VETSCAN® VS2

Hospital Resource Guide

zoetis

Welcome
to the VETSCAN® VS2 Hospital Resource Guide

This guide is designed to help make the VETSCAN VS2 Chemistry Analyser 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:

0345 300 8034

DXSupport.UK@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

Contents

*Requires the use of ZoetisDx.com, the VETSCAN® FUSE or VetScan HUB 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

The VETSCAN VS2 Chemistry Analyser is a state-of-the-art chemistry, electrolyte, immunoassay and acid-base analyser that delivers uncompromising performance.[1,2] 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.[3†]

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

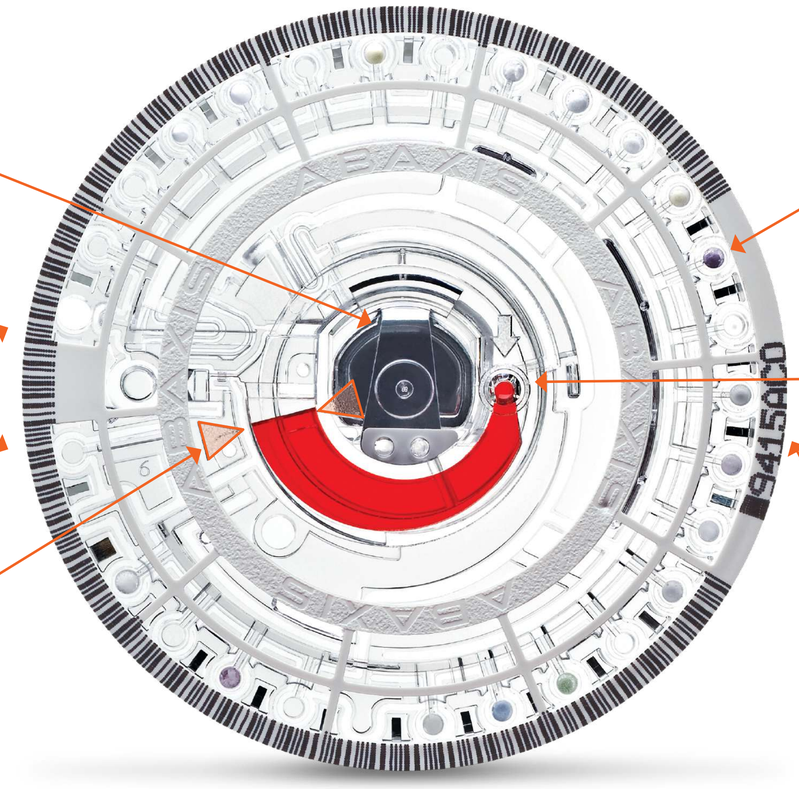
The reagent profiles are specially designed to perform all the steps required to convert just 100 µL of blood into a panel of test results.† The VETSCAN VS2 rotor spins, separating the whole blood sample into plasma and cells. Precisely measured quantities of plasma or serum and diluent are mixed and 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.[3]

VETSCAN VS2 Rotor

Diluent container opens when the rotor is inserted in the analyser. *Do not hold here or inadvertently pierce.*

Hold the rotor **by the sides only**.

Sample fill line is indicated by the 2 arrows on the rotor surface. The sample will form a line between the arrows when a sufficient sample is added (~100 µL of sample).



Cuvettes contain analyte-specific **lyophilised reagent beads**.

Introduce sample via the **sample port**.

Bar code contains calibration coefficients, rotor identification code, lot number and rotor expiration date.

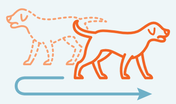
*Always fill sample tube to the manufacturer's sample fill line.

†The routine use of quality controls is not required for optimal analyser 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

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
	• Avoid feeding patients for 10 to 12 hours prior to an appointment unless it is contraindicated • In horses and ruminants, fasting prior to chemistry analysis is not required	• A postprandial sample may cause lipaemic interference • Food consumption can affect biochemistry analytes—particularly glucose, urea and creatinine[4,5]
	• Consider timing requirements for proper test interpretation • Understand that certain medications may impact test results	Confirm timing of medication dosing and testing: • Total thyroxine [T4] and phenobarbital monitoring • Feeding around postprandial bile acid [BA] testing Phenobarbital may decrease T4 concentration; glucocorticoids and phenobarbital may increase liver enzymes
	• Avoid exercise and minimise any excitement/fear prior to the appointment	Can cause: • Physiological leukocytosis[4] • Transient hyperglycaemia in cats[6]

