Evaluating the use of canine olfactory methods for improving disease detection and prevention

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ABSTRACT

The detection and prevention of infectious, malignant, and chronic diseases is pertinent for the health of humans and animals in society. There has been emerging research on the feasibility and clinical efficacy of training canines to become specialized biomedical scent dogs to diagnose such diseases. Over the past two decades, there have been many new studies and experiments on the canine-assisted early detection of cancer in humans by companion canines. However, this is still a relatively foreign method and the goal is not to replace preexisting methods, but to serve medical professionals and patients as a tool for diagnostic and preventative care that concerns the sphere of public health and disease outbreaks. This paper will address the extraordinary abilities of the advanced canine olfactory system and the potential for widespread adoption. The continuation of research and developing strategies may bring improvements to the healthcare system in the future.

KEYWORDS

Canine olfaction, Volatile organic compounds, Biomedical scent canines, Cancer detection, seizure prevention, infectious disease diagnosis

INTRODUCTION

In the modern medical scene, infections, cancer, and chronic illnesses are diagnosed, treated, and monitored utilizing a variety of traditional methods. However, the established methods of testing and treatment present several drawbacks once factors of increased patients, outbreaks and epidemics, and limited accessibility and costs are presented. The devastating COVID-19 pandemic has spurred the search for new ways to address the disadvantages of traditional clinical care while retaining the accuracy, sensitivity, and accessibility already present. Additionally, the rising cost of healthcare in the United States is a concern for many patients as they navigate sickness, including chronic illnesses and cancer, and are often deterred by economic factors (Morens and Fauci, 2013). Malignant diseases pose significant risk for many individuals that only increases in severity when the cancer is not detected early on. There have been cases where owners report to have been signaled by their canines to receive a check up and eventual diagnosis of illness based on the canine's sudden unusual behavior and fixation on an area of the body (Kure et al., 2021). Currently, canines are already being utilized in the field of cognitive and emotional therapy, so there is credibility and a foundation for expanding the scope of what canines can be utilized for (Lundqvist et al., 2017).

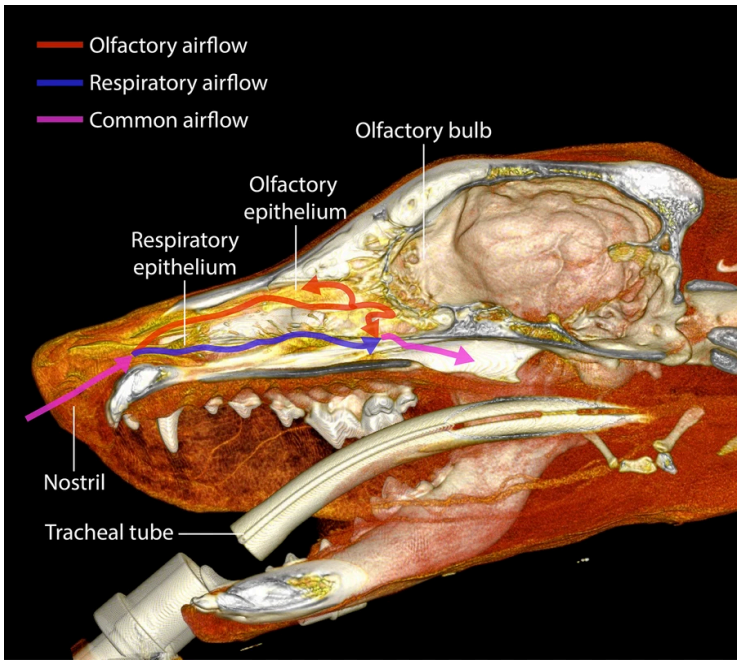


Figure 1: Anatomy of Canine Olfactory Pathways

Canines detect information about the environment including the subtle changes and precise locations and chemical fluctuations (Kowalczyk-Jabłońska et al., 2026). Canines process chemical information primarily through sniffing, as air enters in through the front and is exhaled out the sides of the nose. The canine olfactory system includes 2 main compartments: the main olfactory epithelium and the vomeronasal organ (Figure 1). Within the olfactory epithelium, olfactory receptor cells are activated as the odor is processed, and these receptor cells are also related to the intensity of the odor being analyzed (Kokocińska-Alexandre et al., 2026).

