ONE HEALTH

Rabies and Other Disease Risks from Free-roaming Dogs

Paris, November 5th – 6th, 2013

World Organisation for Animal Health

WSAVA One Health Committee

Programme

Tuesday 5th November

08.00 – 09.00	**Registration**
09.00 – 09.15	**Welcome and introductory remarks** Dr B. Vallat (OIE) and Prof. J. Kirpensteijn (WSAVA)
09.15 – 09.30	**Introductory comments: small companion animals in One Health** Chair, WSAVA One Health Committee: Prof. M. J. Day
09.30 – 10.00	**Understanding the ecology of free-roaming dogs for the purposes of rabies control** M. Morters
10.00 – 10.30	**The welfare of free-roaming dogs** Dr E. Hiby
10.30 – 11.00	**The role of the OIE as the international standard-setting organization for animal health and welfare** Dr A. Thiermann
11.00 – 11.30	Coffee break
11.30 – 12.00	**General discussion: free-roaming dogs**
12.00 – 12.30	**Canine rabies virus: the disease, the problem and current global recommendations for control and elimination** Prof. S. Cleaveland
12.30 – 13.00	**Successful rabies control: examples in Africa** Prof. L. H. Nel
13.00 – 14.00	Lunch break
14.00 – 14.30	**Successful rabies control: examples from Asia** Dr M.E. Miranda
14.30 – 14.45	**Rabies control in India** Major General R. Kharb
14.45 – 15.00	**Mission Rabies** L. Gamble
15.00 – 16.30	**General discussion: rabies control**
16.30 – 17.00	Tea break
17.00– 17.30	**Small companion animal disease surveillance: current systems and how they may integrate with the OIE WAHIS system** Dr A. Radford
17.30 – 18.00	**General discussion: small companion animal disease surveillance**
18.00 – 19.00	Evening reception

Wednesday 6th November

09.00 – 10.00	**Rapporteur's report (draft position statement)**
10.00 – 10.30	**Canine leishmaniosis: the disease, the problem and current approach to control and elimination** Prof. C. Palatnik de Sousa
10.30 – 11.00	**General discussion: control of leishmaniosis**
11.00 – 11.30	Coffee Break
11.30 – 11.55	**Bartonellosis: a One Health approach to an emerging infectious disease** Prof. E. Breitschwerdt
11.55 – 12.15	**General discussion: parasitism and vector-borne disease**
12.15 – 13.15	**General discussion on draft position statement**
13.15 – 13.30	**Concluding statements and End of symposium** Prof. M. J. Day

Welcome to our 1.5 day symposium on *One Health: Rabies and Other Disease Risks from Free-roaming Dogs* presented jointly by the OIE and the World Small Animal Veterinary Association (WSAVA) One Health Committee.

As the One Health movement gathered momentum in recent years, it became apparent that the major focus of new initiatives was on interactions between people, the environment, wildlife and farmed animals. It was clear to those of us who work principally with small companion animals (chiefly domestic dogs and cats) that a large element of the interaction between people and animals was missing from the One Health agenda. For that reason, in 2010 the WSAVA established its own One Health Committee, with the remit of ensuring the representation of the small companion animal sector at the global One Health table. This we have very successfully achieved, through a combination of scientific publication, conference presentations and applied projects, and we were delighted in 2011 to be recognized by the OIE through the signing of a Memorandum of Understanding between our organizations. The present symposium is the culmination of the first three years' work of the WSAVA One Health Committee. We have brought together international opinion leaders on the control of rabies and other canine infectious diseases that remain prevalent in African and Asian countries, and we hope that through our discussions we can formulate some broad recommendations for addressing these significant One Health problems.

I would like to acknowledge members of the One Health Committee who have helped put together the programme for our meeting, the BSAVA Events Management Team who have co-ordinated our logistical requirements and, most importantly, our sponsors who have allowed the symposium to become a reality.

The WSAVA represents some 180,000 small companion animal veterinarians in 76 member countries. We hope that with the support of OIE and national governments our members can make a tangible difference to the canine and human populations of developing countries. I hope that we have a productive meeting.

Professor Michael J. Day

BSc BVMS(Hons) PhD DSc DiplECVP FASM FRCPath FRCVS

Symposium Convenor

President, British Small Animal Veterinary Association

Chairman, WSAVA One Health Committee

Rabies still causes up to 70,000 human deaths every year. More than 95 percent of human rabies cases are transmitted by dogs. Yet, rabies can be prevented at animal source; vaccination of dogs remains the most cost-effective single intervention that protects humans from contracting the disease. In most cases, vaccination of 70% of a dog population leads to rabies eradication in dogs.

The World Organisation for Animal Health (OIE) raises global awareness on the need to control rabies in dogs. Through the One Health concept the OIE encourages public–private partnerships in order to provide help to its Member Countries with implementing appropriate prevention and control methods as found in OIE's international standards. In close collaboration with major donor organizations, the OIE has already established regional vaccine banks to support the fight against rabies.

Rabies is an OIE-listed disease and, as such, Member Countries have an obligation to notify its occurrences to the OIE. Companion animal veterinarians play an essential role in raising public awareness and in controlling the disease in domestic dogs as well as in free-roaming dogs, but also as first sentinels to sound the alarm.

As Director General of the World Organisation for Animal Health (OIE), I am pleased to co-host this Symposium at OIE's headquarters and I would especially highlight the importance of the collaborative efforts with the World Small Animal Veterinary Association (WSAVA), which plays a key role in promoting the 'One Health' concept and the permanent link between human health, animal health and the environment.

Dr Bernard Vallat

General Director, OIE

Realizing that still approximately 70,000 people, mainly children, still die from rabies every year, makes you realize that we as a veterinary community need to get to action. Rabies is a containable disease with the proper measures and vaccination schemes. The question is really: why can't we get it done?

