- Start each test within 10 minutes of transferring the sample into the rotor
- Consider testing plasma or serum:
  - When there is the potential for insufficient plasma volume (eg, dehydrated patients, sight hounds)
  - In very sick patients
  - In animals who just ate a high-fat meal
  - In dogs who are predisposed to hyperlipidemia (eg, miniature schnauzers)

### DON'Ts

- Store rotors in the freezer
- Hold the rotor from the center
- Touch the pipette tip or a false elevation of amylase can result
- Use samples from EDTA tubes for any testing on the VETSCAN VS2
- Remove a sample from the rotor and try to reintroduce it to the rotor
- Apply excess blood to the sample port, as it may contaminate the analyzer (exception if air bubble present—see DO's)
- Spill blood on the bar code ring or rotor
- Run fluids other than whole blood, plasma or serum
  - No other fluids are supported for use on the VETSCAN VS2





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If a profile run is canceled for any reason, please contact Diagnostic Technical Support or Customer Service for assistance before redrawing or rerunning a sample. Further examination of sample run details will indicate the next best course of action and next steps.

### Common VETSCAN VS2 testing errors and solutions

Issue/error	Explanation	Solution
I see an air bubble in my rotor.	Air was inadvertently pulled into the pipette when drawing up the sample.	Ensure the pipette tip is securely fitted.  If the bubble is small, it may not cause an error. If the bubble expands across the channel, an error is likely, and a new rotor should be used.  If an air bubble is introduced, add enough sample to fill the overflow area by 1/3 to 1/2. Make sure any excess sample does not travel beyond the overflow area.
I got an Insufficient Sample Error (4037) message.	There may not be enough plasma to fill the cuvettes and run the rotor. The rotor will cancel due to insufficient sample to mix with the diluent.	Ensure that the rotor was filled properly, with no bubbles.  Note the patient's hydration status or PCV/HCT, if available. If patient PCV/HCT is greater than 60%, contact Diagnostic Technical Support for assistance prior to running a new rotor or drawing a new sample. <sup>3</sup>
My profile run was canceled. What can I do?	This may occur for many reasons, including: an expired rotor, rotor damage, rotor exposed to extreme temperature/humidity or sample quality issue is identified.	Record the iQC code, and print an iQC troubleshooting report using the <b>Recall</b> function, which can be accessed from the <b>Home</b> screen and printed or transmitted to a computer.*  Contact Diagnostic Technical Support for further assistance.
I have a Sample Mix Error (403D) message.	A Sample Mix Error message is displayed when the sample did not mix with diluent sufficiently. <sup>3</sup>	Note the patient's hydration status or PCV/HCT. If patient PCV/HCT is greater than 60%, contact Diagnostic Technical Support for assistance prior to running a new rotor or pulling a new sample.
Why are my K <sup>+</sup> results very high and my total Ca extremely low?	EDTA contamination of lithium heparin tube.	Redraw blood and fill tubes in the correct order (see "Blood tube fill order" on page 5). Run on a new rotor.

*Testing errors and solutions continues on the next page.*

HCT=hematocrit; PCV=packed cell volume.  
\*For details about printing these reports, refer to the VETSCAN VS2 Operator's Manual.





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### Common VETSCAN VS2 testing errors and solutions (cont'd)

Issue/error	Explanation	Solution
What does an asterisk (*) mean on a VETSCAN VS2 report?	The result is outside of the reference interval.	Interpret with clinical signs, history and other diagnostic findings.
What do 3 tildes (~ ~ ~) mean on a VETSCAN VS2 report?	<p>The result was suppressed for multiple possible reasons:</p> <ul style="list-style-type: none"><li>• Improper mixing of a reagent bead with diluted sample</li><li>• A nonlinear reaction; a reaction end point not being reached</li><li>• A concentration outside the analyzer's capabilities</li></ul>	<p>Access troubleshooting report.</p> <p>Contact Diagnostic Technical Support at (800) 822-2947 or <a href="mailto:dxsupport@zoetis.com">dxsupport@zoetis.com</a> for assistance.</p>

### VETSCAN VS2 Rotor Performance Guarantee (available in certain countries)

- The Rotor Performance Guarantee applies when any rotor fails due to any defect or anomaly in the rotor. The Performance Guarantee does not include cancellations or assay suppressions due to improper rotor storage or operator error. *Rotor failures should be rare*
- Contact Diagnostic Technical Support for further details at:

 (800) 822-2947

 [dxsupport@zoetis.com](mailto:dxsupport@zoetis.com)

[Learn more about the VETSCAN VS2 Rotor Performance Guarantee](#) ↗





# Understanding VS2 Chemistry Analysis



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## What is wet chemistry technology?<sup>7</sup>

Wet chemistry, or absorbance spectrophotometry, is the process by which a chemical reaction occurs, and then light is passed through a substance, and the amount of light absorbed is measured. Wet chemistry technology is used in reference and commercial laboratories as well as in the VETSCAN VS2 and is often considered the gold/reference standard for biochemical analysis.

### The value of Intelligent Quality Control (iQC)—reporting physical interference is better medicine

The VETSCAN VS2 incorporates a unique process called iQC. Transparent to the operator, iQC checks the analyzer, the rotor and the sample during every run to verify correct electronic and chemistry performance. iQC automatically suppresses a single chemistry or the entire panel if it detects uncharacteristic performance and immediately alerts the operator to any problems. iQC ensures that the operator receives only reliable results.<sup>2,8-9</sup>







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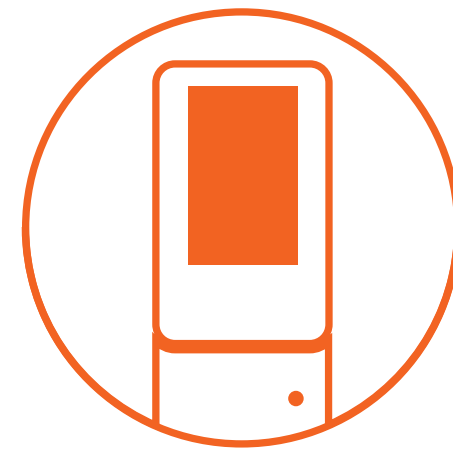
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## Intelligent Quality Control (iQC)

Automatic quality checks with iQC with every run for reliable results<sup>2</sup>

### Quality Check

#### Analyzer

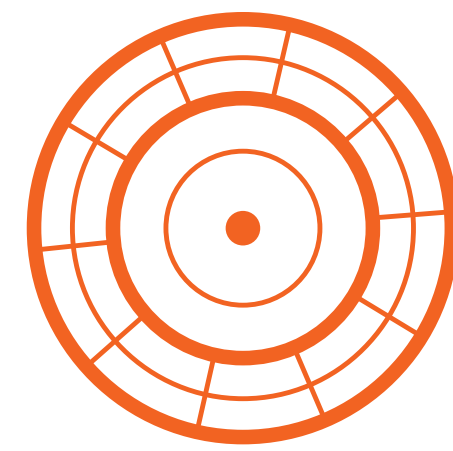


Optics ▶

Temperature ▶

Hardware/Software ▶

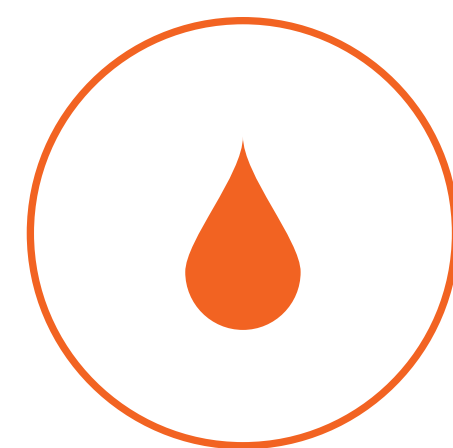
#### Rotor



Fluidics ▶

Reagents ▶

#### Sample



Sample ▶

Chemistry quality control (QC) ▶

Chemistry ▶

### Outcome / Benefit

Validates the performance of the optical components during every run and guarantees the most accurate measurements.

The temperature is controlled with heaters and fans to maintain the ideal reaction temperature of 37°C.

Continual testing of software and hardware features verifies consistent and optimal performance of the analyzer.

Metering and movement of fluids are controlled at all stages of the analysis to ensure the presence of sufficient sample and diluent in all reaction cuvettes.

Rotor type, expiration date and reagent calibration factors are checked prior to every run. Time-consuming and error-prone reagent calibrations are not required.

The analyzer evaluates the sample's quality and reports only valid results that are not influenced by interference (hemolysis, lipemia and icterus). **Minimizes the need for visual evaluation of the sample for physical interference.**

Special QC reagent beads indicate any degradation of the analyte-specific reagents due to suboptimal storage conditions (eg, moisture and temperature).

