How advances in point-of-care testing have improved veterinary patient care

Access to in-house diagnostic equipment is essential to modern veterinary practice. Point-of-care testing is performed at, or near, the site of patient care by specially trained, non-laboratory healthcare professionals. Point-of-care testing has a quick turnaround time, which can aid clinical decision making. This article looks at recent advances in point-of-care testing.

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Point-of-care testing is performed at, or near, the site of patient care by specially trained, non-laboratory healthcare professionals (The Leeds Teaching Hospitals, 2024), rather than at the conventional reference laboratory (Flatland et al, 2013). In the veterinary field, point-of-care testing is also known as 'animal-side' or 'flock-side testing' (Velayudhan and Naikare, 2022), depending on the species.

Access to in-house diagnostic equipment is essential to modern veterinary practice. Historically, practices had access to a limited test portfolio, including urine dipsticks, packed cell volume, total protein and blood glucose measurements (Giger, 2010). Conversely, it is now commonplace to offer a vast array of point-of-care tests that aid patient care, decision-making and client peace of mind. Demand for point-of-care testing is increasing as a result of increased pet ownership and advances in test availability and reliability, and this market is predicted to grow by 11.5% between 2023 and 2030 (Grand View Research, 2023).

With advances in technology and diagnostic capabilities, point-of-care testing has grown from basic haematological and biochemical profiles to include more comprehensive blood chemistry and blood smear analysis, testing for specific infectious diseases, blood gas analysis and assessment of cytology, fluids and effusions, urine (IDEXX, 2023), and faeces (Zoetis, 2023; Antech, 2024). Increasingly, point-of-care testing is preferred over external laboratory tests, especially in emergency or critical patients – where waiting until the next working day (or longer) for results that inform treatment decisions could have serious negative effects on patient outcomes.

What are the benefits of point-of-care testing?

One of the main benefits of point-of-care testing compared to using a reference laboratory is a quick turnaround, which aids with time-pressured decision-making and helps ensure that the patient receives the appropriate care as quickly as possible (Mandray, 2019; Velayudhan and Naikare, 2022). Avoiding delays improves patient outcomes, and while point-of-care testing may not always give a definitive diagnosis, it can help triage patients and exclude diagnoses, provide baseline parameters or monitor patients on long-term medication or with chronic health conditions. Importantly, quick results help strengthen the client–vet bond, allowing prompt communication of results and treatment options and reducing client stress and unnecessary follow-up communications (Giger, 2010). Showing clients their pet's blood results as evidence of their condition can improve client compliance as they feel involved in decision-making (Fender, 2020).

The convenience of point-of-care testing offers many impactful benefits in practice. For example, patients may have blood taken on the morning of a scheduled procedure, with the results used to adjust the anaesthetic protocol or surgical technique to improve safety and reduce risk. The proximity of point-of-care testing equipment also minimises the risk of sample artefactual changes caused by storage, transport or delayed processing (Giger, 2010).

Point-of-care testing is usually cheaper for the client than the reference laboratory and, when used appropriately, can reduce unnecessary treatment and the associated costs (Stewart, 2021). With more companies offering point-of-care testing equipment, test availability has broadened

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(Urbina, 2023) and the associated equipment costs are increasingly competitive. The analysers are also easy to use (Velayudhan and Naikare, 2022), minimising lost revenue during team training.

What is new in the field of veterinary in-house diagnostics?

The dominant companies in the point-of-care testing sector – IDEXX, Zoetis, and Antech – have each launched new in-house diagnostic equipment in the last five years (Grand View Research, 2023). The theme that stands out in the technological advancements of point-of-care testing is the use of artificial intelligence, which has aided in the in-house analysis of various sample types, from fluid cytology and blood smear assessment to urine sediment and faecal analysis.

Haematology

Although testing samples closer to the patient reduces the risk of artefact (Giger, 2010), historically, haematology results have been unreliable, and errors were still common even with technological advancements. Therefore, manual blood film assessment by a specialist at the reference laboratory or in-house was preferred.

Recent improvements in quality control and calibration protocols mean that point-of-care haematological tests are of increasing clinical value, with IDEXX describing their ProCyte Dx analyser as providing 'reference laboratory-quality results' (IDEXX, 2023). Antech's element HT5+ analyser also showed an excellent correlation in a group of animals tested using two different technologies (Antech, 2024).