As President of the WSAVA, I am extremely proud to have a Memorandum of Understanding with OIE, representing the global veterinary companion animal community. It is a great honour to host this extremely important meeting at OIE (the World Health Organisation for Animal Health), our partner in our efforts to eliminate this disease from the earth.

This meeting will bring together the major stakeholders in rabies prevention and the veterinary politicians that can make a difference. After rinderpest, rabies should be the next disease that will disappear thanks to the close cooperation of all involved in the rabies arena. This means that human and veterinary medicine need to work very close together under the One Health umbrella.

The time is here to make a difference. The time is here to start acting appropriately and to get everybody together for the same goal. Rabies is something that really should be of the past. Let's prevent the disease instead of allowing victims to come into contact with it and spend so much in treatments. WSAVA is committed to battling rabies all over the world by uniting stakeholders and forming an active front against the global rabies threat.

Professor Jolle Kirpensteijn

President, WSAVA

Invited speakers

Professor Edward B. Breitschwerdt

Dr Edward B. Breitschwerdt is a professor of medicine and infectious diseases at North Carolina State University College of Veterinary Medicine. He is also an adjunct professor of medicine at Duke University Medical Center, and a Diplomate, American College of Veterinary Internal Medicine (ACVIM). Dr Breitschwerdt directs the Intracellular Pathogens Research Laboratory in the Center for Comparative Medicine and Translational Research at North Carolina State University. He also co-directs the Vector Borne Diseases Diagnostic Laboratory and is the director of the NCSU-CVM Biosafety Level 3 Laboratory.

A graduate of the University of Georgia, Dr Breitschwerdt completed an internship and residency in Internal Medicine at the University of Missouri between 1974 and 1977. He has served as president of the Specialty of Internal Medicine and as chairman of the ACVIM Board of Regents. He is a former associate editor for the *Journal of Veterinary Internal Medicine* and was a founding member of the ACVIM Foundation.

Dr Breitschwerdt's clinical interests include infectious diseases, immunology and nephrology. For over 20 years, his research has emphasized vector-transmitted, intracellular pathogens. Most recently, he has contributed to cutting-edge research in the areas of animal and human bartonellosis. In addition to authoring numerous book chapters and proceedings, Dr. Breitschwerdt's research group has published more than 300 manuscripts in peer-reviewed scientific journals. In 2012, he received the North Carolina State University Alumni Association Outstanding Research Award and in 2013 he received the Holladay Medal, the highest award bestowed on a faculty member at North Carolina State University.

Professor Sarah Cleaveland

BSc BA VetMB PhD MRCVS FRSE

Prof. Sarah Cleaveland is a veterinary epidemiologist at the University of Glasgow at the Institute for Biodiversity, Animal Health and Comparative Medicine. After training as a veterinarian at Cambridge University, in1988 she worked for a year in general practice before embarking on a research career based in East Africa, addressing disease problems at the human–domestic animal–wildlife interface. She obtained her PhD in 1996 from the London School of Hygiene and Tropical Medicine, and subsequently worked at the Centre for Tropical Veterinary Medicine, University of Edinburgh, before moving on to the University of Glasgow in 2008.

In terms of zoonotic diseases, she and her group work to identify animal reservoirs of infection, to understand risk factors of new and emerging zoonotic diseases, and to design cost-effective disease control strategies to improve human, animal and ecosystem health. Most notably, her research on rabies has demonstrated that eliminating canine rabies in Africa is feasible and would provide a cost-effective way of preventing human rabies deaths. She is currently working on several livestock disease projects at the wildlife–livestock interface in Tanzania, including epidemiological studies of endemic foot-and-mouth disease and vaccine trials for malignant catarrhal fever, and has an integrated human–animal health research programme focusing on zoonotic diseases that cause human febrile illness, including brucellosis, Q-fever and leptospirosis.

In 2008 Prof. Cleaveland was presented with the Trevor Blackburn Award in recognition of her veterinary work overseas by the British Veterinary Association. She is also a founding Director of the Alliance for Rabies Control (www.rabiescontrol.org), which spearheads the World Rabies Day campaigns (www.worldrabiesday.org) and received the UK Charity of the Year award for health care in 2013.

Professor Michael J. Day

BSc BVMS(Hons) PhD DSc DiplECVP FASM FRCPath FRCVS

Michael Day qualified as a veterinary surgeon from Murdoch University (Western Australia) in 1982. After a period in small animal practice he returned to Murdoch to complete a Residency in Microbiology and Immunology, and a PhD involving collaborative research with the Royal Perth Hospital. Michael held postdoctoral positions in experimental immunology at the Universities of Bristol and Oxford, and in 1990 returned to Bristol where he is currently Professor of Veterinary Pathology and Director of Diagnostic Pathology. His research interests cover experimental models of autoimmunity and a range of companion animal immune-mediated and infectious diseases. Michael has published widely in the field of immunopathology and is author of the textbooks *Clinical Immunology of the Dog and Cat* (in second edition) and *Veterinary Immunology: Principles and Practice* (second edition in press). He is co-editor of the *BSAVA Manual of Canine and Feline Haematology and Transfusion Medicine* (in second edition) and the texts *Arthropod-Borne Infectious Diseases of the Dog and Cat* and *Canine and Feline Gastroenterology*. He is a diplomate of the European College of Veterinary Pathology, and holds fellowships of the Australian Society for Microbiology, the Royal College of Pathologists and the Royal College of Veterinary Surgeons. Michael is Editor-in-Chief of the *Journal of Comparative Pathology*. He is currently President of the BSAVA. Michael is also chairman of the WSAVA Scientific Committee, the WSAVA Vaccination Guidelines Group and the WSAVA One Health Committee. He is a member of the Petplan Charitable Trust Scientific Committee and Vice President of the WSAVA Foundation. Michael is co-founder of a university spin-out company, KWS Biotest Ltd, where he is Director of Pathology. He has been the recipient of the BSAVA Amoroso Award for outstanding contribution to small animal studies (1999), the BSAVA Petsavers Award (2000, 2006 & 2007), the RCVS Trust's G. Norman Hall Medal for outstanding research into animal diseases (2003) and the Petplan Charitable Trust Scientific Award (2009).