These diseases and symptoms in the human body emit unique chemical compounds that canines are highly sensitive to due to their olfactory abilities. Volatile organic compounds (VOCs) are the main component to be discussed in this paper, present in the odors of bodily fluids and even exhaled breath, which are the target samples canines detect in the following studies. Emerging studies on VOCs and primarily through both animal and electronic noses lead to greater possibilities for researchers' understanding of complex and extremely intricate olfaction structure and potential. These compounds are not constant and depend on environmental factors that also affect the potency of the odors and the sensitivity of the canines (Amann et al., 2014). Training canines to detect certain odors with specific VOCs is the optimal way to develop a specialized biomedical scent dog (Kokocińska-Alexandre et al., 2026).

Studies on canine olfaction working in medical contexts have been presented as a viable option for needs of patients across infectious, malignant, and chronic diseases. Training and implementing canines into the field as a tool to facilitate triage, diagnosis, and treatment can improve disease detection and prevention to an extent. Although there is incredible potential for canines to be implemented in many public settings as a screening tool, there are many barriers preventing the widespread adoption of such methods, intersecting regulatory and public health laws among limiting factors. A One Health perspective recognizes the interconnectedness of human, animal, and environmental health, creating opportunities to investigate scent-based detection across different species and disease contexts (Pellin et al., 2024). This

paper will examine the advantages canine olfactory provides to detecting and preventing human diseases, the established methods being used, as well as support for and against the widespread use of canines in the context of infectious, malignant, and chronic diseases (Jendrny et al., 2021).

CANINE DETECTION OF INFECTIOUS DISEASES

Individuals who are infected with diseases undergo biochemical changes in the VOCs they emit. These metabolic changes may be detected through sweat, breath, and other bodily fluids. These bodily fluids contain indicators of viral pathogens canines have the ability to detect, and in a study of VOCs from Coronavirus-infected murine cell cultures the clinical efficacy of canines in detecting such infectious diseases and to differentiate chemical compounds is supported (Kokocińska-Alexandre et al., 2026).

Biomedical canines address the shortcomings of traditional methods of detection, diagnosis, and prevention in infectious disease outbreaks. Trained canine scent dogs may provide a viable method to all of the shortcomings mentioned. Canines have been proven to detect scents of VOCs from viral samples that varied from urine, sweat, and saliva (Devillier et al. 2022). This is a non-invasive method, as opposed to the uncomfortable and at times painful experience of nose or throat swabs. Additionally, in congested, highly populated areas, the sheer amount of people needing to be tested multiple times a week presents many logistical and economic struggles. Trained scent dogs are able to detect SARS-CoV-2 in public settings with high volumes of people, and without turnaround time as the results are instantaneous (Gottwald et al., 2020).

The capabilities for canine detection of infectious diseases may extend far beyond COVID-19, presenting strong cases for assisting the detection and diagnosis of outbreaks that are even more severe and may pose a direct threat to humans through proximity, but not canines. Researchers and medical professionals have advanced treatment and prevention protocols for SARS-CoV-2, so expanding the scope of viruses and outbreaks beyond makes for a more compelling argument in support of the use of biomedical scent canines (Gottwald et al., 2020). In an experiment where researchers collected foot odor samples from socks of children with asymptomatic Malaria and uninfected individuals, results demonstrated the efficacy of biomedical scent canines to differentiate between the control and the Malaria-infected groups (Guest et al., 2019). The study shows the capability of canines to distinguish infected individuals carrying Malaria parasites, built on the basis that the odors emitted from such parasites were detectable by mosquitos. In addition to SARS-CoV-2, increasingly emerging studies on a diverse range of infectious diseases will provide new detection and diagnosis methods. Public health surveillance and early disease outbreak preparation are all key aspects to consider in epidemics to contain the disease and save human lives (Maughan et al., 2022).