In addition to accurate red blood cell, platelet and white blood cell numbers, modern haematology testing can provide information on morphology and separate similar cell types. The incorporation of artificial intelligence into haematological analysis (for instance, with the Vetscan Imagyst; Zoetis, 2023) adds additional accuracy and clinician confidence, with the option to have prepared slides assessed remotely by board-certified pathologists, as offered by AntechView Telecytology (Antech, 2024). However, the IDEXX inVue Dx Cellular Analyser uses multidimensional interrogation and fluorescence to provide deeper cytological insights without slide preparation (IDEXX, 2023).

In practice, comprehensive results showing agglutination, spherocytes, nucleated red blood cells (Müller et al, 2014) and clumped platelets, in addition to standard red blood cell and platelet counts, can help support diagnosis and decision-making in anaemia or haemorrhage cases, ensuring quick treatment. Activated clotting time, prothrombin time and activated partial thromboplastin time, which are also available in-house (Antech, 2024), allow quick assessment in those with suspected rodenticide toxicity and other coagulopathies.

With in-house technology now able to reliably differentiate band neutrophils and identify toxic change and bacteria in various samples, significant bacterial infections (Leal et al, 2023) and inflammatory conditions can be diagnosed rapidly, facilitating intervention before more serious complications. While culture and sensitivity testing will still influence antimicrobial choice and therapy may change based on these results, initial confirmation of a bacterial infection allows early intervention with a first-line antibiotic in cases where a treatment delay is inappropriate.

Cytology

Up-to-date cytology equipment can now process other sample types. Effusion analysis allows a rapid understanding of composition and subsequent diagnosis or exclusion of conditions such as peritonitis, neoplasia and bacterial infection, without the long wait for external assessment. Similarly, quick interpretation of fine needle aspirate samples means that a lump sampled during a morning consult could be treated surgically the same afternoon.

Blood chemistry

Although not a new technology, point-of-care blood gas analysis is increasingly available in veterinary practice (Proulx, 1999), with options including the VetStat (IDEXX, 2023) and Element point-of-care (Antech, 2024). Analysers allow rapid assessment of respiration effectiveness and metabolic issues using acid–base, electrolyte and lactate measurements from small quantities of whole blood. While capnography and pulse oximetry have a place in patient monitoring, blood gas analysis offers superior reliability and context to the results (Proulx, 1999). While elevated lactate is not diagnostic, it has real benefits as a marker of inadequate oxygenation, triaging patients and early decision-making (EKF Diagnostics, 2024), particularly with repeated measurements used to track treatment progress and predict outcomes. However, a lactate value within the reference range is a more reli-

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KEY POINTS

- Point-of-care testing is performed at, or near, the site of patient care by specially trained, non-laboratory healthcare professionals instead of in reference laboratories.
- Point-of-care testing can speed up treatment for patients and avoid unnecessary delays.
- Artificial intelligence is increasingly being used as part of newer point-of-care testing.

able predictor for case survival than a raised lactate is for predicting death (EKF Diagnostics, 2024). Despite lactate being non-diagnostic, blood gas analysis results can point to certain conditions, including hypoadrenocorticism and diabetic ketoacidosis, and are valuable for directing the choice of fluid therapy (IDEXX, 2023).

One advancement in the scope of point-of-care biochemical testing is the availability of ionised calcium. The availability of this test and the fact that it uses a small volume of blood is hugely beneficial. Previously, specific sample collection and transportation requirements involved minimising contact with air and keeping the sample refrigerated, and there was an extended wait for results. Magnesium is also more widely used in critical patient monitoring and assessment of gastrointestinal and kidney disease (VetConnect PLUS, 2013).

To complement existing biochemistry profiles, symmetric dimethylarginine and C-reactive protein are now also available in-house (Fender, 2020), allowing rapid comprehensive results without waiting for the 'complete picture' provided by external testing. As a marker of inflammation, C-reactive protein holds value in screening at initial patient presentation; because the levels change quickly, it allows more detailed monitoring of patients during treatment (Mandray, 2019).

