Canines Detect Odors In Cancerous Tissues

Introduction:

Canines are used by police departments to search for drugs and are commonly used at airports and other places to sniff for explosives. Recently, research has been done to observe how effective dogs can be at using their remarkable sense of smell to detect certain cancers in humans. Data has been published revealing how well trained dogs have performed in sniffing human odors for several different types of cancer including, bladder cancer, melanoma, lung cancer, and breast cancer. A recently published research experiment concentrated on finding how effective dogs are at detecting the chemical signals of lung and breast cancer. Many magazines and newspapers have effectively summarized the results of these experiments.

On January 17, 2006, *The New York Times* released an article entitled: "*Dogs Excel on Smell Test to Find Cancer."* The article states that a clinic has trained five dogs to detect lung cancer with 99% accuracy and that the dogs have been able to detect breast cancer with 88% accuracy. (McNeil, 2006) This paper will examine in detail the primary literature on which this article was based, and also compare the information from the primary publication to the popular article of the *New York Times*. In addition, primary publications from other researchers will be discussed to observe any differences that might exist in the results of the dogs' ability to detect the different types of cancers. In other words, we will determine if canines are more successful at detecting one type of cancer better than another type.

Canines have a more powerful sense of smell than people because they have a much greater percentage of their nervous system devoted to developing smell. The average dog has over 200 million scent receptors, compared to only about 5 million in humans. However, little research has been done to compare the human versus the canine olfactory system. The olfactory system is the part of the nervous system that deals with perception of odor. Different hypotheses exist to attempt to explain why there are such large differences in olfactory sensitivity between different species of animals. This data could only partly explain why dogs have such a talented sense of smell. Throughout their evolutionary history dogs have developed an incredibly sensitive olfactory system,

possibly due to natural selection. Some research suggests that there is a reduction in the number and function of certain specific genes related to smell in humans and other primates when compared to dogs. (Rouquier et al., 1999) In addition, a dog's nose is designed too much more efficiently detect incoming odors and eliminate unwanted odors from their exhalations that could interfere with the incoming scents. (Schrope, 2000) It is important to understand that, whereas humans mostly experience their environment through sight, the canine's world is full of smells and odors, and relies less on vision. (Rouquier et al., 1999) This is the fact that scientists are trying to manipulate in order to train dogs to detect cancer.

New research consisted of training five dogs to detect lung cancer and breast cancer, the two deadliest types of cancers in humans. The dogs that entered the study had previously only had basic training skills The study had these dogs in an additional 2-3 weeks of scent detection training. It is important to note that the training process involved three steps. In the first step, the experimenters placed dog food in the container that contained the cancer breath. Once the dog sniffed this container they were rewarded. In the second step, the experimenter knew the location of the cancer, but no reward or commands were given until after the dog correctly sniffed the right one. The last step was similar to the first step except that no rewards were given at all for identifying the cancer sample. Once the dogs could satisfactorily and consistently detect the cancerous breath from among four controls they started testing. (Rouquier et al., 1999)

Actual testing involved the use of both single blind and double-blind experiments. To increase accuracy and decrease sources of error of the single blind experiment, the trainer was placed behind a curtain so that the dog could not possibly pick up on any signals. In the double-blind experiment, all new breath samples were used for controls and cancer containers. Unlike the single blind testing, the dog did not receive rewards after identifying a container because neither the experimenter nor the handler of the dog knew which of the containers contained the cancerous odor. For lung cancer, the dog correctly reacted to the containers that were filled with breath from lung cancer patients and the controls 99% of the time. These patients had previously been confirmed as having lung cancer by a biopsy, while the controls were confirmed not to have the cancer. In the

breast cancer patients, the dogs reacted correctly to patient's breath that had been confirmed to have lung cancer, and controls, 88% of the time. (Rouquier et al., 1999)