CANINE DETECTION OF MALIGNANT DISEASES

Biomedical canines process VOCs from malignant diseases to serve as a valuable diagnostic tool. Trained scent dogs have been proven to be able to detect the VOCs from urine samples in individuals with prostate, lung, and breast cancer (Bauër et al., 2022). The most prevalent screening method traditionally used to diagnose prostate cancer is PSA, serum prostate specific antigen measurements that have relatively low accuracy here are also many false-positives since elevated PSA levels may result from non-cancerous conditions. For lung and breast cancer, imaging and biopsies (CT scans, mammograms, MRIs) are the most common, and although these methods can achieve high diagnostic accuracy, they often require expensive equipment, specialized personnel, invasive procedures, or multiple appointments. Consequently, researchers continue to search for alternative screening methods that can improve accessibility while maintaining diagnostic accuracy.

Malignant cells go through metabolic changes that alter the chemical compounds released by the body, producing scent signatures that differ from those of healthy individuals (Feil et al., 2021). Several studies have reported that trained canines can distinguish urine samples from prostate cancer patients with high accuracy, suggesting that dogs may be capable of identifying VOC patterns associated with

cancer (Half et al., 2024). Canines were able to accurately identify exhaled breath samples from patients with lung cancer and in another study, patients with breast cancer (Pellin et al., 2024). This approach offers a non-invasive screening alternative and may potentially reduce the number of biopsies resulting from false-positive PSA tests (Kure et al., 2021).

Beyond their potential diagnostic accuracy, biomedical scent dogs may offer broader benefits by providing a non-invasive approach to preliminary cancer screening. Collecting samples such as urine or exhaled breath may be more acceptable to some patients than undergoing invasive procedures, potentially encouraging participation in screening programs. In addition, canine detection could eventually help identify individuals who may benefit from further clinical testing, particularly in settings where access to specialized diagnostic equipment is limited. Research has explored canine detection across multiple cancers, including lung, breast, and prostate cancer, although results vary between studies and testing protocols (Bauër et al., 2022; Juge et al., 2022). Importantly, a positive canine screening result would still require confirmation through established medical procedures. Further research must determine whether this approach can consistently improve early detection, reduce unnecessary testing, and provide measurable benefits to patients. Overall, further studies are needed to determine whether dogs are detecting cancer-specific compounds or secondary biological processes associated with the disease (Half et al., 2024).

CANINE DETECTION OF CHRONIC NEUROLOGICAL DISORDERS

Epilepsy is a chronic neurological disease that produces seizures in varying severity and can be caused by a wide variety of reasons, related to disruptions in normal brain activity. When brain neurons emit abnormal electrical signals, a seizure occurs and depending on the type of whether it's focal or generalized, the individual is at high risk of injury from falls and lack of intervention. Traditional methods currently being used by individuals with epilepsy or diseases associated with seizures and healthcare workers include EEG monitoring. EEG monitoring, although effective to an extent and is widely regarded as the standard for monitoring brain activity, is more useful as a diagnostic tool rather than predictive and is usually for long-term use under trained personnel. False positives are still relatively common with wearable monitors, another tool with predictive alerts (Jory et al., 2016).