SNAP tests

SNAP tests are also improving the speed at which we can initiate specific treatment, for example, for pancreatitis using cPLI and fPLI, and for infectious diseases such as leptospirosis, *Giardia* and *Brucella* (although samples from potential *Brucella* cases should be tested at the Animal and Plant Health Agency). As well as directing early treatment, SNAP tests can also assess antibody titres, reducing unnecessary vaccination.

Urinalysis

Urinalysis, including dipstick, specific gravity and microscopy, can be valuable during the initial patient assessment. As with many advancements in point-of-care testing, state-of-the-art in-house equipment, including the SediVue Dx (IDEXX, 2023), element AIM (Antech, 2024) and Vetscan Imagyst (Zoetis, 2023), uses artificial intelligence to analyse urine sediment, reducing time spent on manual interpretation and freeing up veterinary staff for other tasks. While there are general concerns regarding the reliability and accuracy of automated testing, one study demonstrated that automated testing was more precise than manual interpretation by veterinary students, nurses and surgeons, especially in large teams (Ferreira et al, 2018). These advanced urinary sediment analysers can rapidly identify crystals, red and white blood cells, casts and bacteria, aiding the diagnosis and management of urinary tract conditions (Zoetis, 2023).

Faecal analysis

The artificial intelligence theme continues in faecal testing, with an extensive database of images to which each sample is compared (Fender, 2020). The Vetscan Imagyst (Zoetis, 2023) identifies faecal parasites at all stages, including *Giardia*, *Cystoisospora*, *Eimeria*, roundworms, hookworms, whipworms and tapeworms, with the Element AIM (Antech, 2024) having a similar identification ability, without the need to prepare slides.

Limitations and outlook

Advancements in technology, particularly artificial intelligence, mean that speed, accuracy, reliability, affordability and overall use of point-of-care testing have increased. Many analysers are multi-purpose, assessing various sample types, which improves affordability.

Despite improvements, point-of-care testing technologies are still considered inferior to the equipment used in reference laboratories, because of inadequate regulatory requirements (Velayudhan and Naikare, 2022) and smaller companies being unable to evaluate their quality effectively (Urbina, 2023). However, standard operating procedures, operator training and statistical and external assessment tools can improve reliability (Flatland et al, 2013; Breheny et al, 2019).

While the use of artificial intelligence may cause concerns, many of these services have board-certified pathologists available to confirm artificial intelligence interpretation, which should reassure users during this novel period.

Conclusions

Overall, veterinary patients benefit from earlier interventions and better care with the broader scope of point-of-care testing now available.

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Advertorial

Don't sweat about monitoring body temperature... because there's no such thing as **normal.**

By Michelle Townley BVM&S MRCVS,
Veterinary Advisor, MSD Animal Health

Have you ever stopped to consider how you came to decide what a **normal** body temperature is for your patients? Or noticed that what you would consider to be a temperature in the pyrexic range is **different** to that of your colleagues?

How can you be certain that your interpretation of a body temperature measurement in a dog or cat is accurate for that particular individual?

It may come as a surprise to you to know that what most veterinary professionals may consider as a normal reference range for body temperature is based on little robust evidence-based veterinary literature[1]!

In fact, normal body temperature is poorly defined in the veterinary literature.

The expectation for a reference range is that a suitably large population has been used with a robust statistical analysis performed to determine a "normal" range, with 95% of that population sitting within it. The reality is that reference ranges stated in textbooks often fail to state their primary source, which makes it impossible to know the size or demographics of the population used, or whether the range was statistically calculated[1] (see Table 1).

Based on this how can we be sure that the reference range quoted is accurate or applicable to the patient in front of us?

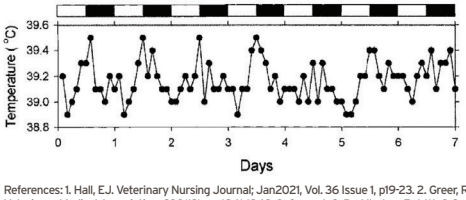
Table 1. A "normal" reference range for cats doesn't exist as demonstrated by the variable reference ranges shown in the table below from several different sources.