The analyzer monitors the analyte-specific reactions and verifies that all measurements are within the expected range.





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### VETSCAN VS2 sample evaluation

Built-in iQC evaluates sample quality and reports hemolysis, lipemia and icterus levels. iQC automatically suppresses a single chemistry analyte or the entire panel if uncharacteristic performance is detected.

VetScan VS2			
Prep Profile II			
18 May 2020		07:45 AM	
Sample Type:		Dog	
Patient ID:		12201	
Rotor Lot Number:		6283AB0	
Serial Number:		00000V123	
.....			
ALP	LIP	20-150	U/L
ALT	58	10-118	U/L
BUN	38*	7-25	mg/dL
CRE	1,2	0,3-1,4	mg/dL
GLU	LIP	60-110	mg/dL
TP	~~~	5,4-8,2	g/dL
QC OK			
HEM 3+		LIP 3+	ICT 0

### PATIENT RESULT WITH ANALYTE SUPPRESSION

- Run-specific information.
- The result of this analyte is suppressed due to lipemia.
- An asterisk indicates that the result is outside of the reference interval.
- Three tildes indicate that the result is suppressed for several reasons. **Contact Diagnostic Technical Support for assistance.**
- Physical interference indexes.

### Interpreting VETSCAN VS2 troubleshooting reports\*

Troubleshooting reports provide technical information from the test run and may display an estimated value for a suppressed result.

Suppressed results must be interpreted with caution due to the impact of sample interference.

If suppressions occur, contact Diagnostic Technical Support for assistance in interpreting the troubleshooting report prior to collecting a new sample and/or sending the sample to a commercial laboratory.

VetScan VS2				
Prep Profile II				
18 May 2020		07:45 AM		
Sample Type:		Dog		
Patient ID:		12201		
Rotor Lot Number:		6283AB0		
Serial Number:		00000V123		
.....				
01	EFEF	FFFF	8FFF	FFFF
02	CFEF	FFFF	C3FA	BEFF
03	0000	0000	0000	0000
04	0000	0000	0000	0000
05	0000	0000	8200	0000
06	0000			
ALP	271 L	0400	0000	U/L
ALT	58	0000	0000	U/L
BUN	38 *	0000	0000	mg/dL
CRE	1,2	0000	0000	mg/dL
GLU	92 L	0400	0000	mg/dL
TP	5,7 ~	1000	0000	g/dL
RQC: 100				
HEM 305		LIP 1994		ICT 0
Version:		3,1,35		

### VETSCAN VS2 TROUBLESHOOTING REPORT

- Run-specific information.
- Run-specific technical codes.
- Analyzer estimated value for the suppressed analyte with an "L" indicator for lipemia.
- Technical codes for suppressed values.
- Quantitative physical interference values.

## Contact Diagnostic Technical Support for assistance with interpreting VETSCAN VS2 troubleshooting reports

 (800) 822-2947     [dxsupport@zoetis.com](mailto:dxsupport@zoetis.com)

\*For VETSCAN® FUSE and ZoetisDx users: cancellation and suppression troubleshooting data are not transmitted to the VETSCAN FUSE or ZoetisDx. Result suppression ("~~~") will show as "SUPP" when transmitted. To capture the troubleshooting data, either print the troubleshooting report from the VS2's printer or view it on the analyzer's screen.





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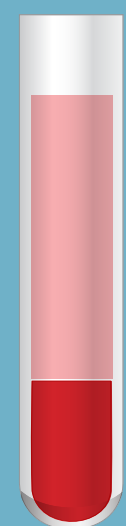
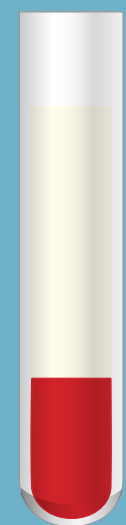
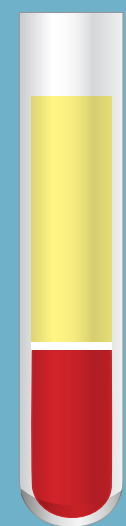
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## What is sample interference?

Sample interferents are substances that affect blood chemistry results during analysis. Sample interferents can contribute to preanalytical and analytical errors. The VETSCAN VS2 iQC assesses the sample interferent levels—hemolysis (HEM), lipemia (LIP) and icterus (ICT)—with every profile run.

*When sample interference is significant based on iQC, some results may be suppressed. This is not an example of a rotor failure. Rather, this is exactly what chemistry analyzers should do if an interfering substance and/or sample quality is adversely affecting results*

	Interference Index	Solution
<b>Hemolysis</b> 	<p>HEMOLYSIS is the rupture or destruction of RBCs, which can occur in 2 ways:</p> <ul style="list-style-type: none"><li>• During or after blood collection (artifactual), MOST commonly due to:<ul style="list-style-type: none"><li>— Inadequate venipuncture technique</li><li>— Lipemia effects on RBC membrane</li><li>— Freezing of whole blood samples</li><li>— Delayed processing</li></ul></li><li>• In the circulating blood (in vivo) due to disease (less common)<ul style="list-style-type: none"><li>— Eg, immune-mediated hemolytic anemia (IMHA)</li></ul></li></ul>	<p>If artifactual hemolysis causes test results to be suppressed, collect a new sample with good technique and rerun the test.</p>
<b>Lipemia</b> 	<p>LIPEMIA is the milky appearance of serum or plasma caused by increased concentrations of triglyceride-carrying lipoproteins (fat).</p> <ul style="list-style-type: none"><li>— The most common reason for lipemia is that the patient has not been fasted (artifactual)</li></ul>	<p>A whole blood sample may be centrifuged once (to obtain serum or plasma) and tested; however, a suppression may still occur.</p> <ul style="list-style-type: none"><li>— If LIP causes test results to be suppressed, it is recommended to fast the patient for 10 to 12 hours, collect a new sample and run the test again<sup>3,4</sup></li><li>— Alternatively, the sample can be sent to a commercial laboratory that has an ultracentrifuge if needed</li></ul>
<b>Icterus</b> 	<p>ICTERUS is the excessively yellow pigmentation of the plasma or serum that suggests hyperbilirubinemia.<sup>3</sup></p> <ul style="list-style-type: none"><li>• Assess a sample visually for ICT, but the magnitude of hyperbilirubinemia should be confirmed with TBIL concentration</li></ul>	<p>None, as ICT is NOT a sample handling issue but a disease process.</p> <ul style="list-style-type: none"><li>— Contact Diagnostic Technical Support for help interpreting the troubleshooting report</li><li>— Consider sending to a commercial laboratory that may be able to process the high level of icterus</li></ul>

RBC=red blood cell; TBIL=total bilirubin.





