Medical Detection Dogs

Dr Claire Guest

CEO and Chief Scientific Officer, Medical Detection Dogs

Medical Detection Dogs
Founded in 2008

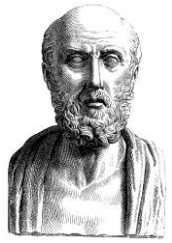
Patron: HRH The Duchess of Cornwall

Medical
Detection Dogs

Volatile Organic Compounds: biomarkers of disease

- Humans emit a 500-600 VOCs

- Varies with age, diet, sex, physiological status, genetic background



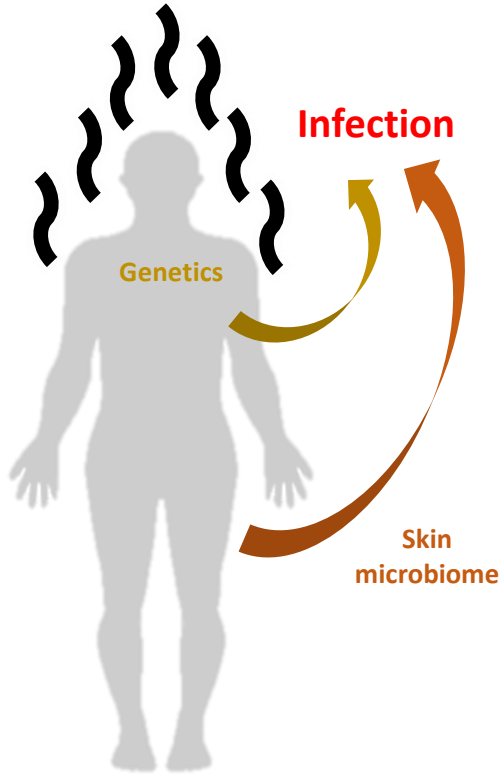
Physicians have used smell to diagnose patients for hundreds of years: Hippocrates (400 BC) recognized the diagnostic usefulness of body odours and reported on several disease-specific odours

- Infection associated VOCs found in body odour (sweat), breath, urine, faeces

Typhoid

TB

Yellow fever



Abd El Qader A, Lieberman D, Shemer Avni Y, Svobodin N, Lazarovitch T, Sagi O, Zeiri Y.. Biomedical Chromatography. 2015 Dec;29(12):1783-90.

Medical Detection Dogs

Medical Detection Dogs approach: dogs detecting human disease

Diagnosis
Bio-Detection Dogs

Assistance
Medical Alert Assistance Dogs

Medical Detection Dogs

Measure of a Diagnostic

- Accuracy
- Affordability
- Accessibility (scalability)

Guest C. and Otto C.M. (2/2020) Editorial: Canine Olfactory Detection. *Frontiers in Veterinary Science, 7:100. doi: 10.3389/fvets.2020.00100 2020*

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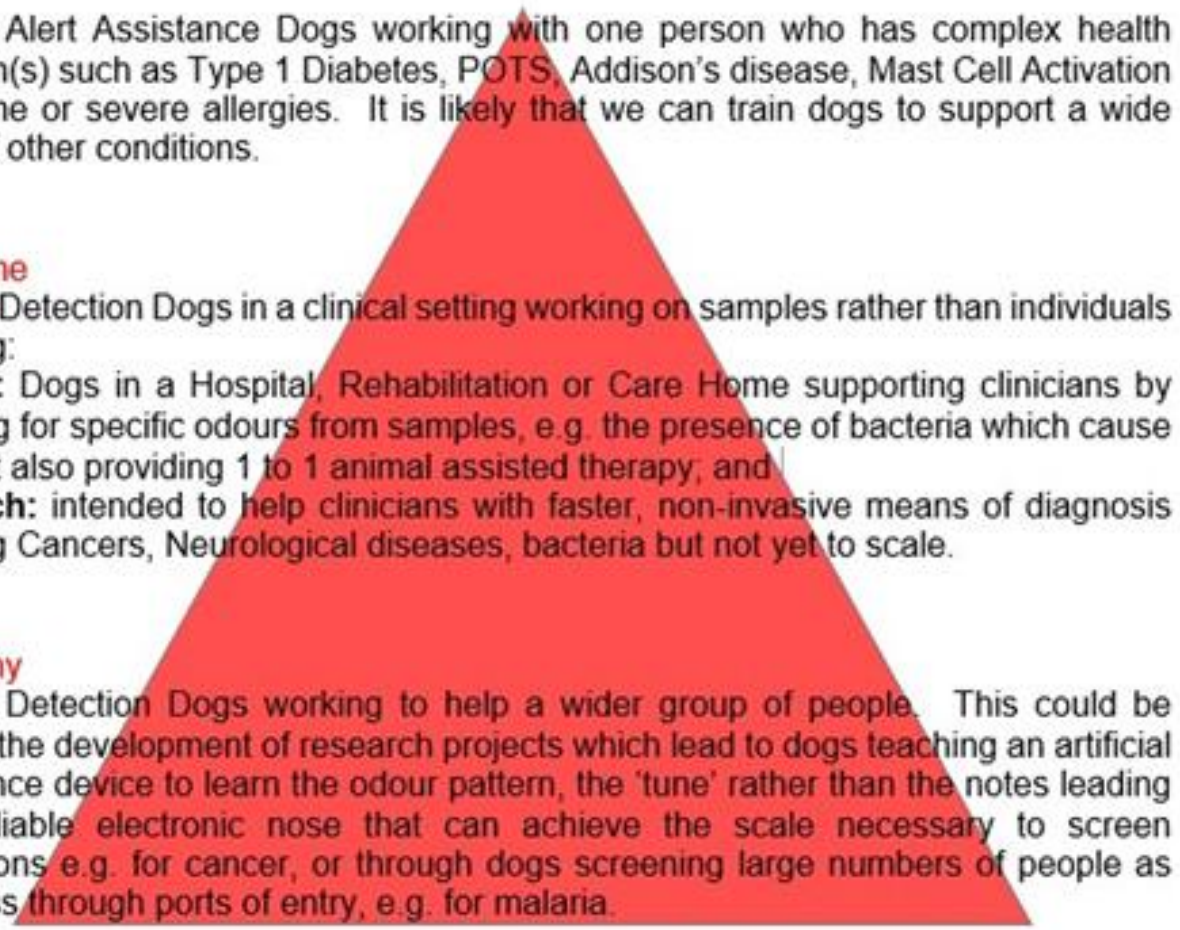
Application and Development