Normal reference intervals in cats	Publications
37.8 - 39.2°C	Khan CM and Line S. The Merck Veterinary Manual. White House station, NJ: Merck and Co, 2010, p. 2822 Smith VA et al. comparison of auxiliary, tympanic membrane and rectal temperature measurements in cats. J Feline Med surg. 2015
37.8 - 38.9°C	Hartman K and Levy JK. Feline Infectious Diseases. London: Manson publishing, 2011, p. 215
37.2 - 39.2°C	Shojai AD. The First Aid Companion for Dogs and Cats. Emmaus, PA: Rodal, 2001, p. 248
38.0 - 38.5°C	Lane DR and Guthrie S. Dictionary of Veterinary Nursing. Second edition. Edinburgh: Elsevier, 2004, p. 201
38.1 - 39.2°C	Frederichs K, Barnhart K, Blanco J, et al. Guidelines for the determination of reference intervals in veterinary species and other related topics. Wayne, PA: Clinical and Laboratory Standards Institute, 2008

Does a normal temperature exist?

Added to this complication is the fact that body temperature is not a constant. Body temperature, in common with most essential physiological functions such as heart and respiration rate, blood pressure, sleep/wake cycle etc., also follows a circadian rhythm. A 2003 study[8] demonstrated this for the first time in 7 female beagle dogs, where rectal temperature was measured every 2 hours for 1 week under rigorously controlled conditions (ambient temperature, lighting, exercise and diet). Interestingly the mean rectal temperature in this study was 39.1°C, which is 0.2°C above the body temperature (38.9°C) generally considered "normal" in dogs. The data from all seven dogs supported the same conclusions: body temperature started to increase immediately after feeding and lasted until lights-out, 8 hours later (see Figure 1). Feeding was not the cause of the day-long increase in body temperature. Given that the environmental conditions were strictly controlled the only cause for the change was endogenous.

Figure 1: The graph demonstrates how the circadian rhythm affects body temperature. This is a representative record of the body temperature of a dog over 7 consecutive days. The data points correspond to 2-hour bins. The white and black bars above the graph indicate the duration of the light and dark phases of the light-dark cycle (Refinetti R and Piccione g., 2003).



Individual physiological factors also contribute to variation in an individual's body temperature and include breed[9], age[9], sex[9,10], body condition[9], level of activity[11] and stress levels[12].

Given the level of individual variation surely it would make sense to get an understanding of an individual pet's temperature range in order to interpret body temperature measurements accurately?

"Gold standard" temperature monitoring

To measure true core temperature either blood temperature, urinary bladder temperature or oesophageal temperature must be measured. However, these methods are invasive and impossible to utilise in the conscious patient.

Rectal thermometry remains the "gold standard" for temperature measurement based on its good correlation with core body temperature[2] and familiarity within the veterinary profession, **however this method isn't without its drawbacks or inaccuracies**. It can be stressful and not always well tolerated in conscious animals[3-5]. Rectal temperature measurements can be affected by faecal material, rectal inflammation, thrombotic conditions[6], peristalsis, muscle tone, physical activity[2], and even just by having the thermometer inserted at an insufficient depth. It can also be the cause of cross-contamination of rectal bacterial flora[7].

An alternative method avoiding these drawbacks is available – and it is as simple as reading a microchip.

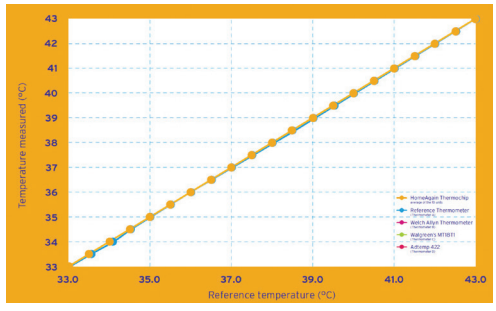
HomeAgain® Thermochip® is a microchip with a difference, as it also has an integrated temperature biosensor. Obtaining a temperature reading is then as **easy as scanning the microchip** with a compatible scanner, such as the SureSense® Universal microchip reader or the Global Pocket Reader® Plus. **As the temperature is measured in the subcutaneous space (where the microchip is implanted) it does not read the same temperature as a rectal thermometer - so these two methods cannot be directly compared.** However, given this method is easier, less invasive and can be performed repeatedly it is simple method to ascertain an individual's temperature reference range.