Luke Gamble

BVSc MRCVS

Luke Gamble is the founder and chief executive of Worldwide Veterinary Services (WVS) and Mission Rabies. He graduated from Bristol University in 1999 and then completed a clinical scholarship at Cambridge University 2001–2002 in large animal medicine and surgery, building experience in dealing with both wildlife and domestic animals.

Luke works for WVS on a voluntary basis. He is the founding partner of Pilgrims Veterinary Practice, a five-vet mixed practice in the New Forest, UK, and a founding director of PetAir UK and PetAir SA.

In 2010 Luke was awarded the JA Wight Memorial Award by the British Small Animal Veterinary Association, for outstanding contributions to the welfare of companion animals.

Dr Elly Hiby
PhD

Elly Hiby is an Independent Animal Welfare Consultant and Scientific Coordinator for the International Companion Animal Management (ICAM) Coalition. Previously she worked at Dogs Trust as International Director, covering a range of dog welfare issues around the world, but with a focus on humane dog population management. Prior to working at Dogs Trust, Elly worked for the World Society for the Protection of Animals (WSPA) for 8 years, including leading on the companion animal welfare programme and advising on humane rabies control internationally. She has also worked as a technical expert with the World Animal Health Organisation (OIE), the World Health Organisation (WHO), and the Food and Agriculture Organisation (FAO) on dog population management.

In 2006 whilst working for WSPA, Elly and contemporaries from Royal Society for Protection of Animals, Humane Society International and International Fund for Animal Welfare formed the ICAM Coalition. This coalition aims to improve understanding of effective population management by sharing experience and data from past and current non-profit projects and by combining knowledge to produce documents outlining best practice. In her current role with ICAM Coalition she leads the Indicators Project, aiming to develop guidance on monitoring and evaluation of dog population management to support academics, practitioners and funders to track progress, learn and subsequently improve their impact through the use of measurable indicators.

Prior to joining WSPA, Elly completed a PhD in dog welfare and behaviour, with a focus on improving the welfare of working dogs and the impact of training methods on pet behaviour. However, her passion for animal welfare has led to work with many other species, from training horses under the guidance of 'horse whisperer' Monty Roberts to surveying wild seal populations along the UK coastline.

Maj. Gen. (Retd) Dr R. M. Kharb
AVSM

Maj. Gen. Kharb is a distinguished veterinarian from India with over five decades of professional experience. He was commissioned into the Remount and Veterinary Corps (RVC) of the Indian Army in 1962, rose to become Director General of Corps and retired after 38 years of service. He was decorated with the ATI VISHIST SEVA MEDAL by the President of India for rendering outstanding services to the nation. In recognition of his significant contribution towards advancement of veterinary science, he has also been awarded a prestigious fellowship of the National Academy of Veterinary Sciences, India.

Currently, he is the Chairman of Animal Welfare Board of India (AWBI), a statutory and advisory body of the Government of India, functioning under the Ministry of the Environment and Forests. The Board has initiated several new initiatives for the welfare of animals under his Chairmanship. He has promoted the Animal Birth Control/Rabies immunization programme in order to address the challenge of rabies. Gen. Kharb is the first veterinarian to have been appointed as Chairperson of AWBI in the 50 years history of the Board.

Michelle Morters

BVSc MRCVS

Michelle was a veterinary surgeon in general practice in New Zealand and the UK (1995–2005) before becoming IFAW Program Manager for the global Companion Animals Program (2005–2006). Since 2007, she has been undertaking studies towards a PhD at the University of Cambridge, while concurrently acting as a veterinary advisor to IFAW.

As IFAW Program Manager she was responsible for overseeing the development and implementation of the strategic plan for the Companion Animals Program. This required extensive collaboration with colleagues in over a dozen country offices and on-the-ground evaluation of programmatic work, which focused primarily on developing communities. The aim of each project was tailored according to local need; e.g. work in Bali and Dominica aimed to reduce the number and improve the health of the roaming dogs, whilst in South Africa the aim was to deliver veterinary services to impoverished communities. All project work combined facets of veterinary services, education, adequate guardianship and local capacity building.

Together with colleagues from IFAW and academic institutions, Michelle developed policy on population management, adequate guardianship and euthanasia and standards on primary veterinary health care, and companion animal behaviour and modification.

As a member of ICAM, she participated in the development of population management guidelines for dogs (published and distributed) and cats (in final development). On behalf of ICAM and in cooperation with the WHO, Michelle evaluated the welfare aspects of vaccine delivery for the Gates-funded rabies control program in KwaZulu-Natal, South Africa.

Professor Louis H. Nel

Leader, Viral Zoonosis Group, University of Pretoria

This abbreviated resumé is intended to reflect my expertise in the rabies field. I have led numerous rabies-related research programmes that are ultimately focused on a global quest to eradicate rabies, one of the most feared and deadly viral diseases ever known to man. Our research relies on state-of-the-art methods in molecular biology, and specific research topics include diagnostic development, vaccinology, immune contraception, viral pathogenesis, host/virus ecology, molecular epidemiology and virus evolution. Apart from about 150 international publications and regular appearances as invited speaker at scientific events, recognition for my research and stature is reflected in international roles and activities – some of which are described below.