	At the clinic	Rationale
	• Minimise any excitement/fear during the appointment • Consider the use of sedation and anxiety medication to help decrease stress for anxious animals and enable safer and gentler restraint, when appropriate	Can cause: • Physiological leukocytosis[4] • Transient hyperglycaemia in cats[6]
	• For dehydrated or very sick patients, consider centrifuging the sample prior to testing, and run the test using plasma (vs whole blood)	• Visual assessment of the sample preanalysis can highlight abnormalities (eg, haemolysis can indicate poor sample quality) or may indicate the presence of disease (eg, lipaemia in pancreatitis/diabetes mellitus/hypothyroidism, icterus in haemolytic anaemia, hepatic disease or cholestasis)
	• Abnormal findings on other diagnostic tests may correlate with abnormal analyte values in certain disease states	• When a urinalysis identifies a glucosuria, expect blood glucose levels to be elevated

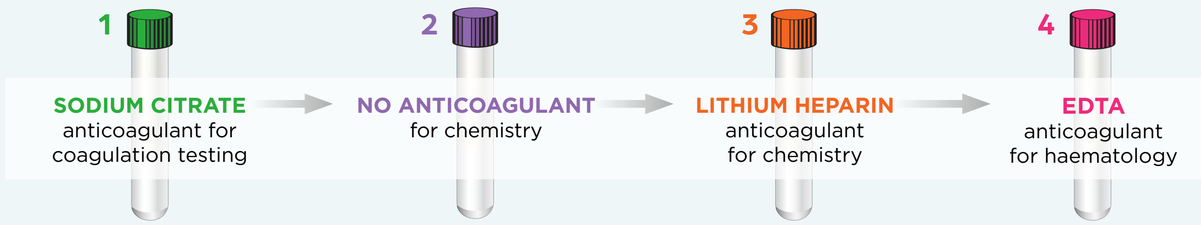
	At time of sampling	Rationale
	• Good sample collection technique is critical (clean needle puncture of the vein, minimal suction, steadily paced drawback)	• Lack of good technique leads to an increased risk of clotting or haemolysis

Sample Handling

Sample collection

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

Keys to success

Avoid vein collapse when drawing samples	• Minimise suction on the syringe and do not draw back too quickly
Prevent haemolysis	• Use the largest vein and needle appropriate for blood collection • Avoid using 23 gauge or smaller needles for most species. Certain exotic species may require a smaller needle • Use minimal alcohol on fur/skin • Remove the needle from the syringe before dispensing into the blood tube unless using a closed vacuum blood collection system
Ensure the correct ratio of anticoagulant to blood	• Fill lithium heparin tube to manufacturer's sample fill line • Immediately after filling the blood tube, replace the cap and invert 10-15 times to sufficiently mix with the anticoagulant
Ensure appropriate tube use	• Select blood tubes based on the testing requirements and size of the patient (Microtainer® 1.3 mL, 3 mL, 5 mL) • Ensure the blood tubes have not expired • Always fill blood tubes in the correct order to avoid contamination — EDTA contamination of chemistry samples may affect electrolyte results and cause a falsely low Ca and falsely high K^+ • If improper tube-filling order occurs, the sample should be redrawn and dispensed in the appropriate order and the rotor rerun Blood tube fill order 
Prevent unwanted blood clotting	• Do not raise the vein for more than a few seconds before venipuncture • For feline samples collected from the medial saphenous vein, a vacuum blood collection system is recommended instead of a syringe
Do not allow samples to degrade	• Run the sample as soon as possible after drawing • Lithium heparin whole blood samples at room temperature must be run within 1 hour[4] • Serum and plasma samples may be stored refrigerated for up to 48 hours[4]

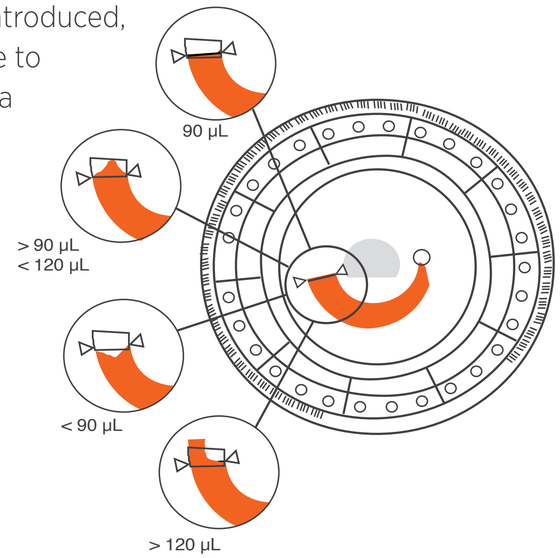
Ca=calcium; K^+=potassium.

