Chapter 11
Canine Olfactory Detection of Human Disease

Claire Guest

11.1 Introduction

For centuries, it has been understood that many human diseases have a characteristic odor. Physicians often came to recognise the odor associated with conditions such as lung infection, diabetes, and typhoid. Dogs have been used by man for their olfactory abilities for many years and are used in a wide variety of disciplines, including the detection of drugs, explosives and currency. In recent years it has been recognised that dogs may be able to assist in the early detection of human disease, notably epileptic seizures (Dalziel et al. 2003; Kirton et al. 2008). However, it is unclear in this instance whether the dogs are detecting oncoming seizures by smell or by some other means.

The first indication that cancer cells may release abnormal volatile substances, and that dogs may be able to smell them, came in a case report published in *The Lancet* by Williams and Pembroke (1989). The authors described how a woman sought medical advice because her dog had been taking an inordinate interest in a mole on her leg. When the mole was removed, it was found to be a malignant melanoma.

The report attracted the attention of an orthopaedic surgeon, Dr. John Church, who, over the intervening years, unearthed another 16 similar stories, one of which he also published as a case report in *The Lancet*. Most of these incidents related again to skin cancer, but several involved internal cancers, including breast cancer (Church and Williams 2001). Prior to clinical evidence of the ability of dogs to detect cancer, there were a number of anecdotes reported. Some of these are presented below.

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Fig. 11.1 Maureen with her dog Max, a red Collie cross

In 1978, magazine editor Gillian noticed that her pet Dalmatian named Trudi was paying constant attention to what she thought was a freckle on her leg. Gillian did not pay attention to a small brownish-yellow spot on her skin until the time when her dog kept sniffing this area. When Gillian went to a physician, the freckle was removed and tests showed that it was a malignant melanoma.

In 2006, Maureen Burns found a lump in her breast during self-examination. A few months earlier, her dog Max, a red Collie cross aged nearly 10 (Fig. 11.1), began showing unusual signs and became less playful, wouldn't jump on Maureen's lap, share her bed or sit at her feet, and his eyes were sad and dull. Max would from time to time come up to Maureen and touch the lump area and back off very unhappily. Also, he kept sniffing her breath on numerous occasions. Maureen was confused and wondered if Max's strange behaviour was due to his advancing years, or indicated that something was really wrong with her.

When she consulted her general practitioner (GP), she was quickly was referred to hospital where numerous mammograms and scans did not show anything extraordinary. Maureen went in for further testing and after having two biopsies, her cancer was finally confirmed. However, she told the nurse that she already knew she had cancer as her dog already had "told" her. Soon thereafter, the lump and four lymph nodes were surgically removed. It was diagnosed that the patient had an invasive lobular carcinoma (grade 1), the size of which was 2.5 cm, while the four lymph nodes were not infiltrated. When Maureen returned home from the surgery, she was greeted by Max, and his behaviour was totally different. He was overjoyed and doing all the things he had done before the diagnosis. The patient began to receive routine radiotherapy and the prognosis was excellent.

11.2 Training of Cancer Detection Dogs

In 2002, following several months of training with many dogs and dog trainers involved, a spaniel called Tangle sniffed up and down a line of patients' urine samples and identified the one that had been provided by a cancer patient. The previous stages of training had gone well, with Tangle proving to be a reliable dog, however there was still uncertainty as to whether the dogs would be able to tell the difference between those half ml samples that had been given by patients with cancer as opposed to those given by patients with other diseases. However, in a training environment, Tangle had demonstrated that the theory was in fact a reality: dogs could be trained to detect cancer. Further studies were now required.

In collaboration with Dr. Church, and together with a research team of scientists and doctors from Amersham Hospital the author started a thorough investigation to see whether there was a scientific basis to these anecdotal stories. It was decided to conduct a simple, but stringent proof of principle experiment, the first of its kind, to see whether dogs could be trained to detect bladder cancer from the odor of urine.