In the international arena, I have championed the case of South Africa as a leader in the developing world that can globally showcase and demonstrate the potential for dog rabies elimination. South Africa was successful and the dog-rabies endemic province KwaZulu-Natal was selected, along with sites in Tanzania and the Philippines. This project was launched in 2009 by the Global Alliance for Rabies Control (GARC), who, together with the World Health Organization (WHO), secured a 5-year sponsorship for the project from the Bill and Melinda Gates Foundation (BMGF). Currently I serve on the International Steering Committee for the larger BMGF/WHO rabies control programme and I am also the custodian for the KZN project within this programme.

I have been the scientific advisor to the African rabies organization, SEARG and was the Chair and organizer of the past five bi-annual meetings, the most recent having been held in Mozambique (October 2011) and Tanzania (November 2013). To this end, I have personally secured all the funding for these meetings, including the full sponsoring of nominated delegates from African member countries.

Apart from the BMGF/WHO international rabies programme steering committee, I have served as advisor to the WHO for some years. From 31 May 2012 I was appointed, on scientific grounds, as a permanent member of the WHO Expert Advisory Panel on Rabies. I served as the Chair for the WHO expert consultation in Geneva at the end of 2012.

Mary Elizabeth G. Miranda

DVM DVPH

Currently Director for Asia of the Global Alliance for Rabies Control, she is a field epidemiologist and public health veterinarian. She was Head of the Veterinary Research Department of the Research Institute for Tropical Medicine, Department of Health Philippines. She was a Fellow of the Field Epidemiology Training Program and belonged to a pool of early emergency responders for the Philippine Department of Health. From 2002–2005, she was regional focal point for rabies and other zoonoses for the WHO Western Pacific Regional Office and worked on rabies, SARS, avian influenza and other emerging zoonoses. From 2006–2010, she was regional veterinary epidemiologist and infectious diseases specialist for the FAO Regional Office for Asia and the Pacific, Emergency Center for Transboundary Animal Diseases. She contributed to the implementation of the regional capacity building project for the prevention and control of avian influenza and other zoonoses, working with national and field veterinarians and paraveterinarians in Bangladesh, Cambodia, Indonesia, Lao PDR, Myanmar, Nepal, Philippines, Timor Leste and Vietnam. In 2011–2012, she was a member of the OIE Ad Hoc Working Group on Epidemiology. Between 2008 and 2013, she has been on rabies outbreak missions in Indonesia, Azerbaijan and Vietnam for the FAO/OIE/WHO Crisis Management Center.

Professor Clarisa B. Palatnik de Sousa

Professor Palatnik de Sousa is Professor of Microbiology and Chief of the Laboratory of Biology and Biochemistry of *Leishmania* at the Institute for Microbiology 'Prof. Paulo de Góes' of the Federal University of Rio de Janeiro. She is also a level 1B Researcher of the Brazilian National Council of Scientific and Technological Development (CNPQ), top reviewer for the journal *Vaccine* (2007 and 2008) and a member of the Executive Board of the International Society for Vaccines (since January 2009) and of the One Health Committee of the World Small Animal Veterinary Association (since January 2011). In acknowledgement of her work in vaccinology and public health in Brazil she received the motion of congratulation from the Rio de Janeiro City Council Chamber. Her experience in vaccine development includes the development of the first licensed second-generation vaccine against visceral leishmaniosis. The vaccine, called Leishmune®, was also the first to be licensed for prophylaxis against canine visceral leishmaniosis. She led the identification and selection of the antigen, the development of the adjuvant, the scaling-up of the industrial formulations, the Phase I-III trials, and the tests required by the regulatory agencies, and described the impact of use of the vaccine on decreasing the human and canine disease in Brazilian endemic areas. She is at present investigating the potential use of the vaccine in immunotherapy and immunochemotherapy of the disease. Dr Palatnik de Sousa contributed to the analysis of the new legislation for registration of vaccines against leishmaniosis by the Ministry of Health in Brazil. She is actively engaged in teaching of vaccinology and vaccine development for undergraduate and postgraduate students, aiming to increase the number of scientists engaged in vaccine development and of the number of vaccines used in Public Health. Dr Palatnik de Sousa's scientific contributions include 59 peer-reviewed publications, one Brazilian and one Mexican patent and three international patent applications. She has been advisor for 7 MSc and 6 PhD students, 3 Post Doctoral Fellows, 15 graduate and 45 undergraduate fellowship students. Dr Palatnik de Sousa has a BSc (Biology) from the Hebrew University of Jerusalem and an MSc and PhD (Microbiology) from the Federal University of Rio de Janeiro.

Dr Alan Radford

Alan graduated from Liverpool University in 1993 with degrees in molecular biology and veterinary science. His PhD started his first passion, virus evolution, and he has since developed novel ways of using sequence analysis to monitor national virus transmission and evolution. In 2008, he received an RCVS Trust Golden Jubilee grant to sequence 50 veterinary pathogens using next generation sequencing. Recent pathogens published on include feline calicivirus, carnivore parvovirus, FMDV, Japanese encephalitis virus, *Mycoplasma*, *Anaplasma* and *Streptococcus* spp. He is currently Reader in the Institute of Infection and Global Health, Liverpool University.

In parallel, in 2008 he helped establish SAVSNET, the Small Animal Veterinary Surveillance Network. In 2012, SAVSNET obtained charitable status and became an exciting collaboration between BSAVA and Liverpool University (www.savsnet.co.uk). SAVSNET provides novel ways to gather syndromic surveillance data economically and efficiently from companion animal electronic health records.