# Profile Utilization Guide



## Define your lab testing minimum database<sup>10</sup>



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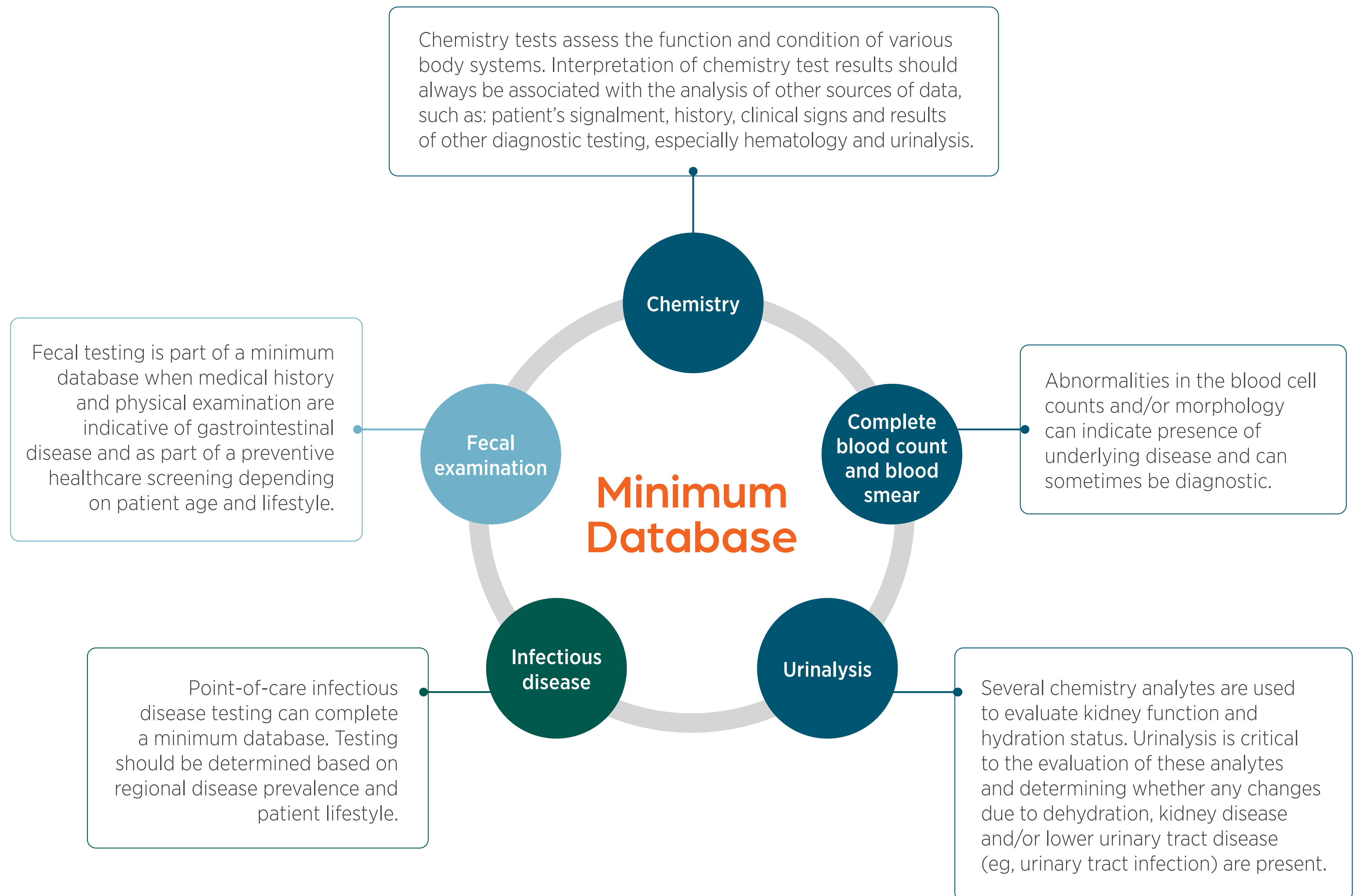
- Wet chemistry technology
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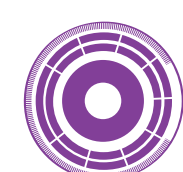
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## Baseline chemistry profiles

When performing a health or preanesthetic screening or initially diagnosing a sick patient, a baseline panel is the best choice and should be combined with a complete blood count and urinalysis to complete the minimum database.

### Baseline Profiles

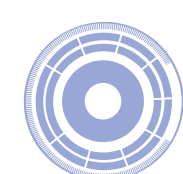
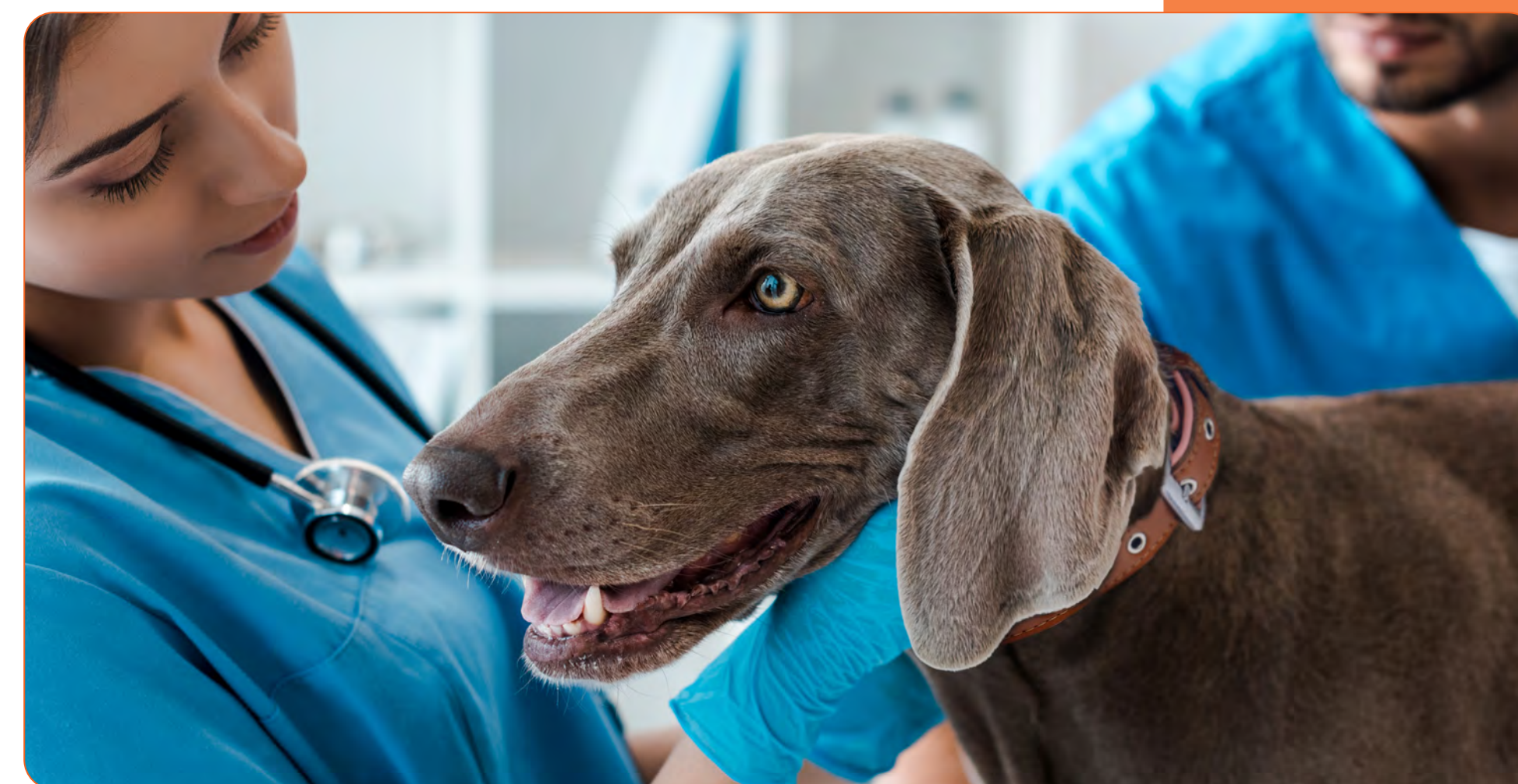


#### Comprehensive Diagnostic Profile (CDP)

ALB, ALP, ALT, AMY, BUN, Ca, CRE, GLOB\*, GLU, K<sup>+</sup>, Na<sup>+</sup>, PHOS, TBIL, TP

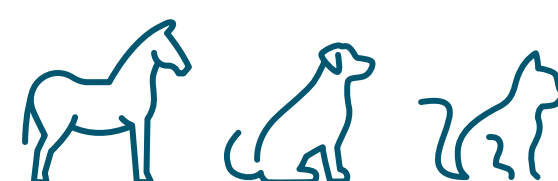


- Monitor hospitalized patients with one of the most comprehensive VETSCAN VS2 profiles, including potassium and sodium
- Phosphorus (PHOS) level aids in assessment of kidney disease, hydration status, calcium disorders
- Elevated levels of amylase (AMY) can indicate pancreatic or intestinal disease, dehydration or decreased renal clearance



#### Preventive Care Profile Plus (PCPP)

ALB, ALP, ALT, AST, BUN, Ca, Cl<sup>-</sup>, CRE, GLOB\*, GLU, K<sup>+</sup>, Na<sup>+</sup>, TBIL, TCO<sub>2</sub>, TP



- Monitor hospitalized patients with one of the most comprehensive VETSCAN VS2 profiles, with full electrolytes, including chloride and acid-base status with TCO<sub>2</sub>
- Additional hepatocellular enzyme with aspartate aminotransferase (AST)



ALB=albumin; ALP=alkaline phosphatase; ALT=alanine aminotransferase; AMY=amylase; AST=aspartate aminotransferase; BUN=blood urea nitrogen; Ca=calcium; Cl<sup>-</sup>=chloride; CRE=creatinine; GLOB=globulin; GLU=glucose; K<sup>+</sup>=potassium; Na<sup>+</sup>=sodium; PHOS=phosphorus; TBIL=total bilirubin; TCO<sub>2</sub>=total carbon dioxide; TP=total protein.

\*Calculated value.





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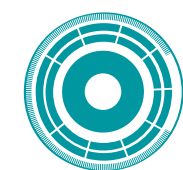
### Responsible Patient Trending

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## Baseline chemistry profiles

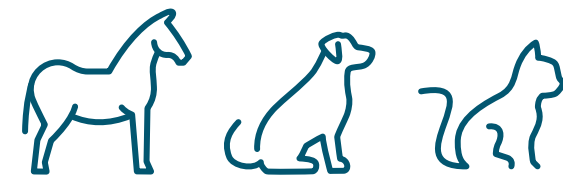
When performing a health or preanesthetic screening or initially diagnosing a sick patient, a baseline panel is the best choice and should be combined with a complete blood count and urinalysis to complete the minimum database.