Sample Handling

Running a sample: adding a sample to a VETSCAN VS2 profile[3]

DO's

- Remove rotor pouch from the refrigerator immediately before testing—there is no warm-up time
- Use a fixed 100 µL 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 analyser (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

Troubleshooting

If a profile run is cancelled 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.[3]
My profile run was cancelled. 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 **Recall** function, which can be accessed from the **Home** 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.[3]	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^+ 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.

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?	The result was suppressed for multiple possible reasons: • Improper mixing of a reagent bead with diluted sample • A nonlinear reaction; a reaction end point not being reached • A concentration outside the analyser's capabilities	Access troubleshooting report. Contact Diagnostic Technical Support for assistance. 0345 300 8034 DXSupport.UK@zoetis.com

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:

0345 300 8034

DXSupport.UK@zoetis.com

Understanding VS2 Chemistry Analysis

What is wet chemistry technology?[7]

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 analyser, 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.[2,8-9]

Understanding VS2 Chemistry Analysis

Intelligent Quality Control (iQC)

Automatic quality checks with iQC with every run for reliable results[2]

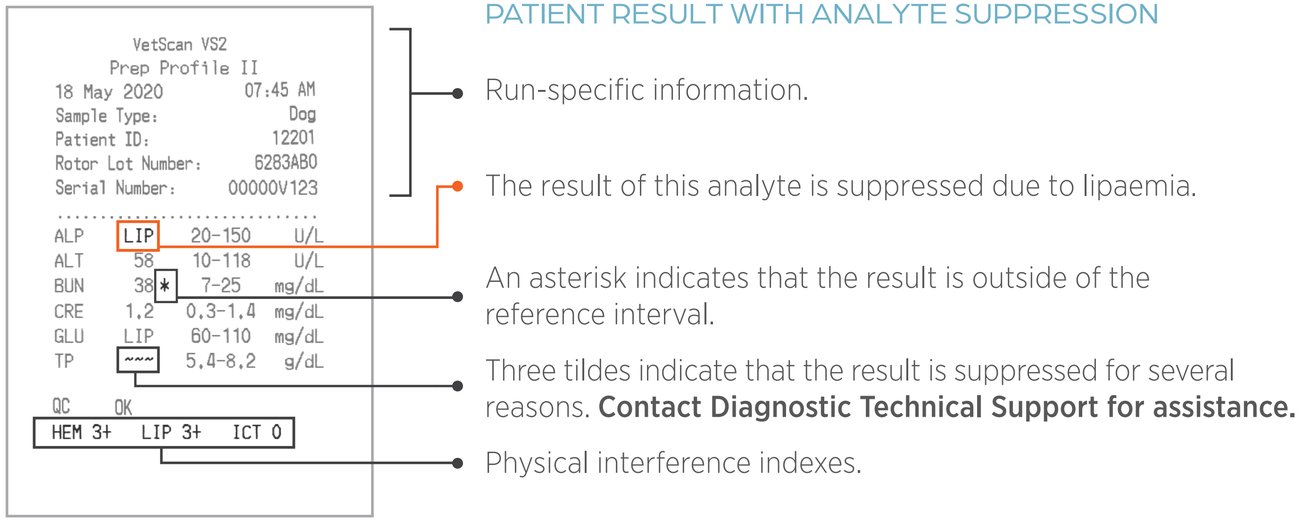
Quality Check	Outcome / Benefit
Analyser	
Optics	Validates the performance of the optical components during every run and guarantees the most accurate measurements.
Temperature	The temperature is controlled with heaters and fans to maintain the ideal reaction temperature of 37°C.
Hardware/Software	Continual testing of software and hardware features verifies consistent and optimal performance of the analyser.
Rotor	
Fluidics	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.
Reagents	Rotor type, expiration date and reagent calibration factors are checked prior to every run. Time-consuming and error-prone reagent calibrations are not required.
Sample	
Sample	The analyser evaluates the sample's quality and reports only valid results that are not influenced by interference (haemolysis, lipemia and icterus). **Minimises the need for visual evaluation of the sample for physical interference.**
Chemistry quality control (QC)	Special QC reagent beads indicate any degradation of the analyte-specific reagents due to suboptimal storage conditions (eg, moisture and temperature).
Chemistry	The analyser monitors the analyte-specific reactions and verifies that all measurements are within the expected range.