Dr Alejandro B. Thiermann

Dr Thiermann is the Senior International Organizations Coordinator for the Animal and Plant Health Inspection Services, USDA. He is also President of the Terrestrial Animal Health Standards Commission, World Organization for Animal Health, (OIE). He has served in this Commission since 1994. In 2001, at the request of the OIE's Director General, USDA seconded him to the OIE to devote most of his time to the OIE's standard setting process and serving as senior advisor to the Director General. Prior to coming to Paris, from October 1996 and until September 2001, he served as Senior Trade Coordinator and Regional Director for USDA-APHIS in Brussels, with responsibility over Europe, Africa, Middle East, Russia and the former Soviet Republics.

During 1997 to 1999 he was twice elected Chairman of the World Trade Organisation, Sanitary and Phytosanitary (WTO-SPS) Committee. In 1994 he was elected vice-president of the Code Commission of the OIE. In 2000 he was elected, and since 2003 has served as president of this important standard-setting committee. He was also an active member of U.S. delegations to the negotiation of the Uruguay Round of the WTO, the drafting of the new International Plant Protection Convention (IPPC) and served for two years as the U.S. Coordinator for the Codex Alimentarius.

Dr Thiermann joined USDA-APHIS in 1989 as the Deputy Administrator for International Services. In this capacity, he promoted APHIS' role in trade facilitation; he also led the overseas animal and plant health eradication and control programs, such as screwworm, foot-and-mouth disease, and Mediterranean fruit fly. Before joining APHIS, he was the National Program Leader for animal health research under the USDA Agriculture Research Service (ARS). He began his career with the U.S. Government in 1979 as the research leader for the leptospirosis and the mycobacterioses research laboratories in Ames, Iowa.

A native of Chile, Dr Thiermann received his doctorate of veterinary medicine degree from the University of Chile at Santiago, and a PhD degree in microbiology and immunology from the School of Medicine at Wayne State University in Michigan.

Introductory comments: small companion animals in One Health

M. J. Day

School of Veterinary Sciences, University of Bristol, Langford, North Somerset, UK

Small companion animals, most typically dogs and cats, are kept by people for companionship or a range of utilitarian purposes. Dogs and cats have a close relationship with their human owners and play an important role in the cultures of both developed and developing communities. The social and societal benefits of pet ownership are significant, with dogs now participating in programmes in institutions such as schools and hospitals, in addition to their role in family life.

The numbers of small companion animals are significant. For example there are an estimated 8 – 10 million dogs living in up to 31% of UK homes and in the USA, 72 million dogs in 37% of homes. In developed countries the relationship between man and dogs and cats has deepened, with these animals now closely sharing the human indoor environment. The benefits of pet ownership are unquestionable, but this close relationship does increase the risk of human owners being exposed to a variety of infectious agents carried by pets.

Of even greater significance are the numbers of 'free-roaming' (i.e. stray or community owned) dogs and cats in the developing nations of the world, particularly in Africa and Asia. Owned and free-roaming dogs and cats play an equally significant role in the lives of people in these countries, but by virtue of economic circumstances receive minimal veterinary healthcare and remain important reservoirs for major zoonotic infectious diseases such as canine rabies and leishmaniosis. It is impossible to enumerate accurately the scale of the human and animal health and animal welfare problems related to free-roaming small companion animals in these countries. For example, conservative estimates in India suggest that there may be up to 25 million free-roaming dogs in a country where there are an estimated 20,000 human rabies deaths annually.

The World Small Animal Veterinary Association (WSAVA) One Health Committee, which promotes the closer integration of human and animal healthcare ('One Health') has published a position paper in collaboration with the US Centers for Disease Control and Prevention (CDC), the World Organisation for Animal Health (OIE) and the World Health Organization (WHO)[1]. This study provides a listing of the key infectious diseases that may be transmitted between dogs and cats and man. It is well recognized that most of the major new diseases of mankind will have an animal origin and dogs and cats are a potential source of such 'emerging diseases'.

In human, livestock and wildlife health there are programmes of active surveillance for infectious disease, which monitor the global distribution and movement of key infectious agents. For example, the WHO monitors human influenza virus infection through a network of 111 centres in 83 countries. In contrast, there is no such monitoring for the infections that may be transmitted between small companion animals and man.

The WSAVA One Health Committee proposes that this omission should be addressed by the establishment of a co-ordinated global disease monitoring system involving those veterinarians who work in small companion animal practice. Development of such a scheme would require significant political will, scientific application and financial support that might best be achieved through a public–private partnership. The knowledge gained through surveillance would permit more effective global control of small companion animal zoonoses and thereby reduce the risks inherent within this most fundamental of human relationships.

Accordingly, in an attempt to address these issues at a global level, the One Health Committee has convened the current symposium and welcomes all delegates to this key international forum. Over the next two days, we will hear of the challenges related to the welfare of free-roaming dogs and the enormity of human suffering related to transmission of zoonoses from these animal reservoirs of infection. We will hear of successful initiatives for canine rabies control in African and Asian countries that may serve as models for developing a strategy for global elimination of this disease. We will also learn of new developments in companion animal disease surveillance and the potential for these to be applied globally.

The specific aims of the meeting are to produce an OIE–WSAVA position statement on (1) issues relating to the ecology, diseases and welfare of free-roaming dog populations, (2) the control and elimination of rabies and other zoonotic disease risks associated with these populations and (3) ways in which small companion animal veterinarians can become engaged in global infectious disease surveillance.

Reference

[1] Day MJ, Breitschwerdt E, Cleaveland S, Karkare U, Khanna C, Kirpensteijn J, Kuiken T, Lappin MR, McQuiston J, Mumford E, Myers T, Palatnik-de-Sousa CB, Rubin C, Takashima G, Thiermann A. Surveillance of Zoonotic Infectious Diseases Transmitted by Small Companion Animals. *Emerging Infectious Diseases* 2012 Dec [*date cited*]. http://dx.doi.org/10.3201/eid1812.120664 DOI: 10.3201/eid1812.120664.