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MDD Method

- Dogs are selected based on internal MDD assessment of performance and suitability for the task
- Dogs are trained to identify the disease odour following a positive reinforcement training process
- Dogs are trained to present a ‘yes’ or ‘no’ behaviour to indicate if a sample is positive or negative
- Samples are presented from both target disease and controls and are tested using double blind protocol
- Rigorous data collection and performance analysis

Medical Detection Dogs

Sample presentation

- Integrity of samples
- Carefully annotated samples
- Strict SOPs for handling and storage
- Dogs learn VOC pattern ‘tune’ of true odour through complex discrimination
- Requirement of multiple new samples without confounders
- Avoid repeated sample exposure

Guest C., Harris R., Anjum I., Concha A., Rooney N. (8/2020) “A lesson in standardisation – subtle aspects of the processing of samples can greatly affect dogs’ learning” *Frontiers in Veterinary Science, 7:525. doi: 10.3389/fvets.2020.00525*

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Target Run

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Blank Run

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Client Partnership: Claire and Magic: Type 1 diabetes

Rooney, N.J., Morant, S. and Guest, C., (8/2013). “Investigation into the value of trained glycaemia alert dogs to clients with type I diabetes”. *PloS one*, *8*(8), p.e69921.
Wilson. C., Morant, S., Kane, S., Pesterfield, C., Guest, C., N.J. Rooney., (3/2019) “An Owner-Independent Investigation of Diabetes Alert Dog Performance”. *Frontiers in Veterinary Science 6:91. doi: 10.3389/fvets.2019.00091*
Rooney, N.J., Guest, C.M., Swanson, L.C. and Morant, S.V., (1/2019). “How effective are trained dogs at alerting their owners to changes in blood glycaemic levels?: Variations in performance of glycaemia alert dogs.” *PLoS ONE*, *14*(1), p.e0210092.

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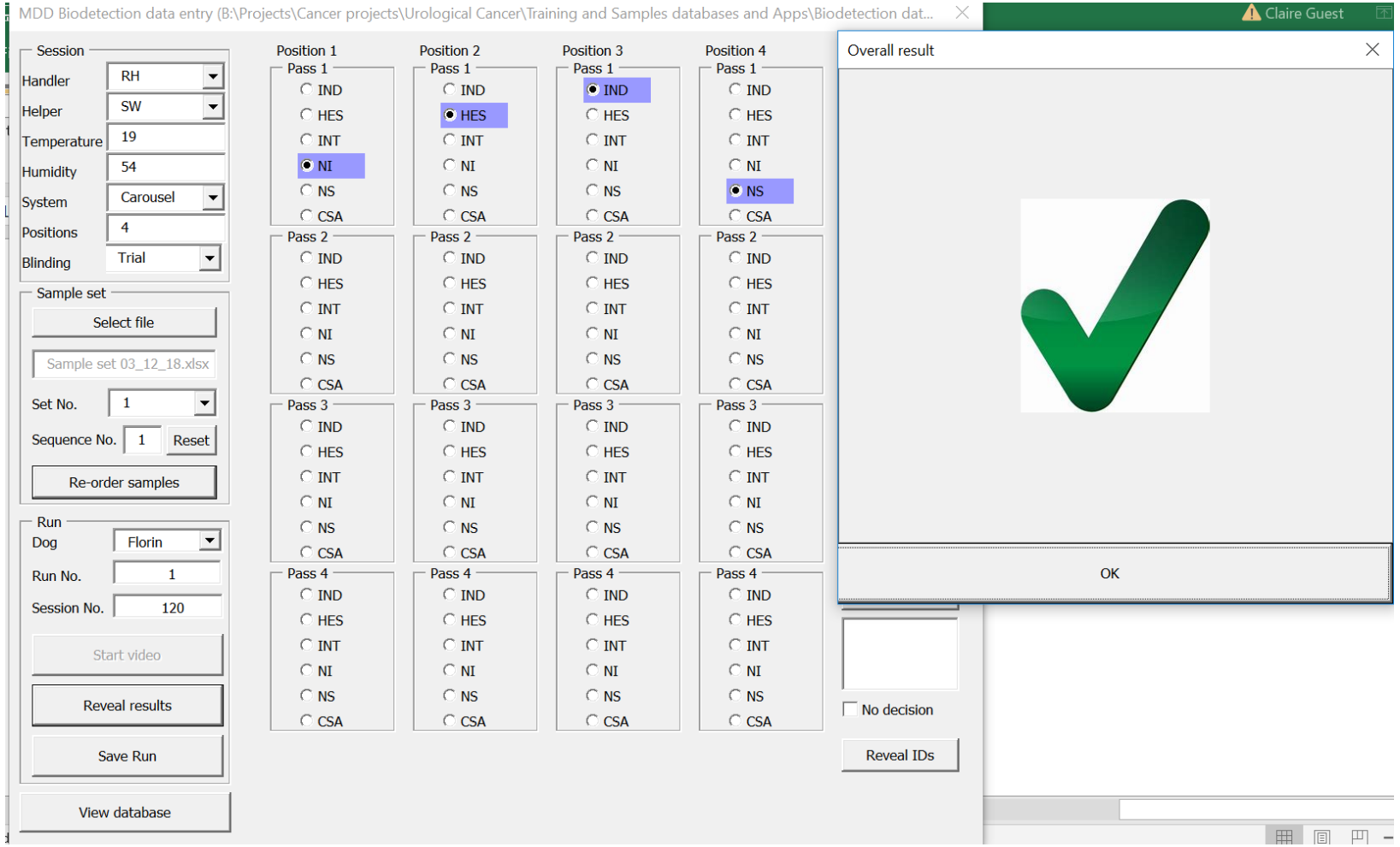
Data-Evaluate