Over a period of 7 months, a training program was developed with six dogs, all of whom were gradually taught to "key into" the specific smell for cancer and to ignore all of the other odors present in the urine, including those associated with other diseases and conditions. Samples were frozen to minus 35 °C. A contribution was given by someone who knew their life may be nearing the end but who hoped to help the team make crucial advances in the fight against cancer – a fight that would continue well after their death. It was agreed to start with dogs that were representative of dogdom itself, rather than an elite subsection of specially picked "scent experts". After all, this was a proof of principle study to see if dogs in general could be trained to detect cancer. All those involved suspected that the best dogs for the job would be the breeds typically associated with working disciplines, but wished to make no assumptions at this stage. Finally, the band of six dogs was selected and consisted of a Papillon, a Labrador, three Cocker Spaniels and a Mongrel.

The dogs were then tested in a rigorously controlled, blinded trial in which they were required to select cancer urines from a range of 'controls' obtained from age-matched, diseased and healthy subjects. All the samples were entirely new to them. Their combined accuracy rate of 41 % was statistically significant, as the results proved unequivocally that dogs can be trained to detect cancer by the sense of smell. Two of the most accurate dogs who performed in this first test had a 56 % accuracy rate. One of the dogs was Tangle as discussed earlier (Fig. 11.2).

The results of the study were published in the *British Medical Journal* (Willis et al. 2004) and were widely reported across the world, both in the press and on television. The dogs have shown that human cancer cells release odorous substances of diagnostic importance. The scientists related to the study above, and other international research groups, now wished to further utilize the dog's olfactory capabilities to help develop diagnostic instruments for clinical use.

Fig. 11.2 Tangle is not alerting he is screening cancer samples

11.3 Development of "Medical Detection Dogs"

During 2005, work continued but progressed in a new direction. It was essential that dogs in training were regularly tested in blinded trials run by hospital personnel in order to assess their accuracy rate and progress. These blind runs were lengthy and needed to be run during the working day, since hospital staff and researchers were not in a position to work in the evenings. It was obvious that the project needed some new initiative in order to succeed. It had become apparent over an extended period of time that to progress in this difficult field, a really intense concentrated effort was required. The staff would have to be freely available to do the work, and premises would be required which enabled the dogs to work in optimal conditions. Additionally, there would need to be more rigorous selection of dogs as well as multi-disciplinary teamwork. A decision was made to take action on a conclusion previously reached, that the best way forward was to form a new charity organization with fund-raising capabilities that would have its own premises and with its own fully employed staff.

"Cancer and Bio-Detection Dogs" was formed as a not-for-profit company in October 2007 and charitable status was obtained in June 2008. Dr. Church became a trustee and the Honorary Medical Director of the organization. Since the development of this not-for-profit organization, the members have now come to understand that dogs are able to detect a variety of diseases and debilitating conditions by identifying changes in the odors of the body or breath. In 2011, the name of the charity was changed to "Medical Detection Dogs" as this described the work more accurately.

The charity is now working in conjunction with Professor Karol Sikora, a leading UK oncologist, as well as mass spectrometry scientists and medical statisticians in the detection of cancer from human breath and urine. Currently, the charity's main focus is the detection of prostate cancer. There are powerful reasons for such a study. Prostate Cancer (PCa) is a major killer in male human populations. Current testing such as the prostate specific antigen test (PSA test) is unreliable, and as a

result, many GPs are reluctant to use it. If dogs can sniff prostate cancer from a urine sample, chances are high that results from the dogs' sniffing research can allow for a test to be developed that is superior than the PSA test. Results would indicate the existence of a potential odor signature of PCa that may correspond to one or, more likely, multiple Volatile Organic Compounds (VOCs). These molecules should then be assessed by specific gas chromatography/mass spectrometry analysis.

Society can benefit tremendously from the work undertaken by Medical Detection Dogs. First and foremost, the work can advance research into the early diagnoses of cancer. It is well known that early diagnosis would save countless lives and would benefit the public significantly. However, research is warranted when there is sufficient motivation to find an answer and a reasonable belief that a particular line of investigation can provide answers. Both of these premises are clear with this work. If answers cannot be determined, i.e. that dogs cannot in practice help doctors with early diagnoses, the research that is conducted will nevertheless be beneficial to overall research into cancer.

11.4 Research with Cancer Detection Dogs

Since the early *British Medical Journal* article in 2004, there have been a number of supporting studies from around the world.