Understanding the ecology of free-roaming dogs for the purposes of rabies control

M. K. Morters[1], S. Cleaveland[2], A. J. K. Conlan[1], O. Restif[1], T. J. McKinley[1], K. Hampson[2], H. R. Whey[3] and J. L. N. Wood[1]

[1]Department of Veterinary Medicine, University of Cambridge, Cambridge, UK
[2]Institute of Biodiversity, Animal Health and Comparative Medicine, University of Glasgow, Glasgow, UK
[3]Faculty of Medical and Veterinary Sciences, University of Bristol, UK

Understanding host ecology and epidemic theory is essential for effective disease control. We review these aspects separately, with particular reference to canine-mediated rabies. Firstly, although human and canine rabies are effectively controlled through vaccinating domestic dogs, culling is still frequently carried out in response to rabies outbreaks. Culling is an immediate and visible response to public concerns about rabies, but it may also be undertaken on the expectation that a reduction in population density by killing dogs will reduce disease transmission and, thus, the incidence of rabies. We present recent evidence that indicates that there is, in fact, no clear relationship between host density and disease transmission, and that culling is ineffective in controlling rabies.

Secondly, demographic processes (births, deaths and immigration/emigration) contribute to variations in dog population density, transmission of rabies, particularly at the global level, and declines in vaccination coverage. We present key findings from a 3-year cohort study, which is the first to generate detailed data on the temporal variation of these processes and their regulatory factors, including human factors. The study was undertaken in two communities in each of Bali, Indonesia and Johannesburg, South Africa in rabies-endemic areas and where the majority of dogs were free-roaming. None of the four communities had been engaged in any dog population management interventions by local authorities or animal welfare organizations. All available dogs in the four communities were tracked at the individual level throughout the study period. Key findings include: (1) no population growth or a progressive decline in population size during the study period, with no clear evidence that population size was regulated through environmental resource constraints; rather, the human populations regulated the dog populations by demand; all of the dogs were owned and fed regularly by their owners; and (2) a substantial fraction of recruited individuals originated from outside the population rather than being born locally. Furthermore, we consistently achieved annual vaccination coverage above 70% through door-to-door vaccine delivery, even in Bali where the majority of the dogs needed to be caught by net on successive occasions.

Overall, these observations have broad implications for disease (and population) control, including: the accessibility of dogs for vaccination and evaluation through owners; recognition of the importance of human movement of dogs and its implications for disease spread, and consequent importance of a local supply of puppies to meet the local demand, and declines in vaccination coverage; and, constraints to reductions in disease incidence through culling (or sterilization programmes), which generally assume density-dependent disease transmission, population growth and closed populations.

The welfare of free-roaming dogs

Elly Hiby

ICAM Coalition Scientific Coordinator and Independent Animal Welfare Consultant

The presence of free-roaming dogs can bring a range of problems, including zoonotic disease risk, but also welfare problems faced by the dogs themselves. As the first species to be domesticated, dogs have developed the most intimate and complex relationship with humans (Serpell, 1996). The closeness of this relationship means that they are dependent on humans, with limited ability to survive and reproduce in the absence of resources provided by people (Boitani *et al.*, 1995). It is a common misconception that all free-roaming dogs are unowned, in most locations the majority of these dogs will have an owner or at least a number of local people that purposefully provide resources to specific dogs. This brings validity to the aim of good welfare of free-roaming dogs. People want their dogs, including those that are not confined, in a good state of welfare.

The ownership status of free-roaming dogs is also relevant in planning interventions, which should maximise the involvement of owners and guardians who have both the legitimacy to be involved in their dog's management and also will be key to sustaining any activities in the long-term. The ownership of free-roaming dogs also explains why inhumane methods of disease control, such as culling apparently 'stray dogs', are not well accepted and why there is commonly a lack of public cooperation in such programmes.

Utilising the framework of the five freedoms we can explore the welfare state of free-roaming dogs and identify where their well-being may be challenged; this may include methods of dog control that are not humane. It is relevant to note that not all challenges to their welfare are as a result of being free-roaming. Indeed, in evolutionary terms, confinement of dogs is a relatively recent concept and requires careful consideration of dog needs to help them adapt to being kept in this way. It may be sufficient and more achievable to maintain good welfare and reduce disease risk without requiring confinement of all dogs, although this will depend on the country, cultural expectations and environmental factors such as the presence of fast moving traffic. Reduction of the free-roaming dog population is sometimes stated as part of disease control, but there are examples of where improved health and welfare without a reduction in numbers lead to reduced disease incidence and a positive response from the public (e.g. rabies control in Colombo, Sri Lanka).

We work in a financially limited space and so it is important that investment is made in the right intervention. This requires a clear understanding of the specific aim of the intervention within the context of the local community and dog population dynamics. In some locations mass vaccination of owned dogs will be sufficient to control rabies; in others additional aims relating to improving dog welfare and reducing dog bites and other nuisance behaviours will be relevant and hence further dog population management may be required. The goal of humane dog population interventions is to establish a sustainable system that creates healthy dog populations with human guardians that invest in good dog welfare, whether the dogs are free-roaming or confined. There is no single intervention programme that will work across all locations, and understanding where free-roaming dogs are coming from and their current ownership status will impact enormously on how interventions are run.

Veterinarians have extremely valuable and unique capabilities that can be applied to animal and public health, which are inextricably linked; in dogs this will include basic health care to reduce disease risk, reproduction control and the most trusted source of animal care advice for the public. Government veterinary services can support this work through: subsidising services; public campaigns encouraging good dog care; supporting access to training for vets in small animal medicine and surgery; and establishing affordable access to those drugs and consumables necessary for good companion animal care. Companion animal ownership has an intrinsic emotional quality, which means that poor veterinary standards are not well tolerated and can be very damaging to public trust in the profession.