Understanding VS2 Chemistry Analysis

VETSCAN VS2 troubleshooting reports

VETSCAN VS2 sample evaluation

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



PATIENT RESULT WITH ANALYTE SUPPRESSION

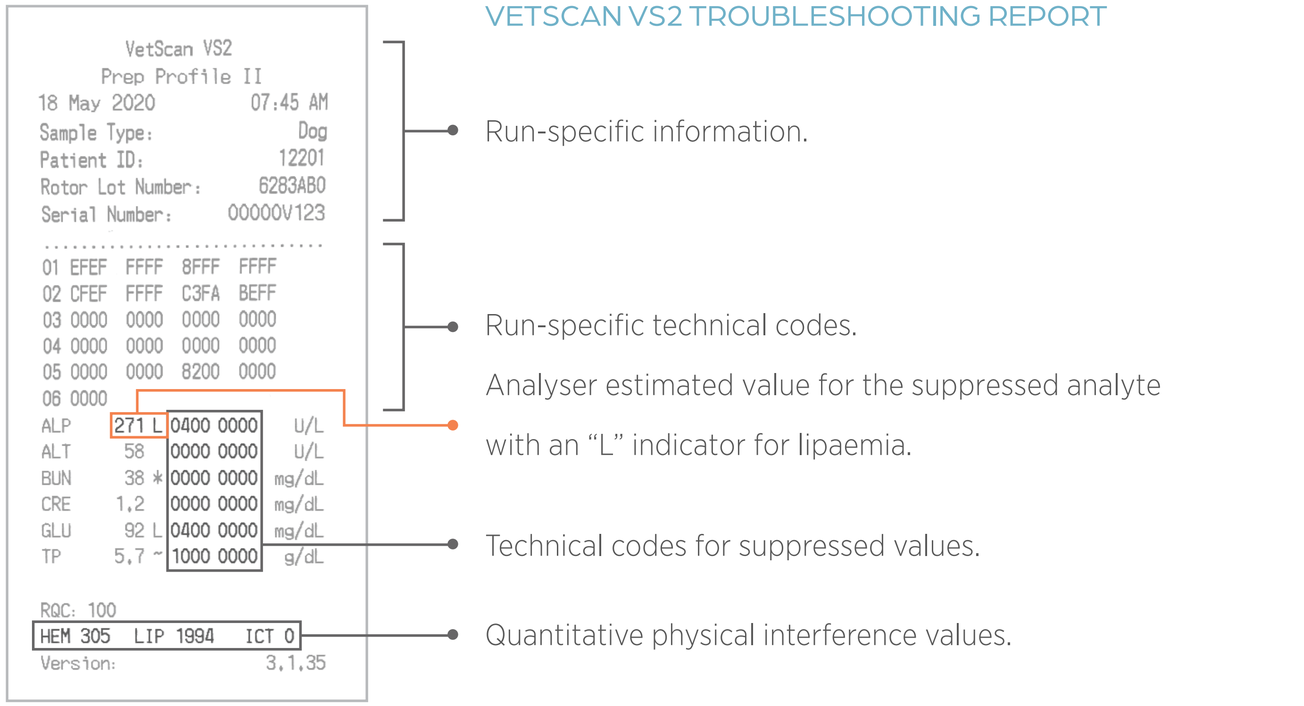
- Run-specific information.
- The result of this analyte is suppressed due to lipaemia.
- An asterisk indicates that the result is outside of the reference interval.
- Three tildes indicate that the result is suppressed for several reasons. **Contact Diagnostic Technical Support for assistance.**
- Physical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

- Run-specific information.
- Run-specific technical codes.
- Analyser estimated value for the suppressed analyte with an “L” indicator for lipaemia.
- Technical codes for suppressed values.
- Quantitative physical interference values.

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

0345 300 8034 DXSupport.UK@zoetis.com

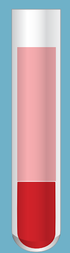
*For VETSCAN® FUSE and ZoetisDx users: cancellation and suppression troubleshooting data are not transmitted to the VETSCAN FUSE or ZoetisDx. Result suppression (“~~~”) will show as “SUPP” when transmitted. To capture the troubleshooting data, either print the troubleshooting report from the VS2’s printer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

Understanding VS2 Chemistry Analysis

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—haemolysis (HEM), lipaemia (LIP) and icterus (ICT)— with every profile run.

