

New & Emerging Biomarkers in Preventative Care: The Monitored Pet

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Glossary of abbreviations

[CVD] cardiovascular disease

[BMI] body mass index

[BP] blood pressure

[CGM] continuous glucose monitors

[SPO2] peripheral oxygen saturation

[IRIS] International Renal Interest Society

[CKD] chronic kidney disease

[PPV] positive predictive value

[LSA] lymphosarcoma

[HAS] hemangiosarcoma

[CBC] complete blood count

[DTC] direct-to-consumer

[SDMA] symmetric dimethylarginine

Why Run Tests?

Veterinarians have a vast and always-expanding array of tests available to run on our patients. In this “Information Age,” it is easy to get caught up in the enthusiasm for collecting information. It is also easy to forget that information has no intrinsic value. Its value is in what it allows us to understand and to accomplish. And because information shapes our understanding and our choices, it has the potential to do harm as well as good if we are not mindful in choosing what information to collect, how to interpret it, and how to integrate it into our understanding and our decisions. Though it may sound almost blasphemous in this moment to say, more information is not always better.

The goal of any test we run should be obtaining information that allows us to more effectively treat or prevent health problems in our patients.(McKenzie, 2021) This seems obvious, but it is all too easy to lose sight of this core aim. We may feel obligated, often by nebulous but psychologically compelling notions of a “gold-standard,” to run tests that confirm our understanding of a patient’s state of health even when our level of confidence is already high and the outcome of the test will not change what we recommend or what the client chooses to do. We may employ tests because of a perceived pressure from clients to do something!” or provide reassurance, even when this is unlikely to change the outcome for the patient. In some situations, we may be completely confused and run multiple lab tests indiscriminately,

hoping for some insight to emerge. And, if we are honest, we may be influenced by the role of laboratory testing as a source of revenue, for us and for companies developing and promoting the tests.

Unfortunately, these practices reduce the reliability of the tests we employ and increase the risk of harm to patients and clients, as well as the cost of care. Effective use of tests requires a deliberate and informed approach. We must consider the strengths and weaknesses of the tests themselves and the specific clinical context, and we must be wary of the many biases that skew our selection and interpretation of tests.(McKenzie, 2014, 2021)

Diagnosis, Screening, and Monitoring

Biomarkers are commonly defined as something “that is measured as an indicator of normal biological processes, pathogenic processes, or biological responses to an exposure or intervention, including therapeutic interventions.”(FDA-NIH Biomarker Working Group, 2016) The most common use of biomarkers is to identify and confirm the presence of disease.

Laboratory tests alone are, of course, rarely sufficient for a definitive diagnosis. They are used in a context that includes the totality of our information about the patient: signalment, history and clinical signs, physical examination findings, etc. The most effective use of tests as an aid in diagnosis is to incorporate them into a process of Bayesian reasoning.(Khan & Freeman, 2022; Timsit et al., 2018) We begin with an estimated probability of potential diagnoses based on the information we have, and we select tests that provide information to shift that probability until we reach a level of confidence sufficient to confirm or exclude each possible diagnosis.

Screening is the application of tests to patients without clinical signs or any other indication of illness in order to detect occult disease.(McKenzie, 2021) This is inherently riskier than using tests as an aid in diagnosis because the prevalence of any condition is likely to be lower in a population with no signs of disease. Due to the statistical properties of how tests are validated and interpreted, this raises the risk of misdiagnosis (the diagnosis of a disease that is not actually present) and overdiagnosis (the diagnosis of a disease that is present but will never cause actual harm to the patient)(McKenzie, 2016). It is critical then, when performing screening, to have a pre-specified plan for judicious use and interpretation of tests, for effective client communication, and for detecting and mitigating the harm caused by misdiagnosis and overdiagnosis.(WHO Regional Office for Europe, 2020)

Monitoring is the use of tests not to diagnosis clinical disease or screen for subclinical disease but to understand the current health state of a patient, predict the future health state, and guide interventions to preserve health and wellbeing. To be effective, monitoring must employ tests that meet numerous intrinsic criteria (Figure 1) and that are supported by a body of evidence that validates not only the performance of the tests but the likely changes in health state over time and the impact of our preventative interventions.