### Baseline Profiles



#### Prep Profile II (PPII)

ALP, ALT, BUN, CRE, GLU, TP



- Concise panel helpful for preanesthetic screening in young, healthy patients
- Can be used to monitor the administration of chronic nonsteroidal anti-inflammatory drugs (NSAIDs)
- Useful profile for patient trending
- Organ-specific chemistry profiles







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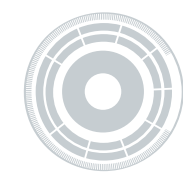
### Reference Intervals

## Specific chemistry profiles

### Choosing the most suitable specific profile

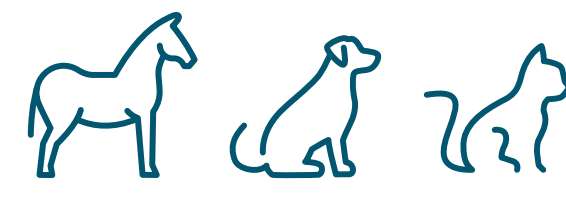
Once an initial diagnosis has been made and/or treatment has begun, a more focused panel can be used for efficient and economical close patient monitoring. See the chart below for common case examples as a guideline to using the focused profiles listed.

#### Preanesthetic + Critical Care Profiles



#### Electrolyte Plus (EP)

Cl<sup>-</sup>, K<sup>+</sup>, Na<sup>+</sup>, TCO<sub>2</sub>

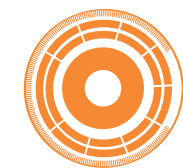


#### Indications of Use

- Monitor fluid therapy for hospitalized or anesthetized patients in routine or emergency situations

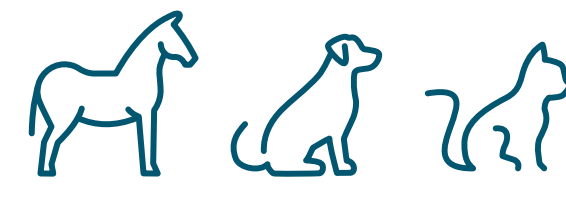
#### Case Examples

- Foal recovering from enterocolitis
- Anorexic cats
- Unstable Addisonian (hypoadrenocorticism) cases



#### Critical Care Plus (CCP)

ALT, BUN, Cl<sup>-</sup>, CRE, GLU, K<sup>+</sup>, Na<sup>+</sup>, TCO<sub>2</sub>



#### Indications of Use

- Hospitalized patient monitoring
- Monitoring for certain chronic conditions
- Can be considered for preanesthetic or during anesthetic procedures

#### Case Example

- Recheck panel for cases such as hypoadrenocorticism, diabetes and urinary tract disease







# Profile Utilization Guide



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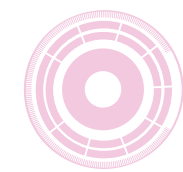
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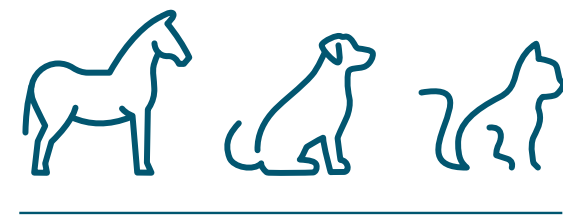
#### Reference Intervals

### Organ-specific Profiles



#### Kidney Profile Plus (KPP)

ALB, BUN, Ca, Cl<sup>-</sup>, CRE, GLU, K<sup>+</sup>, Na<sup>+</sup>, PHOS, TCO<sub>2</sub>



#### Indications of Use

Specifically designed to evaluate renal function:

- Monitor chronic or acute kidney disease
- Monitor patients with toxic exposure or who are taking medications potentially toxic to the renal system
- Monitor hypoadrenocorticism
- Diagnose or monitor urinary tract disease
- Screen for acid-base abnormalities

#### Case Examples

- Recheck cats with early, mid- or late-stage kidney disease
- Monitor cats treated for hyperthyroidism
- Recheck dogs with acute or chronic kidney disease
- Monitor dehydrated patient receiving intravenous fluids
- Monitor general anesthesia







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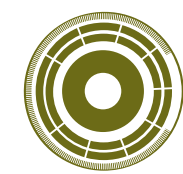
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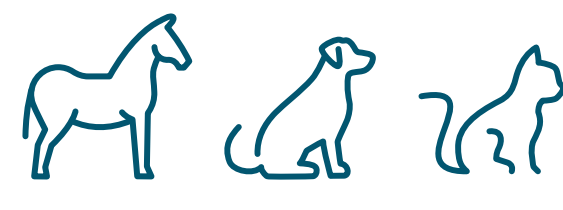
#### Reference Intervals

### Organ-specific Profiles



#### Mammalian Liver Profile (MLP)

ALB, ALP, ALT, BA, BUN, CHOL, GGT, TBIL



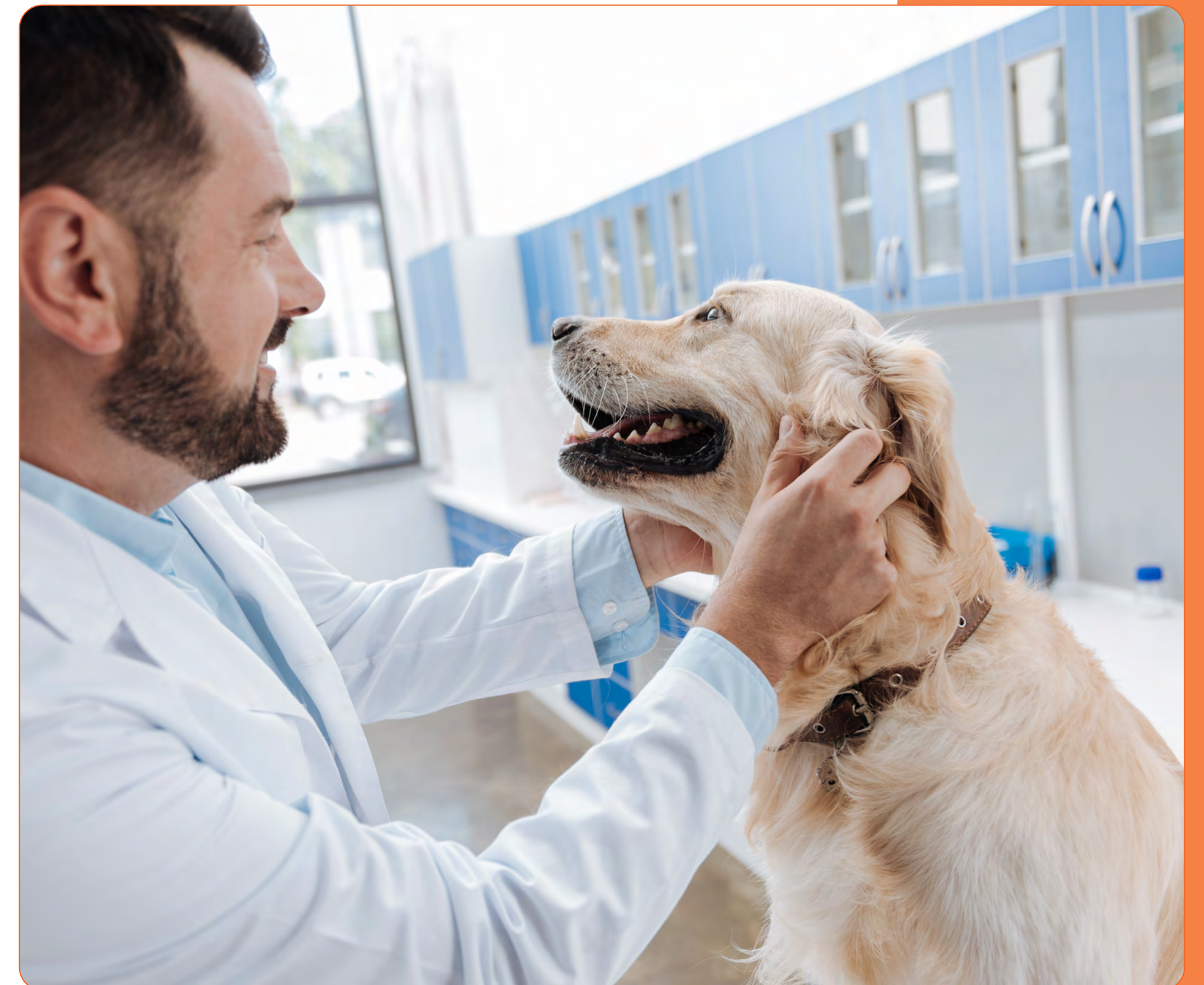
#### Indications of Use

Specifically designed to evaluate liver damage and cholestasis:

- Monitor liver injury, disease and function
- Detect cholestasis/enzyme induction (ALP, GGT)
- Evaluate hepatic function:
  - Liver product levels (ALB, BUN, CHOL)
  - Bile acids (BA) to assess liver function and patients suspected to have portosystemic shunt (PSS)
- Monitor patients on potentially hepatotoxic medications

#### Case Examples

- Perform if elevated liver enzymes present on a baseline profile health screening (CDP, PCPP, PPII)
- Monitor elevated liver enzymes in otherwise healthy patient
- Monitor PSS post treatment
- Monitor chronic liver disease
- Monitor patient receiving chronic medications metabolized by the liver







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## Choosing the most suitable specific profile



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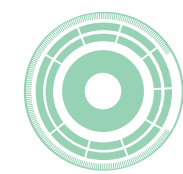
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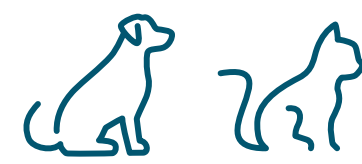
#### Reference Intervals

### Specialty Testing Chemistry Profiles



#### T4/Cholesterol Profile (T4/CHOL)

CHOL, T4

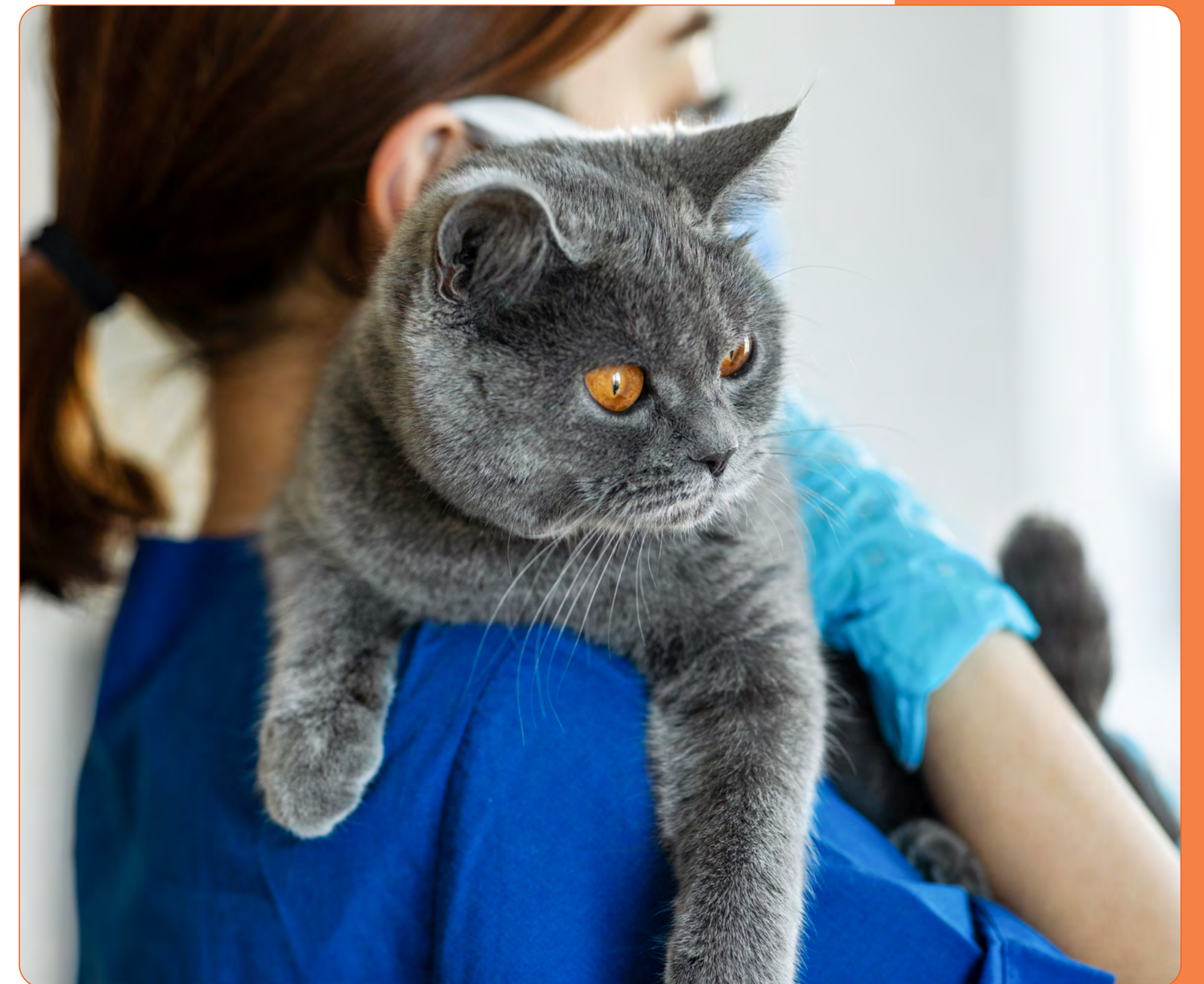


#### Indications of Use

- Screen for hypothyroidism in dogs
- Diagnose hyperthyroidism in cats
- Monitor drug, I-131 or thyroidectomy therapy

#### Case Examples

- Regular screening for senior cats, regardless of whether clinical signs are present
- Screening for cats with clinical signs, such as behavior change, weight loss, unkempt coat, gastrointestinal signs
- Monitoring treatment regularly for hyperthyroidism in cats
- Confirm resolution for cats treated with I-131 or thyroidectomy
- Screen dogs with clinical signs, such as weight gain, alopecia, lethargy
- Monitor treatment regularly for hypothyroidism in dogs 4 to 6 hours postpill and 6 to 8 weeks after starting treatment or change in therapy<sup>11</sup>



CHOL=cholesterol; I-131=iodine-131; T4=total thyroxine.

[Learn more about hypothyroidism](#) ↗





# Profile Utilization Guide



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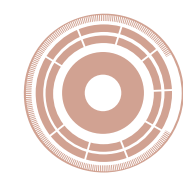
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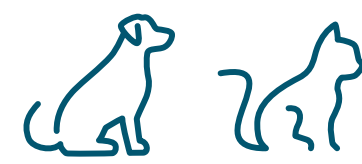
#### Reference Intervals

### Specialty Testing Chemistry Profiles



#### Phenobarbital Profile (PHB)

ALB, ALP, ALT, AST, BUN, GGT, PHB, TBIL



#### Indications of Use

- Monitor PHB levels complete with liver enzymes on a single panel
- Profile can also be used if a patient is not using phenobarbital (PHB will display as 0) to monitor liver values

#### Case Examples

- Initial panel prior to starting PHB therapy
- Regular monitoring once on PHB therapy
- Use if seizures uncontrolled to determine whether current dose is within therapeutic range
- Monitor after a PHB dosage change







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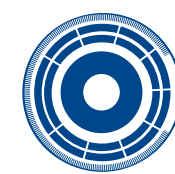
## Species-specific chemistry profiles

The VETSCAN VS2 has many features, including small sample size, which makes it an ideal solution for exotic and large animal species. Several panels designed for some of these species are available.



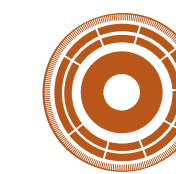
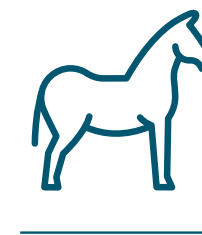
### Avian/Reptilian Profile Plus (A/RPP)

ALB, AST, BA, Ca, CK, GLOB\*, GLU, K<sup>+</sup>, Na<sup>+</sup>, PHOS, TP, UA



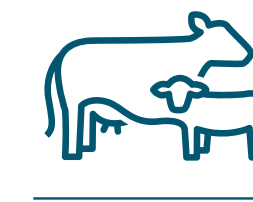
### Equine Profile Plus (EPP)

ALB, AST, BUN, Ca, CK, CRE, GGT, GLOB\*, GLU, K<sup>+</sup>, Na<sup>+</sup>, TBIL, TCO<sub>2</sub>, TP



### Large Animal Profile (LAP)

ALB, ALP, AST, BUN, Ca, CK, GGT, GLOB\*, Mg, PHOS, TP



## VETSCAN VS2 Recommended (Verified) Species

Species other than canine, equine and feline (such as avian, bovine, ferret and rabbit) will need reference values to be manually preprogrammed into the VETSCAN VS2 display using the [VETSCAN VS2 Reference Intervals charts](#). Please refer to section 5.2 of the VETSCAN VS2 Operator's Manual for programming instructions.