11.4.1 Prostate Cancer

In a recent study Cornu et al. (2011) evaluated the efficacy of prostate cancer (PCa) detection by a trained dog (a Belgian Malinois) on human urine samples. After a learning phase and a training period of 2 years, the dog's ability to discriminate PCa and control urine was tested in a double-blind procedure. The dog correctly designated the cancer samples in 30 of 33 cases. Of the three cases wrongly classified as cancer, one patient was rebiopsied and a PCa was diagnosed. The sensitivity and specificity were both 91 %. The authors concluded that dogs can be trained to detect the odour signature of PCa by smelling urine with a significant success rate. They further suggest that identification of the VOCs involved could lead to a potentially useful screening tool for PCa.

11.4.2 Colorectal Cancer

A study by Sonoda et al. (2011) on colorectal cancer using breath and faecal samples showed equally promising results. Sensitivity was at 0.97 with a specificity of 0.99 for faecal samples, while sensitivity was at 0.91 with a specificity of 0.99 for breath

samples. The accuracy of canine scent detection was high even for early cancer. Canine scent detection was not confounded by current smoking, benign colorectal disease, inflammatory disease or the presence of human haemoglobin or transferrin. The authors conclude that a specific cancer scent does indeed exist and that cancer-specific chemical compounds may be circulating throughout the body. These odour materials may become effective tools in colorectal cancer screening.

11.4.3 Lung Cancer

McCulloch et al. (2006) evaluated the ability of trained dogs to distinguish, by scent alone, exhaled breath samples of 55 lung cancer patients from those of 83 healthy controls. Among lung cancer patients and controls, overall sensitivity of canine scent detection compared to biopsy-confirmed conventional diagnosis was 0.99 (95 % confidence interval [CI], 0.99, 1.00) and overall specificity 0.99 (95 % CI, 0.96, 1.00). The authors state that in a matter of weeks, ordinary household dogs with only basic behavioral "puppy training" were trained to accurately distinguish breath samples of lung and breast cancer patients from those of controls.

Additional evidence was published by Ehmann et al. (2012) who found that sniffer dogs can identify lung cancer with an overall sensitivity of 71 % and a specificity of 93 %. The authors anticipated that a robust and specific volatile organic compound (or pattern) is present in the breath of patients with lung cancer.

11.4.4 Breast Cancer

In the same study from 2006, McCulloch et al. also tested the dog's ability to distinguish exhaled breath samples of 31 breast cancer patients from those of the 83 healthy controls. Dog handlers and experimental observers were blinded to the identity of breath samples, obtained from subjects not previously encountered by the dogs during the training period. Among breast cancer patients and controls, sensitivity was 0.88 (95 % CI, 0.75, 1.00) and specificity 0.98 (95 % CI, 0.90, 0.99).

11.4.5 Ovarian Carcinoma

Horvath et al. (2008) trained a dog to distinguish different histopathological types and grades of ovarian carcinomas, including borderline tumours, from healthy control samples. With double-blind tests showing 100 % sensitivity and 97.5 % specificity the authors clearly demonstrated that human ovarian carcinoma tissues can be characterized by a specific odour, detectable by a trained dog. In a subsequent study Horvath et al. (2010) examined whether the cancer-specific odour can also be found

in the blood. Using two specially trained dogs both, ovarian cancer tissues and blood from patients with ovarian carcinoma, were tested. As a result the tissue tests showed sensitivity of 100 % and specificity of 95 %, while the blood tests showed sensitivity of 100 % and specificity of 98 %. In accordance with these results the study strongly suggests that the characteristic odour emitted by ovarian cancer samples is also present in blood drawn from patients with the disease.

11.4.6 Melanoma

In a small, more anectdotal study Pickel et al. (2004) describe two dogs that initially demonstrated reliable localization of melanoma tissue samples hidden on the skin of healthy volunteers. Subsequently one dog "confirmed" clinically suspected (and later biopsy-proven) diagnoses of melanoma in five patients. Interestingly, in a sixth patient, the dog "reported" melanoma at a skin location for which initial pathological examination was negative (despite clinical suspicion). More thorough histopathological examination in this individual then confirmed melanoma in a fraction of the cells.