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The role of the OIE as the international standard setting organization on animal health and welfare

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The World Organisation for Animal Health (OIE) with its 178 member countries is responsible for establishing international standards for animal health and welfare. These international standards are critical for the facilitation of international trade and the prevention of the transmission of animal diseases, including zoonoses. These standards also provide the necessary recommendations and guidelines for the prevention and control of these diseases in national territories. It is important to raise the awareness of all participants, whether representing the public or the private sector, in order to encourage them to become more engaged in this process.

The mechanisms for the development and adoption of these standards will be discussed. The OIE convenes world-renowned experts to deliberate and develop new or update existing standards, based on the most recent scientific information. These draft texts are examined by Specialized Commissions and then circulated twice per year for Member comments. The comments are reviewed by the Commissions; the texts are modified accordingly and resubmitted for Member consideration. Eventually, and usually after two years, these draft are submitted to the General Assembly of Members for adoption.

The Terrestrial Animal Health Code contains standards on general cross-cutting subjects, such as Quality of Veterinary Services, Risk Analysis, Disease Prevention and Control, Export Procedures and Certification and Veterinary Public Health. It contains over 100 disease-specific standards. The OIE adopted the first standards on animal welfare in 2004, and since has expanded into the areas of transport, slaughter and killing for disease control, laboratory animals, and stray dog populations, as well as standards on animal production systems. There is also the Manual of Diagnostic Tests and Vaccines for Terrestrial Animals which provides the approved methodologies for diagnosis and approved vaccines for the animal diseases listed in the Terrestrial Code. The international standards found in the OIE Codes and Manual provide the scientific basis for control and prevention of animal diseases worldwide, while at the same time, preventing unjustified trade restrictions.

The recently updated standard on rabies will be discussed as an example of recommendations to prevent diseases in animal population as well as the control of zoonotic risks. The standard on animal welfare on stray dog population control will be discussed, to illustrate the close link between animal health and animal welfare.

As a critical component of the One Health process, the health of companion animals, as well as that of free-roaming dogs and cats, is critical in the prevention and control of zoonotic diseases. The presentation is intended to encourage the use of these international standards in the control of animal diseases, especially those of zoonotic potential in free-roaming dogs.

Canine rabies virus: the disease, the problem and current global recommendations for control and elimination

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Rabies, caused by viruses in the *Lyssavirus* genus, is a zoonosis with a worldwide distribution. Eleven Lyssaviruses have now been characterized, and several more are awaiting classification; however, the global burden of rabies is dominated by the problems caused by the canine variant of the rabies virus. Although there have been recent successes in the control and elimination of canine rabies, most notably in Latin America and a few countries in Asia and Africa, the disease remains endemic throughout much of Asia and Africa and poses a substantial disease burden: (a) inflicting high mortality, causing an estimated 55,000 human deaths per year; (b) exerting a significant economic burden, with costs associated with human post-exposure prophylaxis in Asia exceeding $1.5 billion per year; (c) causing psychological impacts, as a result of the fear and uncertainty associated with bites from suspected rabid dogs; (d) generating concerns for conservation, as canine rabies is a threat to the survival of several endangered wild carnivore populations; and (e) having significant animal welfare implications, particularly in terms of attitudes towards dogs, and management of free-roaming dog populations.

Over the past 20 years, results from field epidemiological research, disease modelling and insights gained from large-scale rabies control and elimination programmes have greatly advanced our understanding of the epidemiology, control and elimination of canine rabies. The conclusion of these studies and analyses is that the elimination of canine rabies is feasible, even in wildlife-rich areas, through mass vaccination of domestic dogs, and without the need for indiscriminate culling to reduce dog population density. The research is also providing valuable practical insights that support the operational planning and implementation of rabies control measures, including methods for estimating dog population size and ownership patterns, the design and organization of dog vaccination campaigns (e.g. timing of campaigns, vaccination coverage levels required), and surveillance criteria for declaring freedom from canine rabies.

These studies have identified key epidemiological factors that contribute to the success of rabies control, such as uniform vaccination of ~70% of the domestic dog population, as well as key socio-political factors, including effective community engagement, inter-sectoral collaboration, and strong political support. Conversely, in areas where canine rabies remains uncontrolled, progress is hampered by two major problems: first, low levels of political commitment, exacerbated by lack of recognition among policy-makers of the magnitude of the disease problem, as well as the feasibility and cost-effectiveness of control and elimination through mass dog vaccination; second, the misperception that control of canine rabies is futile without addressing rabies in wildlife and without reducing the size of the dog population. This presentation will present evidence that canine rabies elimination is feasible in Africa and Asia through programmes that focus on mass dog vaccination and community participation, and that there is no scientific justification for delaying the implementation of control measures.

Successful rabies control: examples in Africa

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Why has rabies, the most fatal disease ever known, progressively established as a neglected disease throughout Africa and other parts of the developing world, despite the fact that it is completely preventable? With dog rabies being a classical zoonosis, one driver of neglect can be an institutional juggling of the responsibility for dog rabies control and poor awareness or appreciation of the public health impact of the disease. Canine rabies is not associated with any agricultural importance and the veterinary neglect of dogs is exacerbated by the fact that dogs are typically unrestricted and free roaming in Africa. On the African public health side, rabies primarily affects rural community types – characterized by poverty, remote location, poor infrastructure and negligible health care. Misdiagnosis is common and the capacity for laboratory diagnosis is non-existent over most of the continent. On the global health agenda, dog rabies is prevalent only in the developing world and can seem less newsworthy or important than some new diseases with pandemic potential, such as those associated with novel strains of influenza or coronaviruses. In reality, mortalities due to dog rabies, which occur mostly in children and without any other health risk factors, surpass many other infectious diseases that are perceived to be more important. It is evident that any hope of future control of dog rabies is dependent on global, regional and country level execution of a One Health approach.