Canine olfactory systems can detect and alert individuals with chronic illnesses of seizure episodes. Canine olfaction allows biomedical scent dogs to detect chemical shifts in the body of an individual at risk of a seizure. In a chronic disease like epilepsy, seizures are recurring and triggers like alcohol, head trauma, or brain inflammation. Biomedical scent canines also detect these micro changes of VOCs found in breath and sweat around 15 to 60 minutes prior to a seizure episode, which is evidence supporting the capability and use for canines and their impressive olfactory methods (Catala et al., 2019). In the experiment conducted by exposing canines to breath and sweat samples of various disorders including diabetes, anxiety, and epilepsy, the results indicate significantly high accuracy, sensitivity, and specificity among the five dogs. Three dogs scored 100% accuracy and sensitivity, and the remaining two had scores above 67% in the same categories after completing 9 trials each (Catala et al., 2019). Although the study provides the most concrete evidence for detection of scent markers, it can then be applied to seizure detection prior to the episode. Canines may provide an advanced warning, even earlier than many technologies that alert the individual once the abnormalities begin. Waiting until the onset of symptoms, especially for more severe cases, might introduce many more risks (injuries, falls, even stress) that can be anticipated and eliminated overall with canine assistance. In the same study, the canines displayed the clear ability to discern the VOCs associated with epilepsy from other chronic diseases.

Overall, further tests like mass spectrometry will have to be used to narrow down and specify the type of epilepsy and individual information, a skill not yet achieved by scent dogs as it would require

extensive training and scientists should research to confirm the feasibility of such specific predictions and analyses by canines.

CONCLUSION

There are barriers preventing the widespread use of biomedical scent dogs in various settings. The main considerations of implementing specialized biomedical scent dogs in medical and public settings all center around safety, regulations, and consistency. Without standardized training and regulation that can be safely and logistically applied to many different circumstances and environments, it is not possible for the widespread use of specialized canines. There has been robust research already conducted on the clinical effectiveness of detection and diagnosis by biomedical canines through their advanced olfactory senses that surpass electronic noses, but more extensive research will be required for a wider range of diseases to boost the credibility of canines and to give a bigger glimpse into the potential for what can be detected. Studies show canines are capable of discerning scents and their corresponding biomarkers to a wide range of diseases, boosting its viability as a tool for detection and prevention.

Furthermore, the implications extend beyond human medicine. Canines, like humans, don't remain in an exact, constant state every single day, so there are differences to be accounted for that may impact the accuracy, sensitivity, and success of disease detection in all categories. Dogs are sentient creatures and have emotions and consciences of their own that cannot be controlled by scientific methods. The environment has a big impact on the capabilities of the olfactory system, and conditions like humidity and stress levels that follow social interactions all inevitably affect, to an extent, the canine (Jendrny et al., 2021). There are even differences in olfaction sensitivity between different breeds of canines, so it would be optimal to select breeds that have enhanced anatomy for detecting certain odors and with certain temperaments that make them ideal under situations where patient interaction is necessary. Large scale screening that also retains the diagnostic accuracy and sensitivity is crucial to combat epidemics and pandemics alike, an affordable yet effective measure. Overall, there are extensive considerations to be accounted for, in particular animal welfare and the role they play alongside communities in advancing public health initiatives.

The development of electronic noses (E-noses) has become a tool that is anticipated to boost the accuracy even more than canines, and potentially address a lot of limitations and shortcomings biomedical scent dogs face (Kowalczyk-Jabłońska et al., 2026). The potential for E-noses to be created in a compact format while retaining its sensitivity and accuracy will be a significant step forward in public health in general, as individuals who have chronic illnesses can monitor their own conditions and be alerted of necessary medical intervention. Additionally, as subtle changes are detected in the VOCs of individuals who are not yet diagnosed, the integration of E-noses provides another great tool for large-scale screenings, for diseases many are susceptible to, in particular, cancers (Baldini et al., 2020). Ultimately, the continued study of canine olfactory processes in aiding the detection, diagnosis, and prevention of a wide range of diseases and illnesses is significant to advancing healthcare. Novel studies address shortcomings of currently used traditional methods that are often invasive, uncomfortable, and inaccessible for many individuals. Alongside biomedical scent dogs, E-noses are being developed to similarly detect changes in VOCs that, in the future, may surpass the biomedical accuracy of canines and pose even less room for error and inconsistencies.

CONFLICT OF INTEREST

The author declares that there are no conflicts of interest related to this work.

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