Whilst all the above-mentioned studies showed huge promise there is still a long way to go. Much of this work has been with few dogs and on a very limited number of samples. In some cases there has been repeated use of controls in testing and controls have been from younger healthy individuals and not from age and symptom matched individuals. This would result in much higher accuracy levels from the dogs that may not be replicated in a more detailed clinical trial. Further research is required with a larger group of dogs, much larger sample sizes and robust double blind testing with age and symptoms matched controls. This can be done but does require funding as ethics and patient consent must be passed and sample collection can be a lengthy process.

11.4.7 Volatile Organic Compounds (VOCs)

The scientific basis of the ability of dogs to detect cancer is believed to be linked to VOCs produced by malignant cells. It has been established that during tumor growth, protein changes in malignant cells lead to peroxidation of the cell membrane components, which produce VOCs that are detected in the headspace of the cell cultures (Brunner et al. 2010). The interest in the biomarkers of cancer has risen steadily over the past 20 years and a variety of approaches have been used including gas chromatography/mass spectrometry, so called eNoses, and trained sniffer dogs.

A recent study completed by the charity and colleagues at the Buckinghamshire NHS trust was recently published in the Journal *Cancer Biomark* entitled, "Volatile organic compounds as biomarkers of bladder cancer: Sensitivity and specificity using trained sniffer dogs" (Willis et al. 2010). This study aimed to evaluate

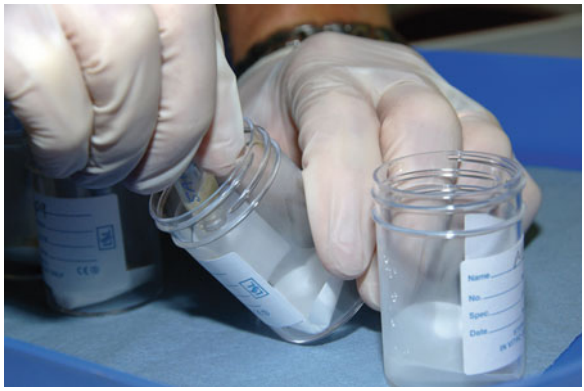

Fig. 11.3 Samples being prepared

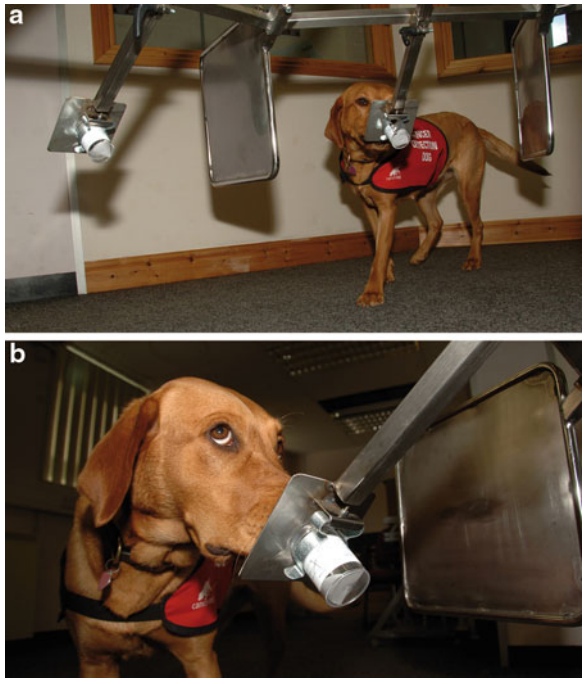

Fig. 11.4 (**a**, **b**) Trained sniffer dog Daisy working on the test carousel to identify samples from patients with bladder cancer

the sensitivity and specificity that can be achieved by dogs in a series of 30 double-blind tests runs, each consisting of one cancer urine placed alongside six controls (see Figs. 11.3 and 11.4).