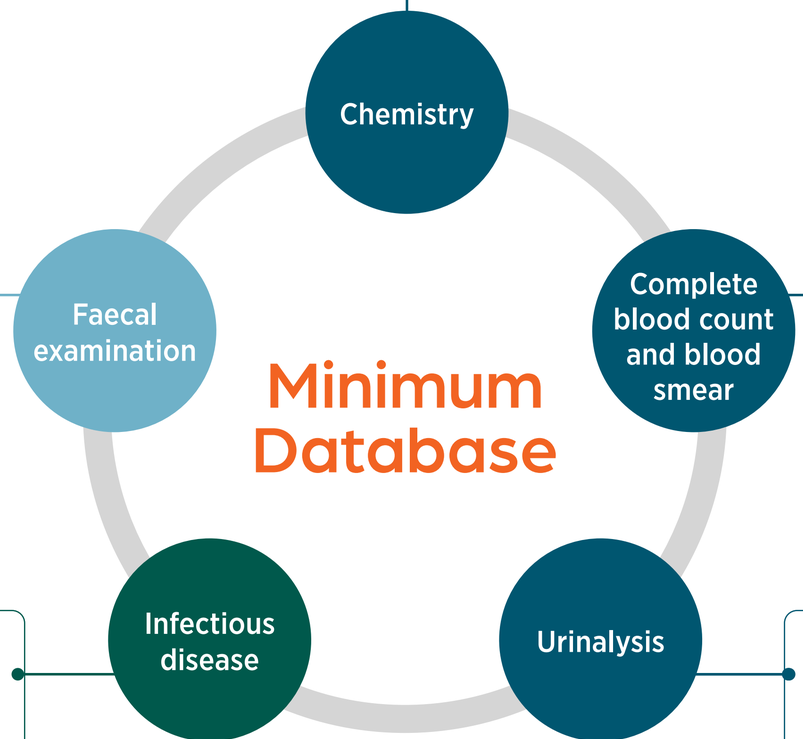
When sample interference is significant based on iQC, some results may be suppressed. This is not an example of a rotor failure. Rather, this is exactly what chemistry analysers should do if an interfering substance and/or sample quality is adversely affecting results

	Interference Index	Solution
Haemolysis 	HAEMOLYSIS is the rupture or destruction of RBCs, which can occur in 2 ways: • During or after blood collection (artefactual), MOST commonly due to:— Inadequate venipuncture technique — Lipaemia effects on RBC membrane — Freezing of whole blood samples — Delayed processing • In the circulating blood (in vivo) due to disease (less common) — Eg, immune-mediated haemolytic anaemia (IMHA)	If artefactual haemolysis causes test results to be suppressed, collect a new sample with good technique and rerun the test.
Lipemia 	LIPAEMIA is the milky appearance of serum or plasma caused by increased concentrations of triglyceride-carrying lipoproteins (fat). — The most common reason for lipaemia is that the patient has not been fasted (artefactual)	A whole blood sample may be centrifuged once (to obtain serum or plasma) and tested; however, a suppression may still occur. — 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[3,4] — Alternatively, the sample can be sent to a commercial laboratory that has an ultracentrifuge if needed
Icterus 	ICTERUS is the excessively yellow pigmentation of the plasma or serum that suggests hyperbilirubinemia.[3] • Assess a sample visually for ICT, but the magnitude of hyperbilirubinemia should be confirmed with TBIL concentration	None, as ICT is NOT a sample handling issue but a disease process. — Contact Diagnostic Technical Support for help interpreting the troubleshooting report — Consider sending to a commercial laboratory that may be able to process the high level of icterus

RBC=red blood cell; TBIL=total bilirubin.

Define your lab testing minimum database[10]

Chemistry tests assess the function and condition of various body systems. Interpretation of chemistry test results should always be associated with the analysis of other sources of data, such as: patient's signalment, history, clinical signs and results of other diagnostic testing, especially haematology and urinalysis.



Faecal testing is part of a minimum database when medical history and physical examination are indicative of gastrointestinal disease and as part of a preventive healthcare screening depending on patient age and lifestyle.

Abnormalities in the blood cell counts and/or morphology can indicate presence of underlying disease and can sometimes be diagnostic.

Point-of-care infectious disease testing can complete a minimum database. Testing should be determined based on regional disease prevalence and patient lifestyle.

Several chemistry analytes are used to evaluate kidney function and hydration status. Urinalysis is critical to the evaluation of these analytes and determining whether any changes due to dehydration, kidney disease and/or lower urinary tract disease (eg, urinary tract infection) are present.