VETSCAN VS2 Profile	Recommended Species	VETSCAN VS2 Profile	Recommended Species
● PCPP	Canine, equine, feline	● EP	Canine, equine, feline
● CDP	Canine, equine, feline, ferret, rabbit	● T4/CHOL	Canine, feline
● KPP	Canine, equine, feline	● PHB	Canine, feline
● MLP	Canine, equine, feline	● EPP	Equine
● CCP	Canine, equine, feline	● LAP	Bovine
● PPII	Canine, equine, feline	● A/RPP	Avian

*The Recommended Species column indicates that the individual rotor profile is approved for use for that species*

- Selecting a species outside of these species recommendations is considered off-label, as supplementary species have not been verified for the VETSCAN VS2
- Certain VETSCAN VS2 analytes use a species-specific assay. For this reason, it is important to use caution when programming reference interval data for nonverified species
- It is best practice to create reference intervals based on your patient population developed for the specific analyzer instead of extrapolating from a source

ALB=albumin; ALP=alkaline phosphatase; AST=aspartate aminotransferase; BA=bile acids; BUN=blood urea nitrogen; Ca=calcium; CK=creatinine kinase; CRE=creatinine; GGT=gamma glutamyl transferase; GLOB=globulin; GLU=glucose; K<sup>+</sup>=potassium; Mg=magnesium; Na<sup>+</sup>=sodium; PHOS=phosphorus; TBIL=total bilirubin; TCO<sub>2</sub>=total carbon dioxide; TP=total protein; UA=uric acid.

\*Calculated value.





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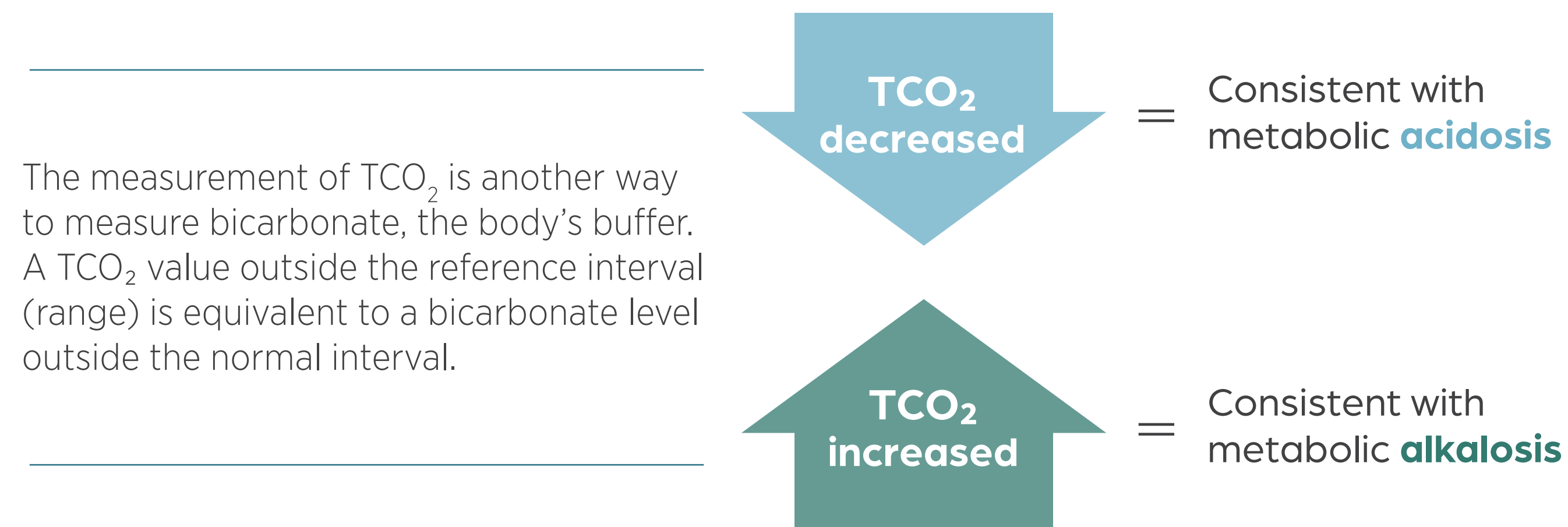
## Reference Intervals

## Using TCO<sub>2</sub><sup>12</sup>




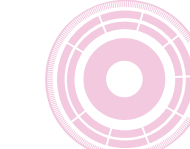

### Beyond the basic chemistry panel

*The use of TCO<sub>2</sub> with chemistry and electrolyte results can often help narrow down a patient's differential list, especially when combined with anion gap*

### Simplified TCO<sub>2</sub> Interpretation



### Profiles with TCO<sub>2</sub>:

-  **Critical Care Plus (CCP)**
-  **Electrolyte Plus (EP)**
-  **Equine Profile Plus (EPP)**
-  **Kidney Profile Plus (KPP)**
-  **Preventive Care Profile Plus (PCPP)**

### If TCO<sub>2</sub> is abnormal, the clinician must determine:

- Whether a complete acid-base analysis is warranted in the case of a difficult or complicated diagnosis or a very ill patient (measurement of pH, pCO<sub>2</sub>, HCO<sub>3</sub>, anion gap, +/- base excess)
- Whether the patient could be treated based on TCO<sub>2</sub> alone if the cause for the abnormality is straightforward

### When possible, interpret a low TCO<sub>2</sub> with Anion Gap=(Na<sup>+</sup> + K<sup>+</sup>) – (Cl<sup>-</sup> + TCO<sub>2</sub>)

An increased anion gap is most often seen with metabolic acidosis due to lactic, keto or uremic acids or the presence of other metabolites (eg, ethylene glycol).

- A decreased anion gap is uncommon
- Alterations in albumin concentrations can alter the anion gap

**Note:** TCO<sub>2</sub> should always be interpreted considering history, signalment, physical examination, clinical signs and other laboratory data. Many other factors, including electrolytes, proteins, ketones, lactic acid, uremic acids and metabolites of ethylene glycol and HCO<sub>3</sub> can affect the acid-base status of the patient.





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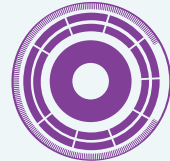
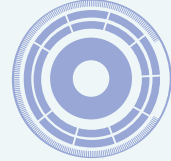


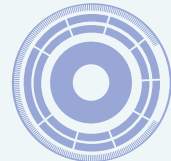


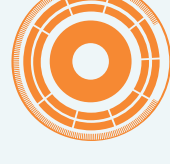

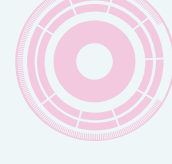


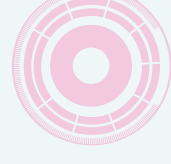



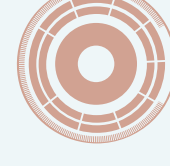


## Responsible Patient Trending

## Reference Intervals

## Profile selection

Common indications to consider:

Suggested profiles available:

Health screening: young adult/adult	 CDP	 PCPP	 PPII	
Health screening: senior	 CDP	 PCPP	 T4/CHOL*	
Anesthetic screening: young adult/adult	 CDP	 PCPP	 PPII	
Anesthetic screening: senior	 CDP	 PCPP		
Screening a sick patient	 CDP	 PCPP		
Monitoring fluid therapy	 CCP	 EPP	 KPP	 PCPP
Monitoring renal patient	 CDP	 KPP		
Diagnosing and monitoring hepatic patient	 CDP	 MLP	 PCPP	 PHB <sup>+</sup>
Monitoring endocrine disease	 CDP	 T4/CHOL		

\*Canine with clinical signs or senior feline.  
†Can be used if a patient is not using phenobarbital and PHB is zero.





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## Responsible Patient Trending

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## Responsible Patient Trending—why perform?