The highest sensitivity achieved by the best performing dog was 73 % overall. This particular dog scored 100 % on grade 1 tumors, 60 and 61 % on Grades 2 and 3, respectively. The sniffer dog group as a whole identified cancer samples in 64 % of the cases. Specificity ranged from 92 % from healthy, young volunteers down to

56 % for those taken from older patients with non-cancerous urological disease. The sensitivities achieved collectively by the dogs for G1, G2, and G3 tumors in the study were 75 % (with one dog achieving 100 % accuracy, 61 and 60 % respectively). Odds ratio comparisons confirmed a significant decrease in performance as the extent of urine dipstick abnormality and/or pathology amongst the control population increased. More importantly, statistical analysis indicated covariates such as smoking, gender, age, blood protein and/or leucocytes did not alter the odds of indication. This means that it is highly unlikely that the dogs were using a confounder for their detection.

These results give further evidence of volatile biomarkers for cancer. In addition, they indicate that the performance of the dogs is higher on early stages of a tumor, though this is yet to be statistically determined. This also increases the possibility that these kinds of works may lead to an early non-invasive way of diagnosis.

Published studies in relation to canine detection of cancer biomarkers show that there is considerable variability between the sensitivity and specificity reported (Lippi and Cervellin 2012). For example, there is a lower level of accuracy rates for canines on bladder cancer than those reported by other groups for different tumor types. There are a number of possible reasons for this difference. First, urine is a very complex medium, which contains numerous compounds.

The study by Cornu et al. (2011) on the canine olfactory detection of prostate cancer, with reported accuracy of 91 %, used warmed samples, which may have improved relative proportions. In this study however, a repeated use of controls was used. This may well have lead to a higher success rate of the dogs as they might have been able to learn the signature of the individuals who were "non-reward individuals". Dogs are extremely adept at this and may use this to 'short cut' the detection if it results in a successful outcome.

It is also likely that the constrictions on the training protocol as set by clinicians in the study by Willis et al. (2010) in relation to rewarding the dogs, was detrimental to performance. This study used the most complicated controls following relatively few training samples. These controls, which were presented as double blinds came from individuals with a variety of other medical conditions, some of which the dogs had not been trained to ignore. In addition, the dogs were not rewarded at all during test runs during the double blind phase. This inevitably resulted in a reduction in motivation and confidence in the dogs. However, the work of the dogs raises the possibility that modern headspace analysis could be used for a diagnosis of bladder and other cancers. Regression analysis also indicated that the dog's ability to detect cancer volatiles was not due to the recognition of confounders.

A recent publication by Weber et al. (2011) evaluating a gas sensor array for the identification of bladder cancer from urine, reported that specificity and sensitivity for cancer resulted in lower accuracy rates when the sensor was compared against diseased controls. Accuracy for the eNose was still slightly lower as compared to using the dogs when more demanding controls were used. The current overall accuracy of the gas sensor was reported at 70 % with a score of 70 % sensitivity and 70 % specificity. Accordingly, this method is not considered sufficient for a diagnostic test.

However, this study opens the door of VOC detection for cancer diagnosis and furthermore suggests that the conditioned dog should be used in the near future to validate candidate molecules emerging from metabolomic screening. The results provide a new insight into the field while additional work with more dogs is now required to further investigate and validate this work.

11.5 Medical Alert Dogs

The use of dogs to assist people living with diabetes is a recent development. For many years, some diabetic individuals have anecdotally reported that their companion animals have reacted to a decrease in their blood glucose (Wells et al. 2008). O'Connor et al. (2008) reported case of hypoglycaemia in a non-diabetic patient being detected by a dog.

The organisation "Medical Detection Dogs" has begun to formally train dogs for this purpose. These dogs are trained to live and work alongside people to provide early alerts of changing glucose levels, prompting clients to take appropriate action. The dogs provide vital early warning signals to individuals who suffer from brittle or aggressive diabetes and/or poor hypoglycaemic (low blood sugar) awareness. This early warning enables the client to better regulate their own blood sugar levels, thereby reducing the incidence of hypoglycaemic episodes and also preventing harmful side effects. For someone living with diabetes, hypoglycaemia, or the avoidance of it can be a daily problem. This condition is frightening and also very distressing; symptoms can vary from confusion to seizures and comas, and can also be life-threatening. Medical Assistance Dogs can be invaluable companions for individuals in this situation. Preliminary studies of the current partnerships suggest that the trained dogs facilitate pronounced reductions in hypoglycaemic episodes and significantly reduce recipients' requirement for paramedic assistance and hospitalization. Self-management of their condition using evidence-based methods can help people with diabetes to live longer, healthier lives and experience improved quality of life.