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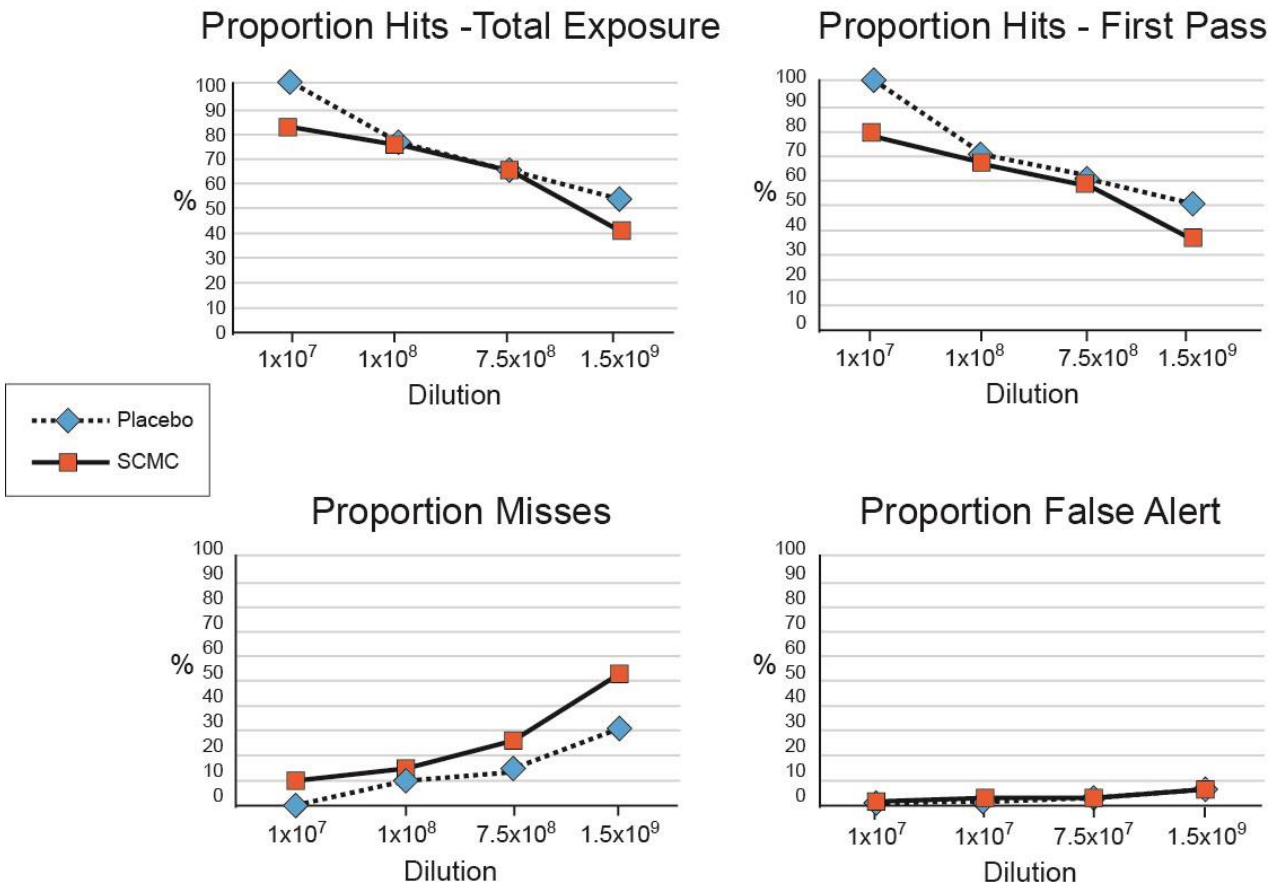
Evaluate: olfactory thresholds

- We can influence the canine sensitivity and specificity through reinforcement schedules



Concha, A., Mills, D.S., Feugier, A., Zulch, H., Guest, C., Harris, R., Pike, T.W: Using sniffing behaviour to differentiate true negative from false negative responses in trained scent-detection dogs. Chemical Senses, Sept. 2014.

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Canine interface for detection dogs

- The olfactory performance in detection dogs may be influenced by training factors such as handler errors (Back and McLean 2003; Lasserter et al. 2003; Wasser et al. 2004; Lit et al. 2011)
- The impact of external factors on the olfactory detection performance can only be measure based on the presence/absence of the trained alert response
- No trained alert for equivocal response –is ‘grey’ yes or no..

Medical Detection Dogs

Improved Understanding of Canine Training and Decision Making, and Communication to Empower Our Dogs

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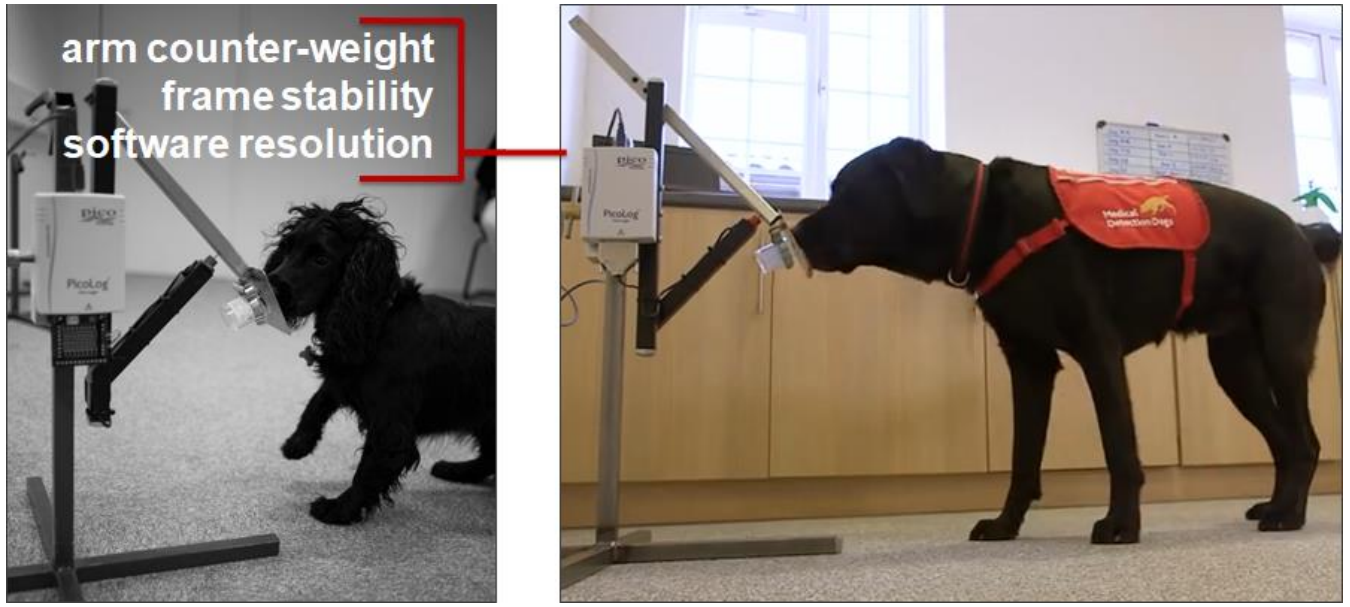
Interactive stands