*Due to biological variations, the best reference values are a pet's own diagnostic values over time, encompassing breed, age, sex and individual variation*

- It is important to understand that most reference intervals represent results expected for 95% (19 of 20) of a healthy population, and therefore 1 of 20 healthy animals is expected to have a measured value outside of the reference interval<sup>4</sup>
  - For example, on the Comprehensive Diagnostic Profile (CDP) rotor with 14 assays, there is a 51% chance that at least one value will be outside of the reference interval<sup>13</sup>
- For these reasons, individual patient trending is more sensitive and better at detecting pathologic changes than reliance on published reference values for chemistry and hematology<sup>14</sup>

### Senior patients

- The common occurrence of physical exam and laboratory abnormalities in apparently healthy senior dogs and cats emphasizes the need for regular health screening, including regular laboratory testing<sup>15,16</sup>
- Visit/exam frequency and testing recommendations should be based on patient's age, breed and lifestyle
- Senior and geriatric dogs and cats should be examined at least semiannually to allow for earlier intervention of chronic disease
- Regular testing at geriatric equine annual examinations assesses overall health and may help detect early signs of potentially serious disease, such as liver and kidney dysfunction or onset of metabolic disease<sup>17</sup>







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### Reference Intervals

## Keys to patient trending success

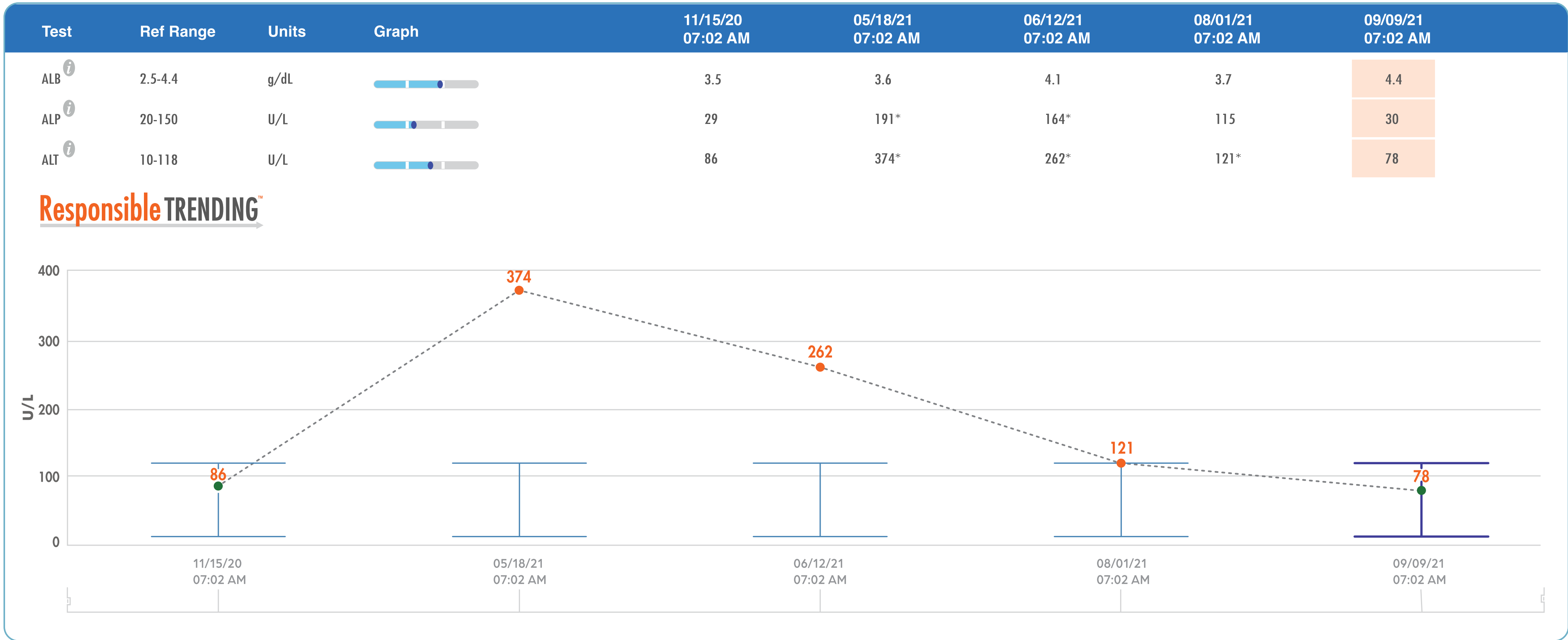
The best practice is to monitor a patient on the same analyzer using the same analytical methods

Whenever comparing or trending analyte results, it is important to trend using best practices and responsible trending to have an apples-to-apples comparison. This practice includes:

- Using the same analyzer every time, where possible
- Performing the test in the same way (how many hours posttreatment, fasted, etc)
- Keeping in mind that different assays and instruments have reference intervals that may differ among analyzers and/or labs
- Performing a quality check or verifying with a different test methodology if a value does not match the clinical picture

## What is responsible trending?

Responsible Trending™, available only on the ZoetisDx online platform, focuses on showing test analyte results as a sequence of graphs. This visual format provides a clear story of each patient's trends in test results over time—with results from different instruments and Zoetis Reference Labs together but always relative to each analyte's reference interval on each instrument.



**Note:** It is imperative when comparing results between different analyzers or labs to interpret the analyte value with respect to the reference interval provided and not the raw number due to inherent methodology differences.





# Reference Intervals



## How VETSCAN® VS2 Works

### Sample Handling

- Patient preparation
- Sample collection
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### Understanding VS2 Chemistry Analysis

- Wet chemistry technology
- Intelligent Quality Control (iQC®)
- Troubleshooting reports
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### Profile Utilization Guide

- Minimum database
- Chemistry profiles
- Using TCO<sub>2</sub>
- Indications to consider

### Responsible Patient Trending

### Reference Intervals

- Reference intervals (ranges) will not display for species other than canine, equine and feline unless preprogrammed as custom intervals
- Verified species—such as avian, bovine, ferret and rabbit—will need to be manually preprogrammed into the VETSCAN VS2 to display, using the VETSCAN VS2 Reference Intervals chart below and on the following page. See the VETSCAN VS2 Operator's Manual (or the VETSCAN VS2 Quick Reference Guide) for further details

Analyte	Species (common units) <sup>18</sup>							Units
	CANINE	FELINE	EQUINE	BOVINE	RABBIT	AVIAN	FERRET	
ALB	2.5 - 4.4	2.2 - 4.4	2.2 - 3.7	2.5 - 3.8	2.5 - 4.5*	1.7 - 3.3	1.9 - 3.8	g/dL
ALP	20 - 150	10 - 90	50 - 170	23 - 135	24 - 128	N/A	8 - 72	U/L
ALT	10 - 118	20 - 100	5 - 20	N/A	20 - 104	N/A	65 - 346	U/L
AMY	200 - 1200	300 - 1100	5 - 15	N/A	113 - 334	N/A	4 - 50	U/L
AST	14 - 45	12 - 43	175 - 340	66 - 211	N/A	107 - 481	N/A	U/L
BA	Fasting: 1-4 2 Hrs Postprandial: 2-15 Cutoff: 25	Fasting: 1-3 2 Hrs Postprandial: 7-9 Cutoff: 25	Cutoff: 25	N/A	1.5 - 14	< 95	1 - 8	μmol/L
BUN	7 - 25	10 - 30	7 - 25	6 - 20	12 - 31	1 - 7	9 - 38	mg/dL
Ca	8.6 - 11.8	8.0 - 11.8	11.5 - 14.2	7.9 - 9.6	12.5 - 16.8	7.8 - 11.1	8.0 - 10.4	mg/dL
CHOL	125 - 270	90 - 205	50 - 140	N/A	11 - 81	N/A	102 - 245	mg/dL
CK	N/A	N/A	120 - 470	83 - 688	N/A	69 - 524	N/A	U/L
Cl-	95 - 119	99 - 122	92 - 104	N/A	N/A	N/A	N/A	mmol/L
CRE	0.3 - 1.4	0.3 - 2.1	0.6 - 2.2	N/A	0.5 - 1.6	N/A	0.2 - 0.7	mg/dL
GGT	0 - 7	0 - 2	5 - 24	12 - 48	2 - 50	N/A	5 - 15	U/L
GLOB <sup>†</sup>	2.3 - 5.2	1.5 - 5.7	2.7 - 5.0	4.0 - 5.5	1.5 - 4.6 <sup>†</sup>	N/A	2.3 - 4.5	g/dL
GLU	60 - 110	70 - 150	65 - 110	N/A	100 - 155	223 - 390	65 - 145	mg/dL
K <sup>+</sup>	3.7 - 5.8	3.7 - 5.8	2.5 - 5.2	N/A	3.5 - 6.2	3.0 - 5.7	4.1 - 5.5	mmol/L
Mg	N/A	N/A	N/A	1.7 - 2.9	N/A	N/A	N/A	mg/dL
Na <sup>+</sup>	138 - 160	142 - 164	126 - 146	N/A	135 - 149	137 - 151	146 - 156	mmol/L
PHB	10.0 - 45.0	10.0 - 45.0	N/A	N/A	N/A	N/A	N/A	μg/mL
PHOS	2.9 - 6.6	3.4 - 8.5	1.9 - 4.3	4.1 - 9.2	1.7 - 6.6	1.2 - 7.3	3.6 - 7.3	mg/dL
T4	1.1 - 4.0	1.5 - 4.8	N/A	N/A	N/A	N/A	N/A	μg/dL
TBIL	0.1 - 0.6	0.1 - 0.6	0.5 - 2.3	N/A	0.1 - 0.3	N/A	0.3 - 0.6	mg/dL
TCO <sub>2</sub>	12 - 27	15 - 24	20 - 33	N/A	N/A	N/A	N/A	mmol/L
TP	5.4 - 8.2	5.4 - 8.2	5.7 - 8.0	6.6 - 9.3	5.3 - 8.5	2.1 - 4.7	5.0 - 7.6	g/dL
UA	N/A	N/A	N/A	N/A	N/A	2.5 - 13.3	N/A	mg/dL

Reference intervals are provided as a guideline for adults only. The most definitive normal values are those established for your patient population. Juvenile or neonatal reference values may deviate from these ranges. Animals should be fasted for 12 hours before sample is drawn. Test results should be interpreted along with patient clinical signs.