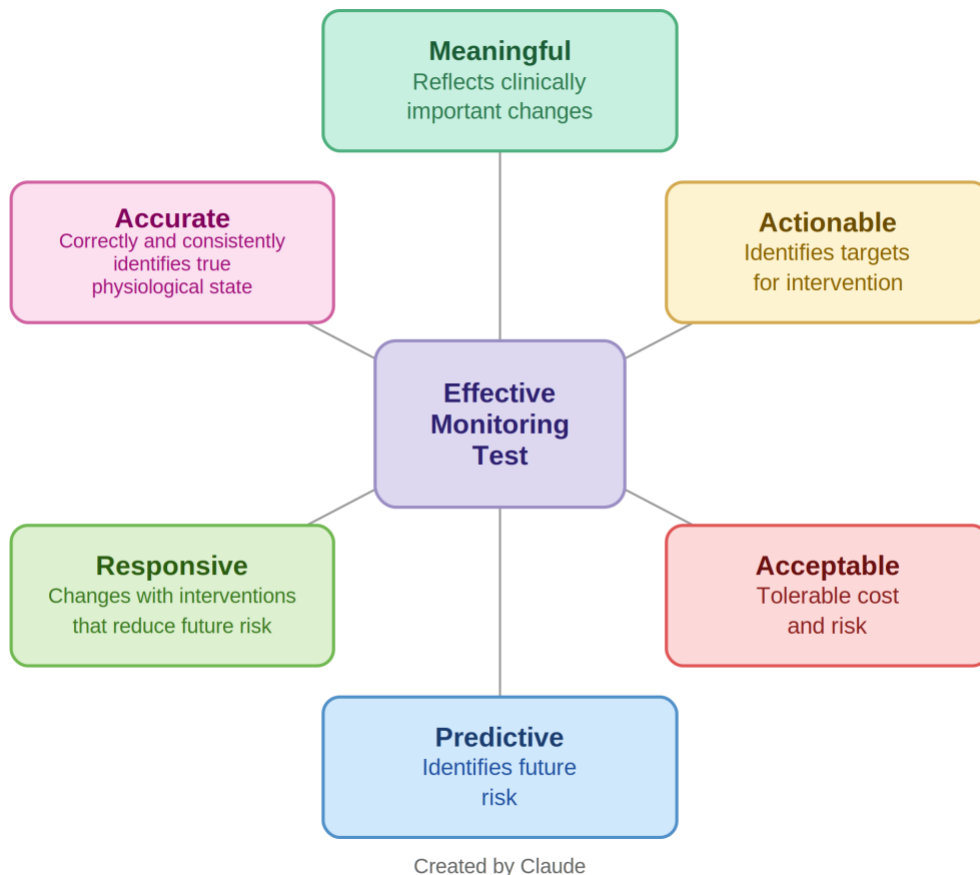


Figure 1. Necessary criteria for effective monitoring tests.

Whenever we employ a biomarker assay to monitor a healthy patient, we should attempt to answer the following questions, for ourselves and for our clients:

- What will I know about the pet after the test that I don't know now?
- How will I use that information?
- What are the risks and costs of gathering that information?
- What evidence is available to evaluate the test, and what degree of confidence can I have in the accuracy and meaning of the results?
- What evidence and what degree of confidence is available to support the actions I might take in response to this information?
- What else could I do (including doing nothing)?

The Monitored Human

Primary prevention efforts in human health, including using biomarker monitoring to identify risk and guide preventative medicine, are better established and have a larger body of supporting evidence than in veterinary medicine. The insights and the pitfalls that have emerged in this domain, can be informative for our profession in developing monitoring strategies for pets.

The most evidence-based preventive monitoring strategies involve some of the most common causes of morbidity and mortality in aging humans, such as CVD. Tests to identify risk and guide preventative interventions before overt disease is manifest are widely used and proven to be effective.

For example, excess adiposity, unhealthy blood pressure, and elevated blood lipids are all variables shown to indicate increased future risk for CVD, and all can be modified to reduce this risk. Specific tests and cutoff values have evolved over time to optimize the value and minimize the risk of testing and interventions in currently health humans. While BMI has long been the main test for excess adiposity, anthropometric assessments such as waist circumference are becoming more common.(Sweatt et al., 2024) In the 1970s, blood pressure was often considered normal if under 160/105, while now targets are much lower, and a healthy BP is typically believed to be under 130/80.(Moser, 2007) The understanding of actionable blood lipid levels has also changed as the value of controlling dyslipidemia in primary prevention of CVD is increasingly recognized.(Blumenthal et al., 2026)

There is also a profusion of novel monitoring options for healthy humans: wearables that track activity and physiologic variables, such as heart rate and SPO2(Gu et al., 2026); continuous glucose monitors (CGM)(Holzer et al., 2022); panels of multiple clinical laboratory values analyzed as a unit, such as PhenoAge(Levine et al., 2018); epigenetic analysis and full genome sequencing; and a variety of biological age clocks based on a mixture of all of the above. The goals are to inform preventative medicine efforts aimed at preventing specific diseases and slowing the deleterious impact of aging processes and to give people more insight and agency regarding their own health.