- We are developing new technology with a sensor pad designed to sense the level of pressure the dog exerts whilst sniffing
- The level of pressure is recorded by a computer that is attached to the stand, this indicates the level of certainty that the dog has the particular disease is present



Mancini, C., Harris, R., Aengenheister, B., Guest, C. (4/2015). “Re-Centering Multispecies Practices: a Canine Interface for Cancer Detection Dogs”, *33rd* International ACM CHI Conference on Human Factors in Computing Systems, ACM CHI’15, *ACM Press*, pp. 2673

Medical Detection Dogs

Interactive stands

Mancini, C., Harris, R., Aengenheister, B., Guest, C. (4/2015). “Re-Centering Multispecies Practices: a Canine Interface for Cancer Detection Dogs”, *33rd* International ACM CHI Conference on Human Factors in Computing Systems, ACM CHI’15, *ACM Press*, pp. 2673

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Bio- detection projects: Malaria

- Trained dogs identified asymptomatic malaria infection with a high degree of accuracy in children - 81% sensitivity and 92% specificity.
- In line with the WHO's criteria for the procurement of rapid diagnostic tests.


THE LANCET
Infectious Diseases

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CORRESPONDENCE | VOLUME 19, ISSUE 6, P578-580, JUNE 01, 2019

PDF [56 KB]

Trained dogs identify people with malaria parasites by their odour

Claire Guest • Margaret Pinder • Mark Doggett • Chelci Squires • Muna Affara • Balla Kandeh • et al. Show all authors

Published: June, 2019 • DOI: https://doi.org/10.1016/S1473-3099(19)30220-8

Supplementary Material

Eliminating malaria would be simpler if a non-invasive method was available for detecting infected individuals in populations with low malaria prevalence. Infected individuals could then be treated with

Guest, C., Pinder, M., Doggett, M. et al. Trained dogs identify people with malaria parasites by their odour. Lancet. Infect. Dis. 2019; 19, 578–580

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Bio- detection projects: Pseudomonas

Davies JC, Alton E, Simbo A, Murphy R, Seth I, Williams K, Somerville M, Jolly L, Morant S, and Guest C., (11/2019) Training dogs to differentiate Pseudomonas aeruginosa from other cystic fibrosis bacterial pathogens: not to be sniffed at?. *Eur Respir J 2019*

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Bio- detection projects: Cancer

Church, J. and Williams, H., (2001). "**Another sniffer dog for the clinic?**" *The Lancet*, *358*(9285), p.930.

First robust published paper, BMJ 2004:
Willis, C.M., Church, S.M., Guest, C.M., Cook, W.A., McCarthy, N., Bransbury, A.J., Church, M.R. and Church, J.C., (2004). "**Olfactory detection of human bladder cancer by dogs: proof of principle study**". *BMJ*, *329*(7468), p.712.

Willis, C.M., Britton, L.E., Harris, R., Wallace, J. and Guest, C.M., (2011). "**Volatile organic compounds as biomarkers of bladder cancer: Sensitivity and specificity using trained sniffer dogs**". *Cancer Biomarkers*, *8*(3), pp.145-153.

C. Guest, R. Harris, K. Sfanos, A. Partin, B. Trock, L. Mangold, H. Steen, R. Bader, A. Kozak, J. Simons, H. Soule, T. Johnson, W-Y Lee, F. Tourlomousis, T. Karydis, P. Stathatou, S. Thaler, A Spiliotopoulos, M. Weinstein, B. Chen and A. Mershin "**GC-MS and Canine/Machine Olfaction for Early Prostate Cancer Diagnostics**" poster presented: (2019) 26th Annual Prostate Cancer Foundation Scientific Retreat