\*Rabbit samples: ALB recovery must be manually multiplied by 1.8. This will correct for the dye-binding affinity of the BCG dye used in the ALB assay. Reference intervals displayed reflect this calculation.

<sup>†</sup>Calculated value.

<sup>‡</sup>GLOB value must be corrected using the formula  $GLOB_{corrected} = TP - ALB_{corrected}$ . Reference ranges displayed reflect this calculation.





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## Responsible Patient Trending

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Analyte	Species (SI units) <sup>16</sup>							
	CANINE	FELINE	EQUINE	BOVINE	RABBIT	AVIAN	FERRET	SI Units
ALB	25 - 44	22 - 44	22 - 37	25 - 38	25-45	17 - 33	19 - 38	g/L
ALP	20 - 150	10 - 90	50 - 170	23 - 135	24 - 128	N/A	8 - 72	U/L
ALT	10 - 118	20 - 100	5 - 20	N/A	20 - 104	N/A	65 - 346	U/L
AMY	200 - 1200	300 - 1100	5 - 15	N/A	113 - 334	N/A	4 - 50	U/L
AST	14 - 45	12 - 43	175 - 340	66 - 211	N/A	107 - 481	N/A	U/L
BA	Fasting: 1-4 2 Hrs Postprandial: 2-15 Cutoff: 25	Fasting: 1-3 2 Hrs Postprandial: 7-9 Cutoff: 25	Cutoff: 25	N/A	1.5 - 14	< 95	1 - 8	µmol/L
BUN	2.5 - 8.9	3.6 - 10.7	2.5 - 8.9	2.1 - 7.1	4.1 - 10.9	0.3 - 2.3	3.2 - 13.4	mmol/L
Ca	2.15 - 2.95	2.00 - 2.95	2.88 - 3.55	1.98 - 2.40	3.13 - 4.21	1.95 - 2.78	2.00 - 2.60	mmol/L
CHOL	3.2 - 7.0	2.3 - 5.3	1.3 - 3.6	N/A	0.3 - 2.1	N/A	2.6 - 6.3	mmol/L
CK	N/A	N/A	120 - 470	83 - 688	N/A	69 - 524	N/A	U/L
Cl-	95 - 119	99 - 122	92 - 104	N/A	N/A	N/A	N/A	mmol/L
CRE	27 - 124	27 - 186	53 - 194	N/A	47 - 144	N/A	18 - 62	µmol/L
GGT	0 - 7	0 - 2	5 - 24	12 - 48	2 - 50	N/A	5 - 15	U/L
GLOB*	23 - 52	15 - 57	27 - 50	40 - 55	15 - 46 <sup>†</sup>	N/A	23 - 45	g/L
GLU	3.3 - 6.1	3.9 - 8.3	3.6 - 6.1	N/A	5.6 - 8.6	12.4 - 21.6	3.6 - 8.0	mmol/L
K <sup>+</sup>	3.7 - 5.8	3.7 - 5.8	2.5 - 5.2	N/A	3.5 - 6.2	3.0 - 5.7	4.1 - 5.5	mmol/L
Mg	N/A	N/A	N/A	0.70 - 1.19	N/A	N/A	N/A	mmol/L
Na <sup>+</sup>	138 - 160	142 - 164	126 - 146	N/A	135 - 149	137 - 151	146 - 156	mmol/L
PHB	43.1 - 194.0	43.1 - 194.0	N/A	N/A	N/A	N/A	N/A	µmol/L
PHOS	0.94 - 2.13	1.10 - 2.75	0.61 - 1.39	1.32 - 2.97	0.56 - 2.13	0.39 - 2.36	1.16 - 2.36	mmol/L
T4	14 - 52	19 - 62	N/A	N/A	N/A	N/A	N/A	nmol/L
TBIL	2 - 10	2 - 10	9 - 39	N/A	2 - 6	N/A	5 - 10	µmol/L
TCO <sub>2</sub>	12 - 27	15 - 24	20 - 33	N/A	N/A	N/A	N/A	mmol/L
TP	54 - 82	54 - 82	57 - 80	66 - 93	53 - 85	21 - 47	50 - 76	g/L
UA	N/A	N/A	N/A	N/A	N/A	149 - 791	N/A	µmol/L

### Can alternative fluids be run on the VETSCAN VS2?

No. Other than whole blood, plasma or serum, no other fluids have been validated for use on the VETSCAN VS2.

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\*Calculated value.

<sup>†</sup>GLOB value must be corrected using the formula  $GLOB_{corrected} = TP - ALB_{corrected}$ . Reference ranges displayed reflect this calculation.





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**References:** **1.** Data on file, Study No. TI-04239, Zoetis Inc. **2.** Data on file, Study No. 02R-0705, Zoetis Inc. **3.** VETSCAN® VS2 Operator's Manual, LBL-03064, Zoetis Inc. **4.** Monti P, Archer J. Quality assurance and interpretation of laboratory data. In: Villiers E, Ristic J, eds. *BSAVA Manual of Canine and Feline Clinical Pathology*. 3rd ed. British Small Animal Veterinary Association; 2016:11-26. **5.** Elliott J, White J. IRIS staging system: Overview of the IRIS staging system for CKD. International Renal Interest Society. 2019. Accessed May 12, 2022. [http://iris-kidney.com/education/staging\\_system.html](http://iris-kidney.com/education/staging_system.html). **6.** Allison RW. Laboratory evaluation of the pancreas and glucose metabolism. In: Thrall MA, Weiser G, Allison RW, et al., eds. *Veterinary Hematology and Clinical Chemistry*. 2nd ed. Wiley-Blackwell; 2012:425-440. **7.** Macquarie University. Wet Chemistry Analysis and Testing. Accessed June 21, 2022. <https://www.mq.edu.au/research/research-centres-groups-and-facilities/secure-planet/facilities/chemical-analysis-facility/wet-chemistry-analysis-and-testing>. **8.** Data on file, Study No. TI-05899, Zoetis Inc. **9.** VETSCAN® Comprehensive Diagnostic Profile, Zoetis Inc. **10.** Kipperman BS. The demise of the minimum database. *J Am Vet Med Assoc*. 2014;244(12):1368-1370. doi:10.2460/javma.244.12.1368. **11.** Scott-Moncrieff JC. Hypothyroidism. In: Feldman EC, Nelson RW, Reusch C, et al., eds. *Canine & Feline Endocrinology*. 4th ed. Saunders; 2015:120. **12.** DiBartola SP. Introduction to acid-base disorders. In: DiBartola SP. *Fluid, Electrolyte, and Acid-Base Disorders in Small Animal Practice*. 4th ed. Elsevier Inc.; 2011:231-252. **13.** Stockham SL, Scott MA. Introductory concepts. In: Stockham SL, Scott MA, eds. *Fundamentals of Veterinary Clinical Pathology*. 2nd ed. Wiley-Blackwell; 2008:3-51. **14.** Walton RM. Subject-based reference values: biological variation, individuality, and reference change values. *Vet Clin Pathol*. 2012;41(2):175-181. doi:10.1111/j.1939-165X.2012.00414.x. **15.** Willems A, Paepe D, Marynissen S, et al. Results of screening of apparently healthy senior and geriatric dogs. *J Vet Intern Med*. 2017;31(1):81-92. doi:10.1111/jvim.14587. **16.** Paepe D, Verjans G, Duchateau L, et al. Routine health screening: findings in apparently healthy middle-aged and old cats. *J Feline Med Surg*. 2013;15(1):8-19. doi:10.1177/1098612X12464628. **17.** Ralston SL. Care for the older horse: diet and health. Equine Science Center. Published 2004. Accessed October 10, 2022. [https://esc.rutgers.edu/fact\\_sheet/care-for-the-older-horse-diet-and-health/](https://esc.rutgers.edu/fact_sheet/care-for-the-older-horse-diet-and-health/). **18.** Data on file, VTS-00038, Zoetis Inc.