Baseline chemistry profiles

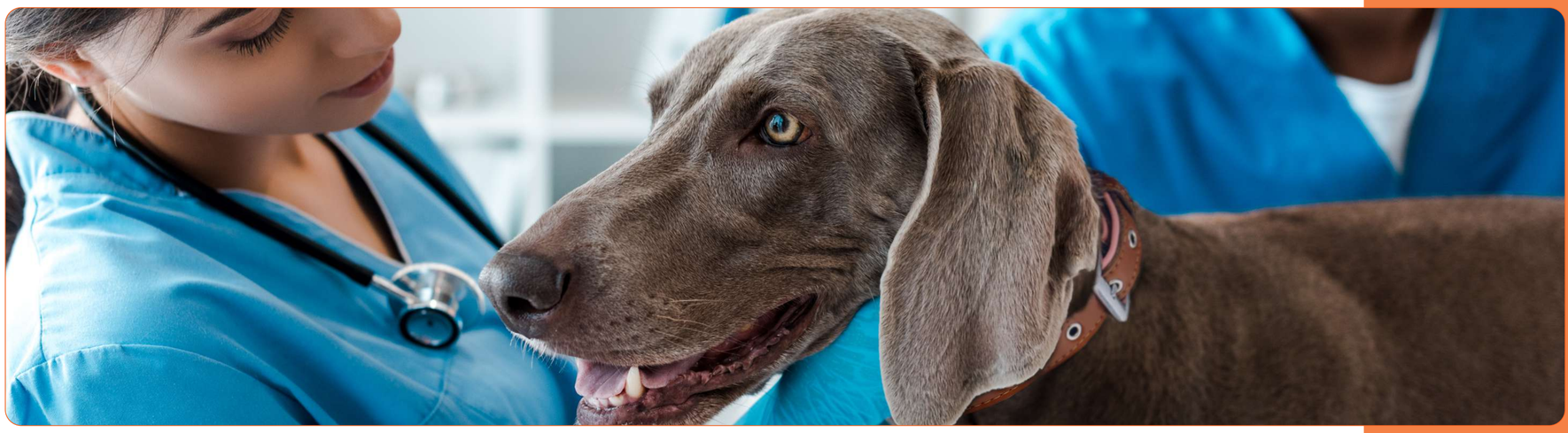
When performing a health or pre-anaesthetic screening or initially diagnosing a sick patient, a baseline panel is the best choice and should be combined with a complete blood count and urinalysis to complete the minimum database.

Baseline Profiles

Comprehensive Diagnostic Profile (CDP)

ALB, ALP, ALT, AMY, BUN, Ca, CRE, GLOB*, GLU, K^+, Na^+, PHOS, TBIL, TP

- Monitor hospitalised 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



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

*Calculated value.

Baseline chemistry profiles

When performing a health or pre-anaesthetic 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 pre-anaesthetic 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

ALP=alkaline phosphatase; ALT=alanine aminotransferase; BUN=blood urea nitrogen; CRE=creatinine; GLU=glucose; NSAID=nonsteroidal anti-inflammatory drug; TP=total protein.

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-, K^+, Na^+, TCO_2

Indications of Use

- Monitor fluid therapy for hospitalised or anaesthetised patients in routine or emergency situations

Case Examples

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

ALT=alanine aminotransferase; BUN=blood urea nitrogen; Cl-=chloride; CRE=creatinine; GLU=glucose; K^+=potassium; Na^+=sodium; TCO_2=total carbon dioxide.

Choosing the most suitable specific profile

Organ-specific Profiles

Kidney Profile Plus (KPP)

ALB, BUN, Ca, Cl-, CRE, GLU, K^+, Na^+, PHOS, TCO_2

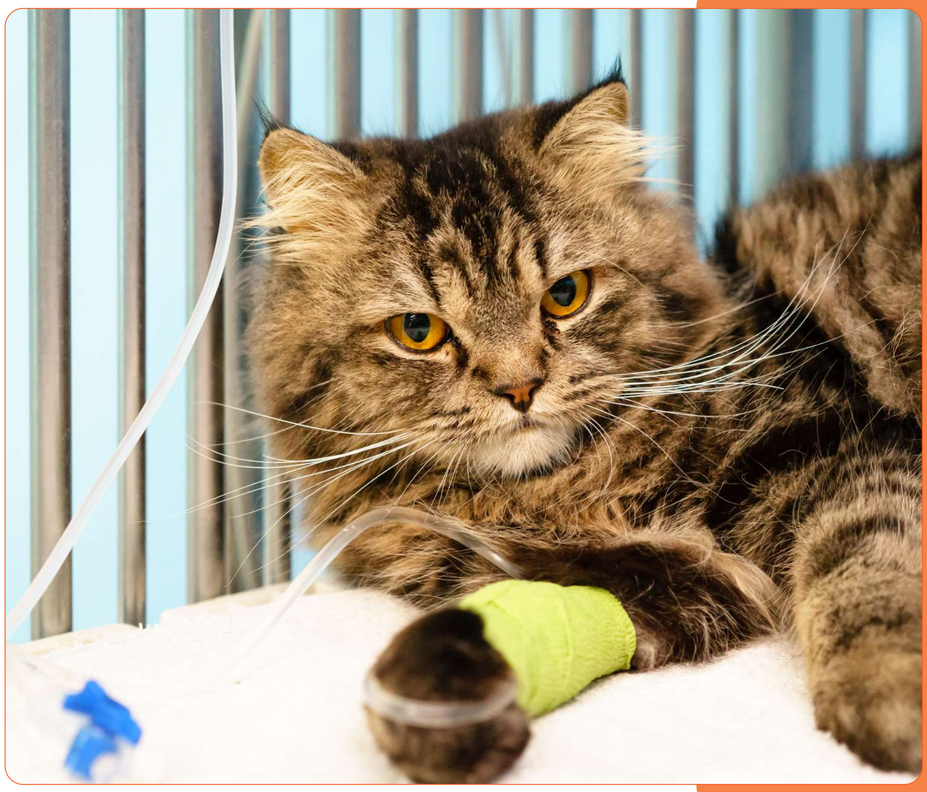
Indications of Use

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 anaesthesia



ALB=albumin; BUN=blood urea nitrogen; Ca=calcium; Cl-=chloride; CRE=creatinine; GLU=glucose; K^+=potassium; Na^+=sodium; PHOS=phosphorus; TCO_2=total carbon dioxide.