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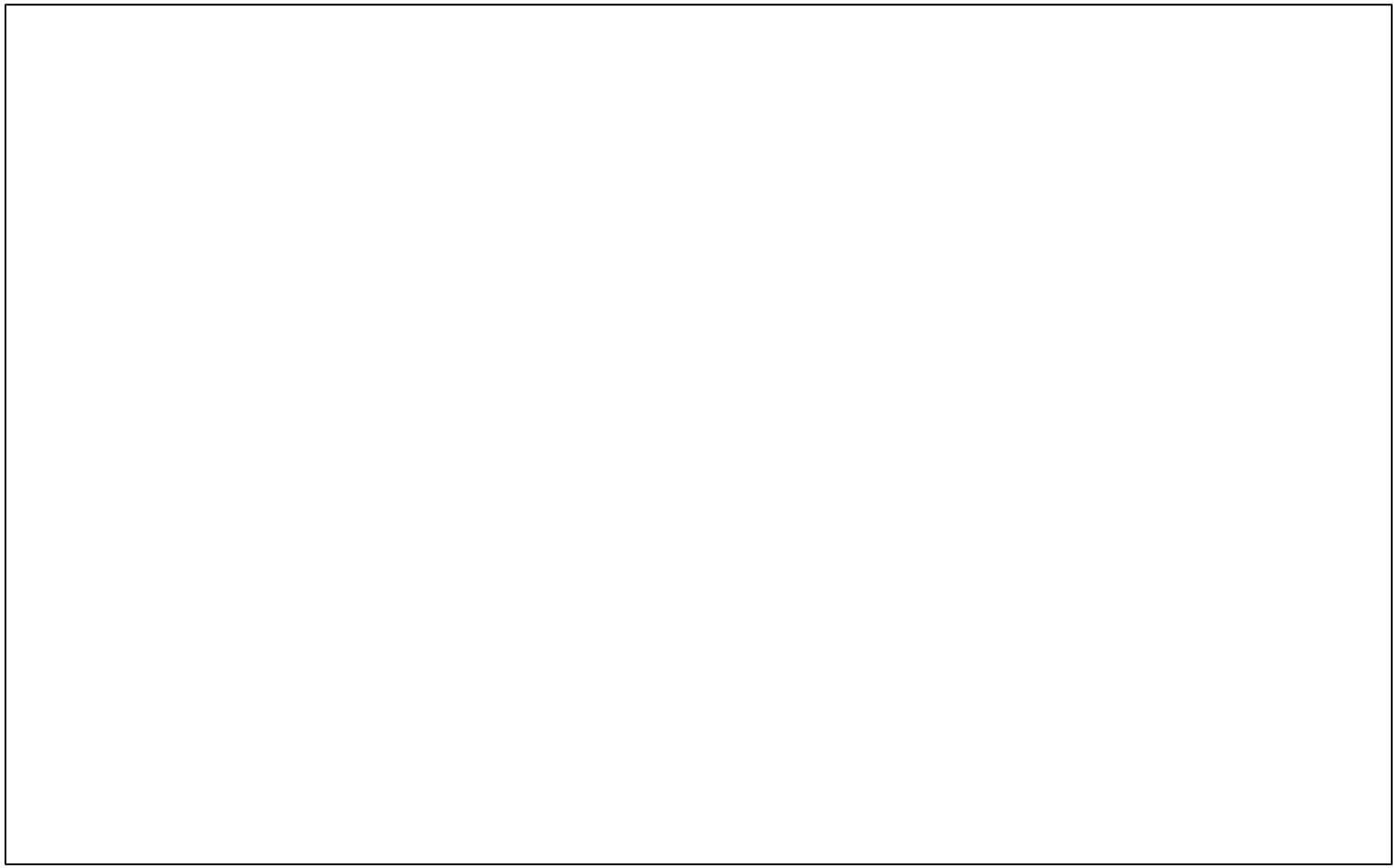
Dog detection to electronic application



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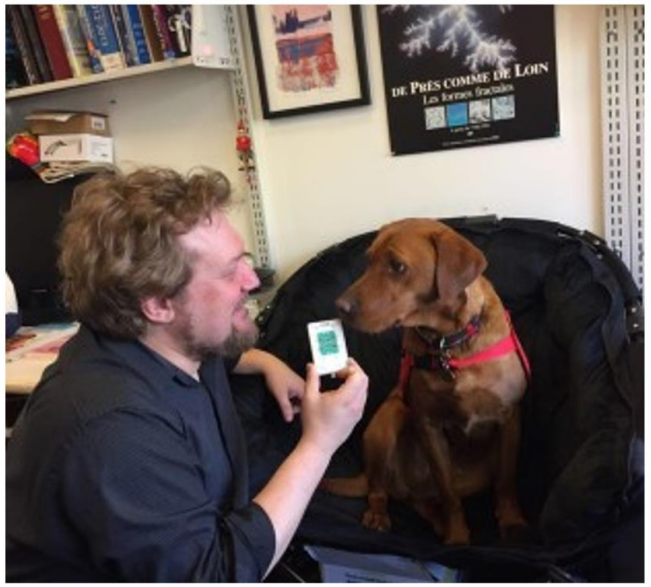
Development of Bio- Nose

Smell, the final frontier. To boldly go where no man has gone before.



Guest C, Harris R, Sfanos KS, Shrestha E, Partin AW, Trock B, et al. (2/2021) “Feasibility of integrating canine olfaction with chemical and microbial profiling of urine to detect lethal prostate cancer”. *PLoS ONE 16(2): e0245530*

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COVID-19 Detection: Phase 1

Millie, aged 4, Golden Retriever

Tala, aged 3, Labrador

Marlow, aged 4, Labrador

Kyp, aged 4, Labrador X Golden Retriever

Asher, aged 8, Working Cocker Spaniel

Lexi, aged 5, Labrador

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COVID-19 Detection: Phase 1

- COVID-19 infection does have a distinct odour
- Dogs can detect it with incredible speed and accuracy, achieving a sensitivity range of 82·1 to 94·3% and a specificity range of 76·4 to 92·0%
- The accuracy of dogs is consistent – detecting asymptomatic cases, and when the viral load is low
- Dog screening plus a PCR test could prevent more onward transmission than isolating symptomatic individuals only, or testing people with a LFT plus a PCR test

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What Next? – Development

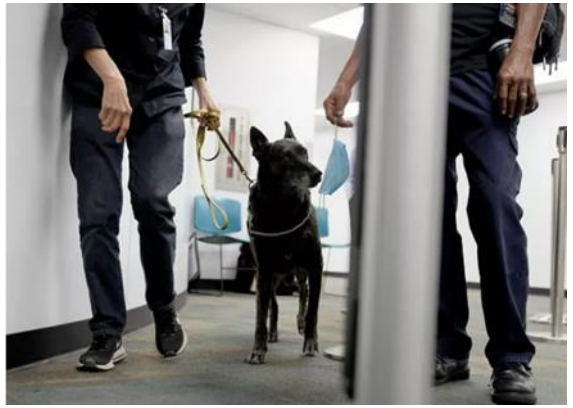
Screening by Sample	Indirect Screening	Passive Screening
		

Image Credit: Joe Raedle/Getty

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Passive Search: Association of Covid-19 and Ball Reward

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Restrictive Factors: Passive Screening

Samples	Training	External
Procurement of continuation training samples	Random or inconsistent exposure to training sample materials	Limited access to training & test locations
Sample collection materials: storage, uses & shelf-life	Odour 'Tags' developed during training	Changes in UK covid legislations including removal of testing & self-isolation
Procurement of Covid-19 positive participants for transition & continuation training	Transition from collected samples to direct detection	Varied rates of infection