Until now, Medical Assistance Dogs have been trained to assist individuals who must manage their complex medical conditions on a day-to-day basis. The dogs are taught to identify the odour changes that are associated with certain medical events. The charity has now placed 40 of these blood sugar detection assistance dogs with people living with so called brittle or unstable diabetes. Trained to be highly sensitive to glucose levels, they warn the individual when levels deviate from the normal range, and can indicate changes within one or two millimoles of blood sugar. Normally the dogs are trained to alert blood sugar levels below 4.5 (but above 3) millimoles per litre and also alert to high blood sugars at the level chosen by the client (normally above 10–12 millimoles per litre).

Additional benefits of the placement of a blood sugar detection dog include:

- Increases in individuals' confidence, reducing the tendency to maintain high blood sugar levels as a method of preventing hypoglycaemia;

- Reduction of prolonged periods of hyperglycaemia (high blood sugar level), which has a major benefit on the long-term health and well-being of individuals with diabetes;
- Reduction in symptoms in patients with high blood sugar is the cause of many long-term complications normally associated with diabetes such as sight loss, severe ulcerated wounds, amputation of limbs and kidney damage.

There is some evidence that diabetics with assistance dogs might have improved HbA1c (glycosylated haemoglobin; a long term marker for average blood glucose levels) or average blood glucose levels (Korljan-Babić et al. 2011). This fact alone has a significant impact on the lives of those with diabetes or hypoglycaemia.

11.5.1 Training Medical Alert Dogs

Training a blood sugar detection dog requires both training in odour identification and a reliable alert, which enables the dog to communicate blood level changes to the individual. When outside the normal range, dogs, once trained, can warn before the symptoms are felt. Depending on their 'owners' needs, the dogs will alert in a variety of ways; for example, with jumping up, licking or pawing. They can also be trained to push alarm buttons. These dogs are also trained to fetch the medical bag/blood testing kit if asked or when, due to the cognitive confusion caused by low blood sugars, the person does not respond to the alert.

For many individuals with unstable diabetes who get no warning of such an episode, these dogs are truly lifesavers. The dogs are also trained to warn when blood sugars become too high. Although this is rarely an emergency situation there are numerous serious and potentially life-threatening side effects of hyperglycaemia, as previously discussed. Medical Alert Dogs quickly recognise these signs and are taught to bring vital medical supplies and to summon help. Below are some examples.

11.5.2 Rebecca and Shirley's Story

Six-year-old Rebecca had been hospitalised eight times in 2 years due to her unstable diabetes resulting in unpredictable changes in her blood sugar level. To support the family, the charity paired Rebecca with a Labrador cross Golden Retriever named Shirley (Fig. 11.5). Within just 3 weeks following her placement, the dog was alerting successfully. Shirley wakes the mother at night when Rebecca is experiencing a dangerous change in her blood sugar levels, meaning prompt actions can be taken at home and avoidance of trips to the hospital. Rebecca was previously collapsing three or four times a week, unable to feel any change in her sugar levels. With the arrival of Shirley, the fear of collapsing has eased. As a hypo-alert dog trained to sense changes in odour when the sugar levels drop or increase, Shirley can

Fig. 11.5 Rebecca and Shirley, a Labrador cross Golden Retriever trained to detect unpredictable changes in her blood sugar level

warn Rebecca by licking her hands, sitting on her lap and bringing a sugar-level testing kit to her.

Since the arrival of Shirley, the young girl regained confidence, and it has been a relief to the whole family. Shirley accompanies Rebecca wherever she goes, and there has not been a single hospital admission since the dog arrived. On the request of the Headmaster and Governors, the dog now attends school with Rebecca and alerts the teachers when the young girl's blood sugar levels become high or low. This is the first case where an assistance dog has been permitted to attend a mainstream primary school in the UK.