Choosing the most suitable specific profile

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 or PPII)
- Monitor elevated liver enzymes in otherwise healthy patient
- Monitor PSS post treatment
- Monitor chronic liver disease
- Monitor patient receiving chronic medications metabolised by the liver

ALB=albumin; ALP=alkaline phosphatase; ALT=alanine aminotransferase; BA=bile acids; BUN=blood urea nitrogen; CHOL=cholesterol; GGT=gamma glutamyl transferase; TBIL=total bilirubin.

Choosing the most suitable specific profile

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 behaviour 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[11]

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

Choosing the most suitable specific profile

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

ALB=albumin; ALP=alkaline phosphatase; ALT=alanine aminotransferase; AST=aspartate aminotransferase; BUN=blood urea nitrogen; GGT=gamma glutamyl transferase; PHB=phenobarbital; TBIL=total bilirubin.

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^+, Na^+, PHOS, TP, UA

Equine Profile Plus (EPP)

ALB, AST, BUN, Ca, CK, CRE, GGT, GLOB*, GLU, K^+, Na^+, TBIL, TCO_2, 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
CDP	Canine, equine, feline, ferret, rabbit	T4/CHOL	Canine, feline
KPP	Canine, equine, feline	PHB	Canine, feline
MLP	Canine, equine, feline	EPP	Equine
PPII	Canine, equine, feline	LAP	Bovine
EP	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 analyser 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^+=potassium; Mg=magnesium; Na^+=sodium; PHOS=phosphorus; TBIL=total bilirubin; TCO_2=total carbon dioxide; TP=total protein; UA=uric acid.

*Calculated value.

Using TCO_2[12]

Beyond the basic chemistry panel

The use of TCO_2 with chemistry and electrolyte results can often help narrow down a patient's differential list, especially when combined with anion gap

The measurement of TCO_2 is another way to measure bicarbonate, the body's buffer. A TCO_2 value outside the reference interval (range) is equivalent to a bicarbonate level outside the normal interval.

Simplified TCO_2 Interpretation

TCO_2 decreased = Consistent with metabolic **acidosis**

TCO_2 increased = Consistent with metabolic **alkalosis**

Profiles with TCO_2:

- **Electrolyte Plus (EP)**
- **Equine Profile Plus (EPP)**
- **Kidney Profile Plus (KPP)**

If TCO_2 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_2, HCO_3, anion gap, +/- base excess)
- Whether the patient could be treated based on TCO_2 alone if the cause for the abnormality is straightforward

When possible, interpret a low TCO_2 with Anion Gap=$(Na^+ + K^+) - (Cl^- + TCO_2)$

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_2 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_3 can affect the acid-base status of the patient.

HCO_3=bicarbonate; pCO_2=partial pressure of carbon dioxide; pH=potential of hydrogen; TCO_2=total carbon dioxide.

Profile selection

Common indications to consider:	Suggested profiles available:
Health screening: young adult/adult	CDP, PPII
Health screening: senior	CDP, T4/CHOL*
Anesthetic screening: young adult/adult	CDP, PPII
Anesthetic screening: senior	CDP
Screening a sick patient	CDP
Monitoring fluid therapy	EPP, KPP
Monitoring renal patient	CDP, KPP
Diagnosing and monitoring hepatic patient	CDP, MLP, PHB†
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.