The article mentions several topics that are important. The authors, Michael McCulloch, et al, state that the results for lung cancer compare with what one would expect to find when a chest x-ray is used to detect lung cancer in the early stages and they compare with a CT scan in trying to rule out lung cancer. Similarly, McCulloch et al claim that the results for testing of breast cancer have similar results with a mammogram testing. The article also states that these results can be an overestimate of the true results because all of the controls that were used were from completely healthy patients. No patients that had similar symptoms or illnesses as the cancers were used. For example, no patients that had bronchitis or emphysema were used as controls in the lung cancer experiment. This is important because the dog may have responded to these illnesses in the same way that they did to the lung cancer, because the illnesses affect the liver and may have similar chemical signals. The article states that there probably should have been some patients with fibrocystic breast disease or mastitis to be used in the breast cancer control group to see how this would affect the overall results because of false positives made by the dogs. It would probably take much more training for the dogs to learn to be able to distinguish between these diseases and cancerous cells (McCulloch et al., 2006)

The journal article mentions that the dogs seemed to be very accurate in responding to the cancer stimulus. However, they actually may have only been "responding to odors associated with cancer, such as inflammation, infection, or necrosis, rather than to cancer specifically," (Rouquier et al., 1999). The author suggests this can be dealt with by adding controls that have a nonmalignant form of these conditions in addition to the healthy controls. It is emphasized in the paper that much more research needs to be done. Chemical tests and experiments should be done to analyze the breath for what exactly the dogs are detecting in the odor samples. (Rouquier et al., 1999)

For the most part, the popular article in *The New York Times* was accurate in reporting the results of this experiment. The article presents the material in a manner that someone with no prior knowledge could understand the basics of why the experiment was being performed. The article was too quick to judge the validity of the research and summarize

the procedure. The procedure from the primary research is too detailed to be summarized in a couple of lines of a popular article. If the reader had not previously read the published article, he would probably have only a vague idea of how the experiment was run. The author of the newspaper article adds a great deal of background information that did not come from the published article, but instead came from outside sources. These outside sources seem to effectively add to the article and make the results more understandable to the average person who wants to know more about the experiment. The popular article even gives background information about how previous research had been done that shows dogs can have been trained to see how effectively they detect skin cancer, and tests have been done to see if dogs can distinguish the urine from a healthy patient with that of a patient with bladder cancer based solely on odor. (McNeil, 2006)

Various cancer experts were quoted in the popular article. The overall feeling is that most of these experts find the results interesting, but they are skeptical of them. In addition, the author interviews Michael McCulloch who was the principle researcher. McCulloch only says that the researchers were surprised by the results as much as anyone else. But, because the results were consistent, more time needs to be put into similar experiments and the breath samples needed to be studied chemically. According to the article, McCulloch is now seeking National Science Foundation (NSF) grants in order to "analyze breath samples with a gas chromatograph to figure out exactly which mixes of chemicals (in the breath) the dogs are reacting to." He hopes that technology will allow for the construction of a device that can then detect these chemicals from the breath and tissues based on the sensitivity of the canine olfactory system. (McNeil, 2006).

The article also addresses the objections to the experiment that many experts have pointed out. For instance, the dogs could have smelled other chemicals that could have generated from chemotherapy or illness. Or perhaps the dogs were getting clues from the trainers, patients, or researchers. No chemotherapy patients were included, and the breath of smokers was found in the controls as well as the lung cancer samples. Likewise, the experiment was a double blind experiment and the only person who knew the contents of the samples was nowhere near the testing room when the experiment was being conducted (McNeil, 2006).

Ultimately, the popular accurately portrayed the true results of the experiment. However, it offered too much emphasizes on the usefulness of the results. Much more research and many more experiments need to be complete before any result is taken seriously in the medical community. It also added some background information that made an unknowledgeable reader of the newspaper more able to understand the significance of the experiment. The popular article should only act as a supplement to the original published paper - and not replace it - to form a full understanding of the research done. The article spends too much effort looking for opinions on the research from outside sources, but because this is a popular article for a newspaper it does make sense to get outside opinions on the subject. Nevertheless, so much data lies in the original publication that cannot be relayed in a 300-word newspaper article.