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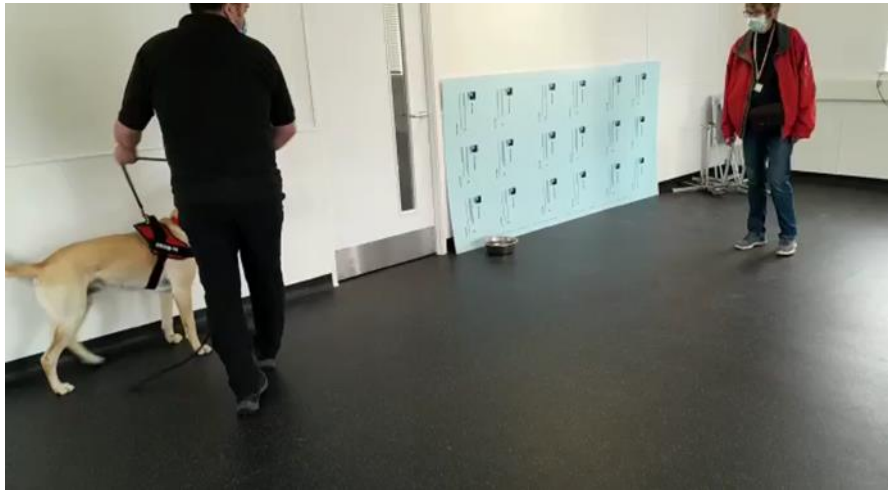
Target: Position 3
Confirmed Positive by LFT (Day 1)
Dog: Storm
Run: 1
Indication: **NO**



Target: Position 2
Confirmed Positive by LFT (Day 4)
Dog: Storm
Run: 1
Indication: **YES**

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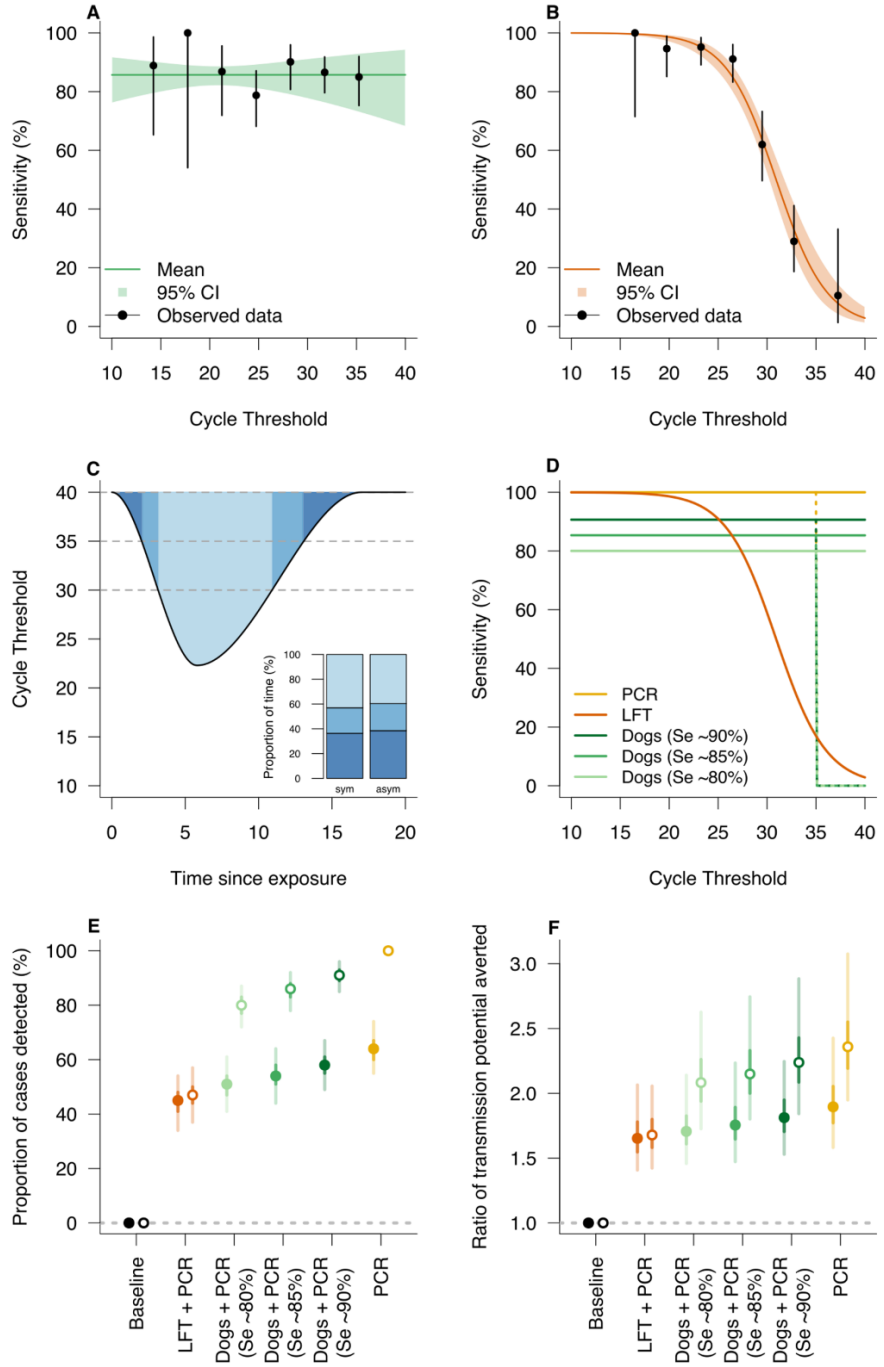
Mathematical modelling

- Dogs could be highly effective in detecting cases and averting transmission.
- Dogs detect low viral loads.
- 91% of cases detected with dog screening plus PCR test strategy.
- LFT plus PCR test strategy less effective in comparison.
- Dogs are significantly quicker



Mathematical modelling

- Two dogs could screen 300 people in 30 minutes.
- PCR testing only needed on those identified as positive by the dogs.
- Dogs may also serve as a visual deterrent.
- Possibilities for use at other mass gatherings.