Responsible Patient Trending

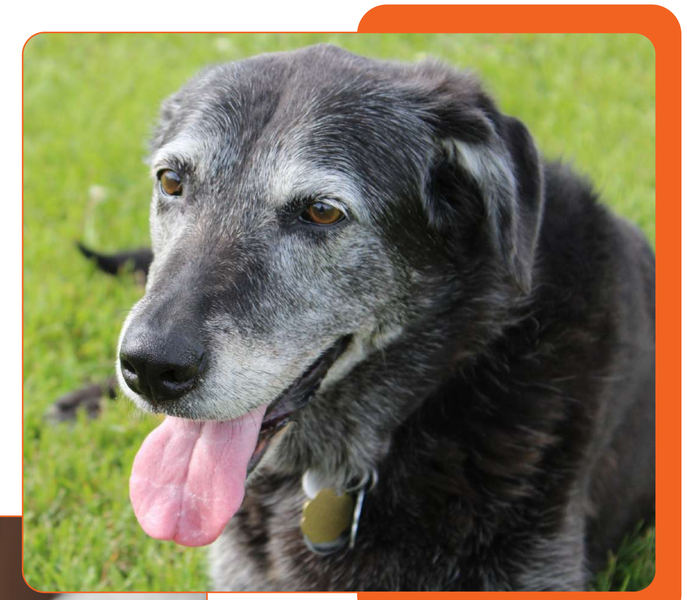
Responsible Patient Trending—**why perform**?

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[4]
  - 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[13]
- For these reasons, individual patient trending is more sensitive and better at detecting pathological changes than reliance on published reference values for chemistry and haematology[14]

Senior patients

- The common occurrence of physical exam and laboratory abnormalities in apparently healthy senior dogs and cats emphasises the need for regular health screening, including regular laboratory testing[15,16]
- 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 twice yearly 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[17]



Responsible Patient Trending

Keys to patient trending success

The best practice is to monitor a patient on the same analyser 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:

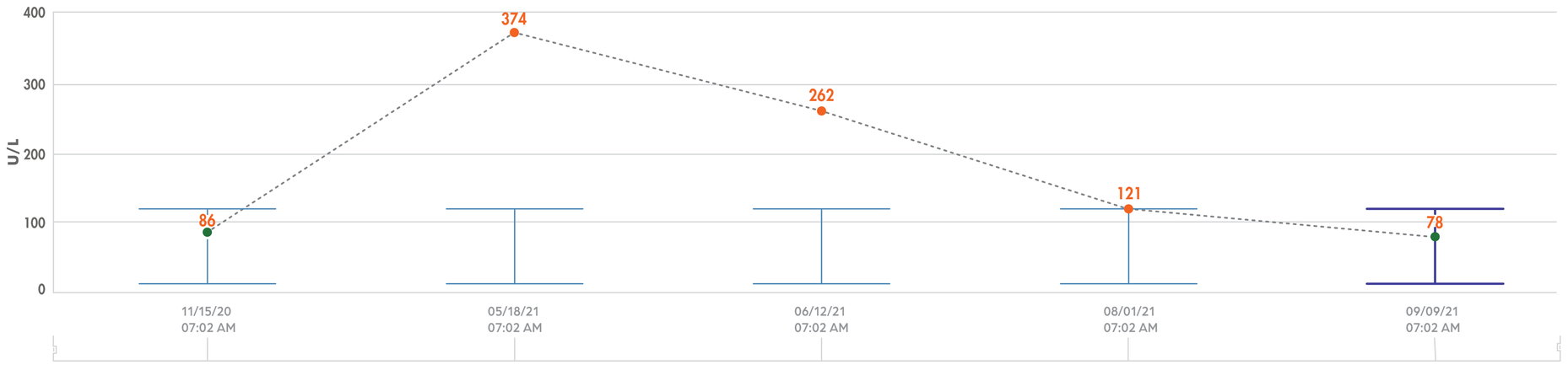
- Using the same analyser every time, where possible
- Performing the test in the same way (how many hours post treatment, fasted, etc)
- Keeping in mind that different assays and instruments have reference intervals that may differ among analysers and/or labs
- Performing a quality check or verifying 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.**

Test	Ref Range	Units	Graph	11/15/20 07:02 AM	05/18/21 07:02 AM	06/12/21 07:02 AM	08/01/21 07:02 AM	09/09/21 07:02 AM
ALB	2.5-4.4	g/dL		3.5	3.6	4.1	3.7	4.4
ALP	20-150	U/L		29	191*	164*	115	30
ALT	10-118	U/L		86	374*	262*	121*	78

Responsible TRENDING™



Note: It is imperative when comparing results between different analysers 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

- 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)[18]							
	CANINE	FELINE	EQUINE	BOVINE	RABBIT	AVIAN	FERRET	Units
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†	2.3 - 5.2	1.5 - 5.7	2.7 - 5.0	4.0 - 5.5	1.5 - 4.6‡	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^+	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^+	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_2	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.

†Calculated value.

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

Reference Intervals

Analyte	Species (SI units)[16]							
	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†	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^+	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^+	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_2	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.

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.

*Calculated value.

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

References

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. **6.** Allison RW. Laboratory evaluation of the pancreas and glucose metabolism. In: Thrall MA, Weiser G, Allison RW, et al., eds. *Veterinary Haematology 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/. **18.** Data on file, VTS-00038, Zoetis Inc.

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