It is important to look at research that is similar to the lung and breast cancer experiments to see how they compare. The first people to actually hypothesize that dogs could detect cancerous tumors through their sense of smell were Williams and Pembroke in 1989. They had a patient who complained that her dog was constantly licking and trying to bite a mole on her leg. Upon removal, they found that the mole was actually a melanoma, a deadly skin cancer. They reasoned that perhaps there was something about the melanoma that was attracting the dog. In recent years, there have been several similar stories of doctors who reported dogs being attracted to moles on patients that have turned out to be melanoma. (Church and Williams, 2001) This report by Williams and others sparked all of the research that has been done on the subject.

Duane Pickel and other researchers recently performed an experiment that involved the use of two dogs to try and detect melanoma in patients. There were seven patients that were suspected of having melanoma that were used. The first dog detected melanoma in five of the patients that were later proven to have melanoma by a biopsy. In another patient, the dog detected melanoma in a patient that at first was thought to be negative, but further tests proved the dog was right. In another patient, both the dog and the original pathological exam were inconclusive, and it was shown through biopsy that this patient had melanoma also. The second dog did not interact with as many patients as the first dog, but for the ones that he did, he got the same results. The authors of this published article declare from the results that there is some “volatile cue” that is being

released from the melanoma; and the dogs are capable of detecting this cue using their olfactory system (Pickel et al, 2004).

Another recent study focused on how well dogs could detect bladder cancer in a sample of urine. Six dogs were used in this experiment. After the dogs had been trained to the scent of the urine of those patients with bladder cancer they began the experiment. Seven samples were presented; one of the samples was from a patient with bladder cancer and the rest being controls. Some of the controls were healthy and others had other problems such as inflammation or infection. The dogs correctly picked the sample from the bladder cancer patient 44% of the time. Dogs that had not been trained picked the sample correctly 14% of the time. Which was a much lower result then the breast and lung cancer testing. So this experiment, even though it was not as amazingly consistent as the lung cancer or breast cancer experiment, does show that the dogs that had been trained performed much more successfully than those who had not, and picked a sample based only on chance. This fortifies the hypothesis that the tumors in the body are releasing some kind of chemical that can be picked up by an enhanced olfactory system. (Willis et al. 2004)

New research has also been focused on determining exactly which chemicals are being released by the tumors and apparently recognized by dog's sense of smell. In a recent publication of *Chest: The Cardiopulmonary and Critical Care Journal*, there was an article titled Detection of Lung Cancer With Volatile Markers in the Breath. The experiment tried to determine if there were any differences in the number of molecules produced between healthy patients and patients with lung cancer. The findings showed that those patients with primary lung cancer had a greater amount of these molecules. Patients with lung cancer induce an enzyme that breaks down the chemical molecules. These finding could prove vital to determining the specific markers in our released odors that dogs are detecting. Much more research on this topic needs to be done, covering many more types of cancers and different chemical markers. In the future, the information gathered from this type of study could be used to perhaps create machines that can pick up on the released chemicals in odors of cancerous tissues (Phillips and Cataneo, 2006).

It is amazing to imagine how a dog experiences the world. Their extraordinary sense of smell leads them to recognize many things based solely on odor. In doing research for this paper, we have discovered that their noses are evolutionarily constructed for maximum efficiency in detecting scent, and many genes for the olfactory system that have been lost or not expressed in the primates are still present and functioning in dogs. The fact that scientists are using this information to help in detecting human cancerous tissues is almost unbelievable, yet extremely brilliant. Now that research is supporting the hypothesis that there are distinct chemicals being released from cancerous tissues, it is important for scientists to take the data and make important breakthroughs in the diagnosis of cancer. Technology needs to be implemented in doing this. Most of the articles we have encountered in writing this paper hope that the ultimate goal of this research is for a Breathalyzer to be built that can be used to detect these distinguishing odors that are being released. Hopefully, this will allow cancers to be diagnosed in much earlier stages; the earlier that cancer is found, the better the chance of survival and more effective treatment. It will also be much cheaper than more costly forms of diagnosis. It is hard to believe that all of this stemmed from the fact that in 1989, a woman complained to her doctor that her dog would not leave a mole on her leg alone (Church and Williams, 2001).

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