Reliability and accuracy

HomeAgain Thermochip is just as reliable and accurate as your trusty digital rectal thermometer, as an independent laboratory study demonstrated[13]. This study compared the temperature readings of 10 HomeAgain Thermochips with 4 digital thermometers placed in the same temperature-controlled conditions between 33°C and 43°C at 0.5°C intervals and confirmed the reliability and accuracy of HomeAgain Thermochip (see Figure 2).

A study investigating the correlation of temperature-sensing microchip and rectal temperature measurements in cats has recently been published[15]. The study aimed to determine the agreement between subcutaneous temperature measurements obtained from a microchip (MT) and rectal temperature measurements (RT) in normal, hospitalised, and sedated/anaesthetised cats.

Figure 2: Temperatures collected by HomeAgain Thermochips were as reliable as those taken by 4 digital thermometers between 33°C and 43°C in 0.5°C intervals under the same temperature-controlled conditions[13]



This study included 120 cats previously implanted with a temperature-sensing microchip (HomeAgain Thermochip Mini, MSD Animal Health). Three measurements were taken using both methods in each cat. The correlation and differences between MT and RT were measured and analysed.

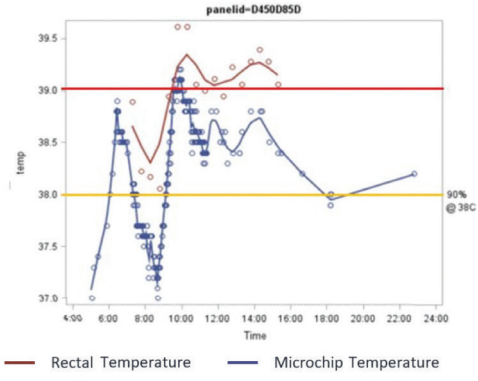
The results showed a strong positive correlation between MT and RT in all three groups of cats (normal, hospitalised, and sedated/anaesthetised). The correlation coefficient (r) ranged from 0.7 to 1.0, indicating a high degree of association between the two methods. The coefficient of determination (R^2) ranged from 0.5 to 0.9, suggesting that a significant proportion of the variance in RT could be explained by MT.

The mean differences (average biases) between MT and RT were always negative, indicating that MT tends to be slightly lower than RT. However, these differences were statistically significant but likely of no biological importance. The overall mean difference was -0.1°C in all three groups of cats. The 95% limits of agreement between MT and RT were within an acceptable range, ranging from -0.71°C to 0.53°C in normal cats, -0.51°C to 0.34°C in hospitalised cats, and -0.60°C to 0.42°C in sedated/anaesthetised cats.

Based on these findings, the study suggests that subcutaneous microchip temperature measurement could be a good alternative to rectal temperature measurement in cats, and this type of microchip would make measuring temperature easy, fast, safe, and less stressful for both the cat and the veterinary team.

The ability to detect a fever is obviously an important factor when considering a different method of recording temperature, and the HomeAgain Thermochip is very capable of picking this up. In an unpublished study HomeAgain Thermochip was able to detect the same physiological fever patterns as rectal thermometry. In this study[14] 10 Beagle dogs were given an intravenous injection of lipopolysaccharide and their temperatures were monitored 4 to 8 hours after the injection to record the febrile response. Rectal temperatures were taken every 30 minutes and the HomeAgain Thermochip was scanned every 5 minutes. Following fever induction, 2,721 temperatures were collected from the 10 dogs, with the greater majority measured using HomeAgain Thermochip. The challenge response was unique for all dogs but was characterized by an initial decrease in temperature (vasoconstriction) followed by a gradual increase to peak temperature demonstrated by both rectal and HomeAgain Thermochip temperature monitoring following a similar shaped curve (Figure 3).

Figure 3. Graph demonstrating the febrile response pattern to intravenous lipopolysaccharide as monitored by rectal thermometry and Thermochip. Both temperature monitoring methods follow a similar shaped curve.



Although our reliance on rectal thermometry will not be disappearing anytime soon having an alternative temperature recording method which is reliable, accurate, easy, non-invasive and doesn't distress the patient may encourage us to change our established routines. Especially if this method allows us to obtain an individual pet's reference range from which we can interpret temperature variations correctly.

The HomeAgain® Thermochip® microchip can already be used for various clinical applications, including as a screening tool or as part of the clinical examination, monitoring temperature during anaesthesia, surgery and the post-operative period, or for hospitalised patients, particularly those that need regular temperature monitoring.

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