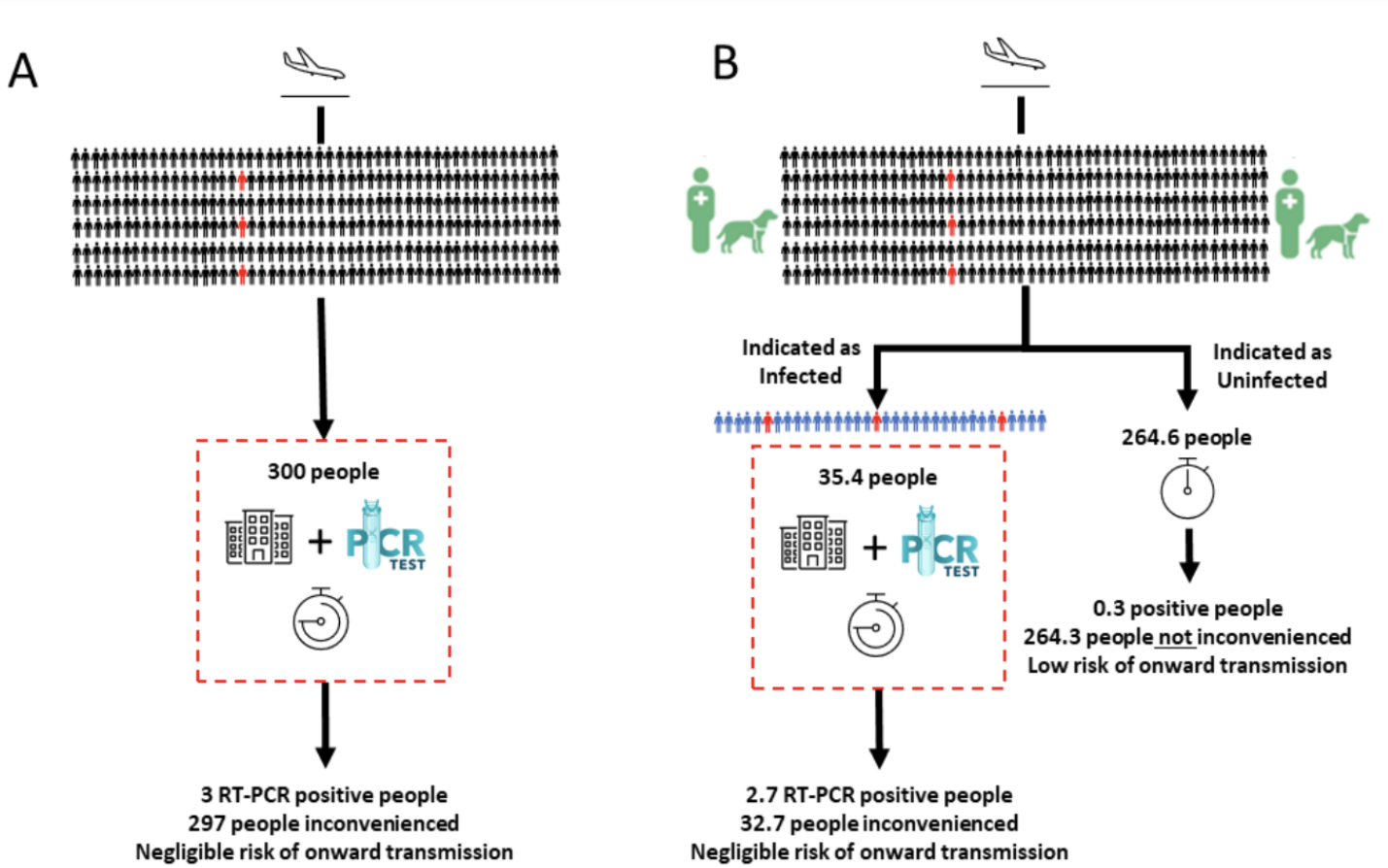
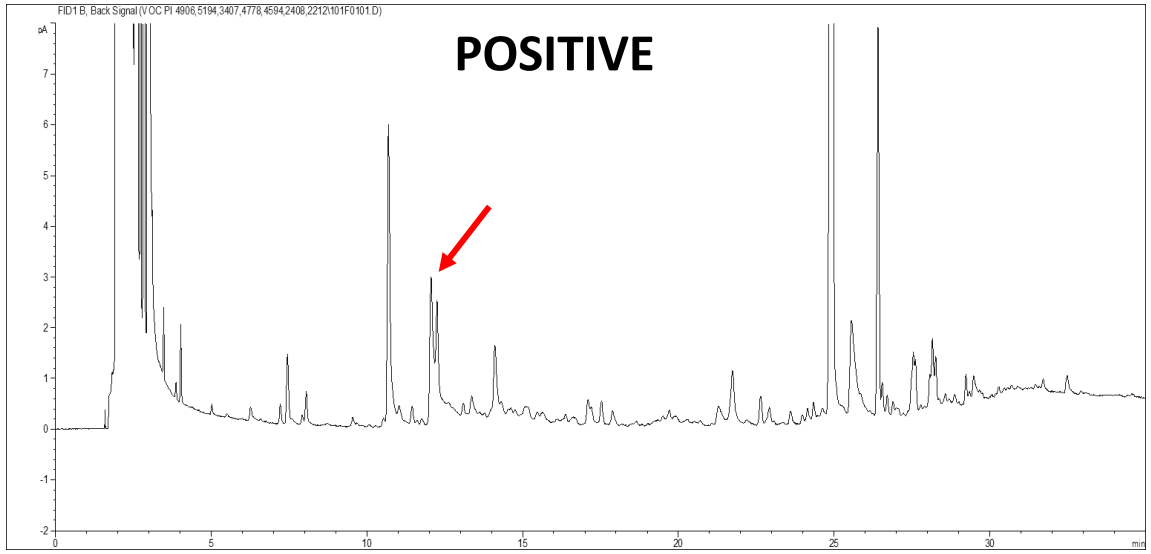
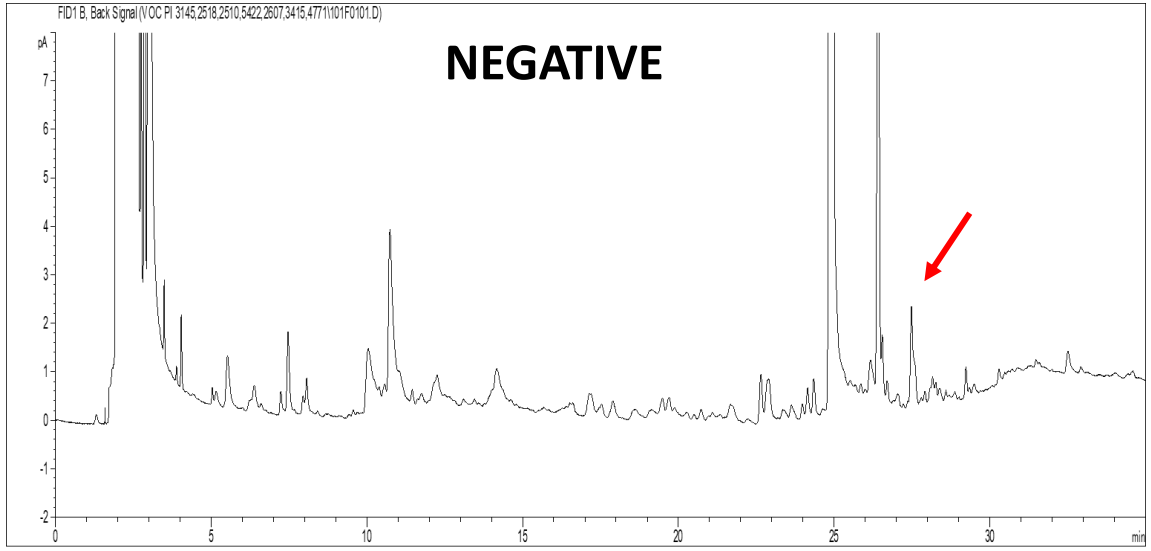