There is both great enthusiasm and significant controversy about the impact, beneficial or harmful, of these tools, particularly when they are offered directly to the consumer, without the advice and guidance of a physician.(Ho et al., 2026; Orth et al., 2025) There is a lot of money to be made in marketing such tools, which influences the research and the discussion of such methods. The marketing is typically far ahead of the scientific evidence.

In theory, for example, CGM can provide dietary guidance to support long-term metabolic health(Klonoff et al., 2023). In practice, however, there is little evidence that monitoring blood glucose and adjusting diet to minimize glucose spikes has meaningful impact on long-term health in people without diabetes.(Ahmed et al., 2025)

Epigenetic clocks can reassure us if our biological age measures lower than our chronological age, or instill anxiety if the reverse is true. But does knowing this change behavior in a way that actually extends our healthspan? Associations between a biomarker and health outcomes does not automatically mean that monitoring and acting on that biomarker improves these outcomes.

Microbiome testing and a variety of “wellness panels” are also promoted to give consumers control of their health. However, there are serious questions about the validity and utility of these tests. There is also significant potential for harm to patients from any action taken based on inaccurate results or findings interpreted without appropriate context and evidence.(Hoffmann et al., 2025)

For most biomarkers promoted to measure the impact of aging or support preventative interventions to maintain health, explicit evidence demonstrating this is absent. While the rationales for many of these tools are plausible, and early evidence is promising, longitudinal data showing that utilizing them to guide lifestyle or pharmaceutical interventions extends healthy lifespan is universally absent. Not all of our key

questions have been satisfactorily answered for any of the numerous self-monitoring strategies commercially available for humans.

The Monitored Pet

Similar tools and strategies for healthy pets have been suggested, though there is less emphasis on monitoring and more on screening. Routine clinical laboratory tests, such as a CBC, chemistry panel, urinalysis, and others, are commonly recommended for senior dogs and cats.(Creevy et al., 2019; Dhaliwal et al., 2023; Quimby et al., 2021) These are mostly focused on early detection and treatment of occult disease.

However, the IRIS guidelines for staging and managing CKD do arguably include a monitoring component. Stage 1 is defined in terms of risk factors, including elevated BP and urine protein levels, and renal biomarkers, creatinine and SDMA, which are still within the reference range but trending upwards, indicating elevated risk of future disease. There is also some evidence that intervention, specifically dietary therapy, can slow progression and delay mortality due to CKD, though the true effectiveness of comprehensive primary prevention strategies is still unknown.(Coyne et al., 2026; Hall et al., 2018)

Conventional clinical laboratory measures have also been used to create a tool for assessing biological age, the impact of aging on the resilience, health, and function of an individual. This tool can predict mortality prior to the onset of any detectable disease, and it can demonstrate the impact of lifespan-extending interventions, such as caloric restriction, even when individual lab values remain within reference intervals.(Herzig et al., 2024) The clinical value of the tool has yet to be evaluated.

Other such biological age “clocks” have also been tested to show particular biomarkers can predict future mortality risk in dogs. Clocks based on epigenetic changes, such as DNA methylation, can predict future mortality hazard.(Horvath et al., 2022; McCoy et al., 2024) There is also interest in the prospect of broad-omics analyses, evaluating proteins, metabolic end products, lipids, and other biomarkers, as biological clocks in pets.(Harrison et al., 2024; Koch et al., 2025) Such tools have shown predictive power in humans, for mortality and morbidity, though none have yet been validated to show long-term beneficial response to interventions in healthy individuals of any species.

The field of geroscience (the study of the biology of aging) also provides other examples of biomarker monitoring opportunities. It has been shown, for example, that certain markers of metabolic health, such as serum insulin, adiponectin, and blood lipids, are associated with lifespan and the risk of aging-associated diseases in dogs, and also with measures of wellbeing, such as frailty and quality of life(McKenzie et al., 2025). These associations are present even when the absolute values of these biomarkers remain within the reference interval, indicating that patterns of change over time can be meaningful and predictive even if they are not indicative of a defined disease state.