11.5.3 Claire and Kiska's Story

Claire was diabetic for 40 years, since she was a child. She had always tried to manage her diabetes but for the last 16 years had very little or no hypo awareness, with her sugar levels often dropping as low as 1.1 (values below 4.0 are defined as hypoglycaemic). She was experiencing regular diabetic seizures and collapsing, often on a daily basis.

As a direct consequence of long-term diabetes, she was diagnosed with early stage retinal maculopathy, which is likely to result in loss of sight. Ten years ago she also experienced a heart attack followed by a second, 18 months later. At this point,

Fig. 11.6 Claire and Kiska, her medical alert dog in training

she was collapsing on an almost daily basis, sometimes even several times a day from severe hypos. Her family were constantly worrying and were unable to leave her alone. Research has shown the link of heart attacks to repeating severe diabetic hypoglycemic episodes (Frier et al. 2011). Claire now has a complex heart condition and takes daily medication, some of which masks low blood sugar levels. Her doctors have warned that another severe hypo could cause a further heart attack, which may be fatal.

The charity has placed a dog named Kiska into training as a Medical Alert Dog with Claire (Fig. 11.6), which has already made a difference to the whole family's lives. Although still in training, the dog is accurately alerting on a daily basis, meaning Claire can take appropriate action before her blood sugar levels drop too low. The last severe hypo attack she experienced was in April 2010, the longest she had survived without collapsing since being diagnosed with diabetes. Her retinal maculopathy has also stabilised and her sugar levels are much more balanced, which in turn has assisted in her diabetes related complications.

11.5.4 Neil, Jack and Roots

Roots, a working Cocker Spaniel has become the first Medical Alert Dog to alert two Type 1 diabetics to dangerous drops in their blood sugar levels. Neil and his

Fig. 11.7 Neil and his son Jack with Roots, a trained Cocker Spaniel able to detect dangerous drops in their blood sugar levels

8-year old son Jack are the first to share a Medical Alert Dog. Roots has been specially trained to sniff out drops in both Neil and Jack's blood sugar levels, long before they begin to experience any ill-effects, so that they can treat themselves before their condition escalates to a medical emergency (Fig. 11.7).

Both Neil and Jack were diagnosed with Type 1 diabetes when they were just 2 years old and have been relying on Neil's wife, Sarah, to spot the signs of an oncoming hypo. Although they tried to lead a normal life, they always had to be careful due to their unawareness. This placed a great deal of pressure on Sarah as she was on constant alert. Before Roots moved in with the family, father and son would both collapse with very little warning. On occasions, Sarah would find her husband unconscious downstairs during the night. Since the arrival of their medical alert dog, Neil and Jack are no longer collapsing, because Roots is alerting when one of them has a drop in blood sugar, while retrieving the test kit for either one of

them. This is a great relief to the whole family, giving them greater confidence when they leave the house together with Roots.

11.5.5 Medical Alert Dogs for Diabetics – Further Research

In conjunction with scientists and endocrinologists, the charity is now working to further establish a dog's sensitivity skills and to learn exactly what it is that the dogs are detecting. This study will explore the reliability of the dogs' response, and the factors, which may affect this response. It will also be possible to determine the range of benefits as perceived by the clients.

The organization is empirically assessing the effectiveness of dogs as an intervention modality for people living with diabetes by comparing the range of blood glucose levels of the individuals before and after allocating trained dogs. HbA1c levels and rates of medical emergencies reported are compared before and after placement of trained dogs. In addition, the health and psychosocial benefits of alert dogs are being assessed by means of established interview methodologies and questionnaires.

The National Health Service (NHS) is currently spending £1 million every hour on treating diabetes and its complications, accordingly Medical Alert Dogs have the potential to save money and resources related to these services.

11.5.6 Addison's Disease Alert Dog

Soon after the training of the first blood sugar detection dogs, the charity began to recognize that dogs were able to indicate the changes in odor that occurred with other medical emergencies. In 2009, it was discovered that the same principles applied to people living with Addison's disease, a chronic condition resulting from an adrenal cortex hypofunction/dysfunction with a deficient production of glucocorticoids, mineralocorticoids and androgens. One of the most significant consequences of Addison's disease is the body's failure to adapt to stress and, in the absence of adequate steroid cover, this may result in a state of shock, known as an Addison's crisis requiring urgent treatment. Usually, lifelong replacement therapy with gluco- and mineralocorticoids is required for patients with Addison's Disease.