Figure 4: **Exemplar of (A) Current SARS-CoV-2 Strategy and (B) Proposed Rapid Screen and Test Strategy.** Schematic outlining the number of true negatives (black) and true

VOC analysis

- Approximately 15 compounds significantly different.
- Hexanal, 5-methylhexanal, heptanal, 2-octanone, 7-octenal, nonanal, and 2-methyldodecane (tentative identification)
- Sensors





* In collaboration with Roboscientific Ltd, Littleport, Cambridgeshire.

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ARCTECH INNOVATION
LONDON SCHOOL of HYGIENE &TROPICAL MEDICINE
Durham University

Client Partnerships

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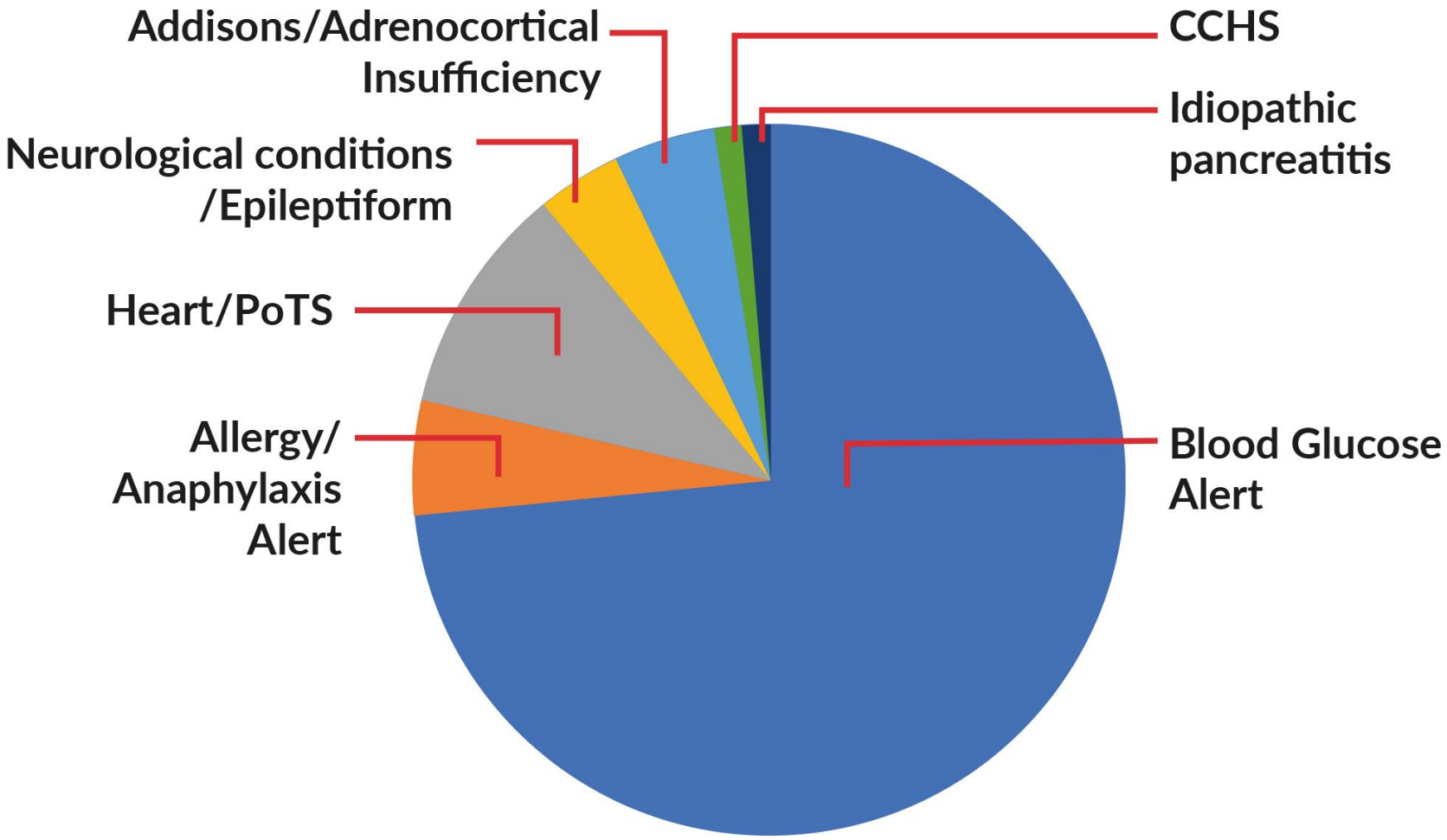
Qualified Partnerships by Condition



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Summary

- Canine bio sensor
- Robust evidence based data
- Advanced training and communication methods
- Canine welfare
- Appropriate application of canine for maximum impact
- Scaleable responses to disease detection

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