Interventions that can extend healthy lifespan, such as caloric restriction, also impact these measures of metabolic health. Dogs fed a lifelong caloric restriction diet not only lived longer and showed delayed onset of aging-related diseases than dogs fed a control diet, they also showed improved insulin sensitivity and lower circulating insulin levels, which indicated the intervention mitigated the negative impact of aging on metabolic health.(Lawler et al., 2008)

This raises the possibility that a “metabolic health panel” comprised of relevant biomarkers could predict future mortality and morbidity hazard in currently healthy dogs and could also demonstrate changes

consistent with improved metabolic health, and lower future risk, if appropriate interventions were employed. The exact composition of such a panel, and its real-world clinical value, remain to be demonstrated, but this is an example of the future potential for using biomarkers to assess both current health state and future risk and then to reflect the changes caused by interventions intended to preserve health and prolong healthy lifespan.

Novel biomarkers are appearing rapidly, such as “liquid biopsy” tests to identify occult neoplasia. The utility of these tests depends on the extent to which they meet the criteria in Figure 1, and on the evidence showing that our responses to the results are meaningfully beneficial. So far, these tests also focus more on screening than monitoring, and their net benefit is uncertain.

In the case of liquid biopsy tests for occult neoplasia, for example, the clinical import of this detection is not always clear, and the risk of overdiagnosis has not been ascertained. The risk of misdiagnosis is also disturbingly high. Based on published sensitivity and specificity data and prevalence estimates for various cancers, the PPV of one such test currently available varies from 34%-64%.(Burton et al., 2025; McKenzie, 2021; Wilson-Robles et al., 2022) This means that over 40% of the positive results will be in dogs who do not have cancer.

And since there is virtually no evidence that treatment in the subclinical stage of common canine cancers, such as LSA or HSA, leads to a true extension of the time without symptoms or overall survival, even accurately diagnosed patients may well not benefit from the earlier diagnosis. The potential harms of this diagnosis, true or false, include anxiety and cost for the owner and potentially harmful and uncomfortable diagnostics and treatments for the patient. The use of such tests before we clearly understand their risks and benefits in specific patient populations is unlikely to yield a substantial net benefit for pets or owners.

There are also plenty of commercial DTC products already on the market promoting wellness monitoring in pets, though the evidence is even less robust than for humans. The concept of an integrated set of devices monitoring biomarkers (e.g. urine electrolytes and glucose), physical parameters (e.g. body weight), and behavior (e.g. water intake and activity) have been proposed as a comprehensive approach to home health surveillance in pets.(Sun, 2025) In principle this could provide not only early warning of disease but information useful in guiding preventative medicine, such as adjustment of feeding and activity to maintain a healthy body condition.

The enthusiasm for monitoring tests for pets is similar to that for human wellness testing, though the scale of the market is much smaller. Genetic and epigenetic tests, microbiome assays, purported allergy tests, and many others are available to pet owners. But while the potential market is smaller than for humans, the quality and quantity of scientific evidence for such tests is also much less robust, making the use of these biomarkers even more problematic.

Conclusion

Moving from a reactive to a proactive approach to health requires the right information. We need tools to measure the current health state of our patients, to predict the future risks of disability, disease, and death, and to show us that our interventions are working to extend healthspan and lifespan. While screening and early detection and treatment of disease are still going to be critical components of a comprehensive preventative medicine strategy, we also want to be able to know when and how to intervene well before disease develops.

There are many promising biomarker strategies being explored for this kind of monitoring. Some focus on the core mechanisms of biological aging, which is the most important risk factor for disability, disease, and death in adult pets and which is potentially modifiable. There are not yet validated biomarkers, alone or in combination, that can serve this function, and we must be mindful of the potential risks of gathering information injudiciously. Unproductive anxiety or false reassurance for owners, unnecessary testing and treatment for patients, and the increase in cost and potential loss of public trust that would accompany these effects, are dangers we must be careful to avoid. The best way to do so is to follow a scientifically rigorous, evidence-based approach to developing and employing biomarker monitoring and preventative health strategies.

Conflict of Interest

The author is employed part-time by Loyal, an animal health company developing prescription medications to extend healthy lifespan in dogs.

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