The charity "Medical Detection Dogs" has trained what is believed to be the world's first dog to reliably detect and alert an oncoming episode of Addision's Crisis. The dog reliably alerts Karen when her cortisol levels drop dangerously, thereby allowing sufficient time for her to self medicate and preventing an emergency hospital admission (Fig. 11.8). Karen, after having regular hospital visits including admissions to intensive care, is now able to manage her condition at home. At the present moment, there are a number of Medical Assistance Dogs in training for individuals with this condition.

Fig. 11.8 Karen with her dog Coco, trained to detect episodes of low cortisol levels

11.6 Future Research

The charity continues to investigate and train dogs for individuals with other debilitating and life threatening conditions, which dogs have the potential to detect through odour. These include severe pain induced seizure and allergic reactions, as well as narcolepsy (a malfunction of the sleep/wake regulating system, which causes sleep attacks and paralysis). As yet, no rigorous data exist as to whether seizure prediction by Seizure-Alert Dogs is better than chance, and what false positive and negative prediction rates might be (Brown and Goldstein 2011; Kirton et al. 2008).

Experienced medical practitioners and those who have worked in countries where there are high incidences of tuberculosis have reported that infected patients frequently have a distinctive breath odour, which distinguishes them from uninfected individuals. This enables an initial diagnosis of such patients. Rapid screening of individuals affected with tuberculosis has developed to a more sophisticated level in southern Africa by the APOPO group. This group has shown that specially trained African giant pouched rats (initially trained to detect land mines) can also be trained to perform reliable screening of human sputum samples, where the reward for successful identification of Tuberculosis, are morsels of food. Published results suggest that pouched rats are a valuable adjunct to, and may be a viable substitute for, sputum smear microscopy as a tuberculosis diagnostic in resource-poor countries (Mahoney et al. 2012).

As assistance animals must reside in our homes and accompany us in social situations, clearly dogs are the species of choice. However, what is clear is that we are just scratching the surface. Dogs evidently have the ability to detect small odor changes that occur as a result of illness. Training of a dog is currently underway to support a young lady with severe narcolepsy and also a woman with a severe life threatening auto-immune/allergic condition. There is great optimism that life-saving preventative cares and measures for these diseases will be successfully provided. All of the training regimens and methods have developed based on anecdotal reports, and the list continues to grow. Many of the anecdotal stories describe dogs displaying fear or an avoidance response to a medical event.

Moreover, it is clear that medical dog assistance care dramatically increases an overall sense of added security and comfort, thereby decreasing anxiety in the affected individuals and limiting potential dangerous situations or episodes. All Medical Detection Dogs have the potential to help and save countless lives. For those living with life threatening and disabling health conditions, having a Medical Detection Dog can make all the difference. Not only can they reduce both the cost of health care and hospital admissions, but more importantly they provide owners with a better quality of life, freedom, and independence.

Whilst the work of medical assistance dogs is overall well accepted by the medical establishment, the use of cancer detection dogs is greeted with scepticism (Lippi and Cervellin 2012). The author of this chapter was inspired to continue this part of the charity's work by her own personal experience and story. In 2009, one of her cancer detection dogs, Daisy, started to behave anxiously around her. Daisy is trained to detect bladder, prostate and renal cancer from small urine samples. However, 1 day she jumped against the author and caused her to feel what felt like a deep bruise in her left breast. Soon thereafter she felt a small lump, which was investigated and diagnosed as a harmless cyst. However, a mammogram and subsequent biopsies revealed a deep cancer well behind this cyst. Through surgery, lymph node removal and radiotherapy, the author came to appreciate firsthand the importance of early diagnosis. The surgeon told her how fortunate she was that the tumour had been detected early, as due to the deep location it would have been detected at least 1–2 years later. A routine mammogram was not necessary for the next 5 years, and the prognosis today would have been very different, if Daisy had not detected it early.

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