New global partnerships and roadmaps, together with associated projects, are indeed focused on factors such as those illustrated above and include issues of dog ecology and primary health care, a demand for better disease surveillance, and optimal approaches to the planning, execution and evaluation of rabies control campaigns. In this regard examples from Africa, such as the programme in KZN, South Africa, demonstrate that successful rabies control is a long-term goal that requires substantial investment, but offers inevitable and worthy returns.

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Successful rabies control: examples from Asia

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Global Alliance for Rabies Control Asia

Over 99% of human rabies deaths today occur in Asia and Africa where dog rabies is still endemic. Rabies is a neglected disease of poverty, especially affecting underprivileged communities in developing countries. As a result of being a non-notifiable disease in many countries, accurate mortality data do not exist, thus rabies is ranked low on the priority list for disease control programmes. In Asia, over 99% of all human rabies deaths occur after a person is bitten by an infected dog and up to 60% of all deaths occur in children under 15 years of age. The incidence of human rabies and even dog bites in Asia is not fully known. Despite this, there are fewer than five WHO and OIE Reference Centres for rabies in Asia; since surveillance is lacking, every dog bite is usually considered an exposure to rabies.

Until the creation of the Global Alliance for Rabies Control (GARC), no organisation existed to unite the rabies community. With no strong advocate to bring the case for rabies prevention to the international community, and few reliable data to prove the true burden of rabies, this disease continues to be neglected and to take a heavy toll on poor communities in countries where dog rabies is endemic. Tools are available to formulate and implement strategies to control rabies successfully. The 'Bohol model' as tested in GARC's project in the region has proven that, in collaboration with the local government, by eliminating rabies in the dog population, educating children, improving surveillance, and empowering the local community, human rabies will disappear.

The expansion of GARC projects in the Philippines, and the scale-up and replication of the 'Bohol model' of vaccination for dogs and education for people, covers two provincial and an urban cross-border canine rabies elimination initiative. These will protect over 3.2 million people, among these almost a million children who are being reached directly with educational materials or vaccinations. With committed but limited local resources, their local governments are keen to collaborate and are advancing towards dog rabies elimination.

GARC believes that we can build the political will to control rabies and scale up prevention programs that will dramatically reduce human rabies deaths. We will do this by empowering communities to establish their own rabies control programs; ensuring the full awareness/participation of the community on the situation, issues, approaches taken and the community's key role; giving them access to more cost-effective tools for control and prevention; and provide open collaboration between global rabies experts. Urgent requests for help to prevent rabies have come to the Alliance from over 150 countries as a result of coordinating a global day of action to raise awareness – World Rabies Day. As a result, there is realization that there is a pressing need to build global consensus among the key opinion leaders and experts to embark on a global campaign to eliminate canine-mediated rabies and empower countries to build and implement their own national rabies control strategies.

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Rabies control in India

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Rabies is one of the most important zoonotic diseases in India. It is responsible for a heavy burden in terms of loss of human and livestock lives, as well as being a huge financial expenditure for post-exposure prophylaxis (PEP) vaccination of people and animals exposed to dog bites. The dog is the main vector of rabies in India. Therefore, controlling the incidence of rabies in human beings and animals depends on controlling rabies in dogs, which can be achieved by mass immunization of 70% of the stray and pet dog population. The burden of rabies in India can be recognized from statistics for human lives lost (approximately 17, 400 per annum), dog bites (approximately 17.5 million people per annum) and human PEP (administered to approximately 3 million people and costing around US $25 million). Most human deaths occur in children in rural areas where awareness and facilities for PEP are not as well developed.

The Animal Welfare Board of India (AWBI), a statutory and advisory body of the Government of India, has facilitated the implementation of India's Street Dogs Animal Birth Control/Anti Rabies (ABC/AR) Vaccination programme for the last 12 years with the help of civic bodies and NGOs. With recent joint participatory efforts of civic bodies and the AWBI, approximately 1.5 million dogs are being sterilized and vaccinated every year, which is grossly inadequate for the control of rabies as the population of street dogs in India is estimated to number 20 million. However, this programme has successfully impacted on control of the incidence of human and animal rabies in Chennai, Jaipur, Kalimpong, Ooty and Gangtok where the programme has been implemented on an intensive scale. The limited infrastructure of NGOs and the lack of adequate financial and political support, combined with limited availability of skilled veterinary surgeons and dog catchers, are the main impediments to enlarging the scope of the programme nationally.

In order to upgrade the skills of veterinarians, paravets and dog catchers, the AWBI, with the help and cooperation of international NGOs such as Humane Society International, Vets Beyond Borders and Worldwide Veterinary Services, is conducting training programmes at three training centres in Jaipur, Ooty and Gangtok to provide trained personal for expanding the scope of the programme.

Public awareness about the benefits of the ABC/AR programme for controlling dog populations and rabies and public support are vital for the success of this programme. Similarly, proper solid waste and garbage management needs to be strictly enforced by the civic bodies in their respective areas. Formulation and implementation of a National Rabies Control Policy in India, and including rabies in the list of notifiable diseases, could help considerably in addressing the huge challenge of controlling this important zoonotic disease. Adequate financial outlay for mass sterilization of street dogs is also required along with mass immunization programmes, as dogs are prolific breeders and unless their population is also controlled through a humane sterilization programme, a new crop of pups will be added twice a year, which will impact on the success of any immunization programme that is carried out in isolation.

For the first time the Ministry of Public Health, Government of India under the One Health approach has drafted a National Rabies Control Programme involving human as well as animal components under the 12th Five Year Plan. The human component will be implemented by the National Centre for Disease Control and the animal component by the AWBI covering a dog census, mass immunization of street and pet dogs, dog population control using fast-track laparoscopic techniques, registration and licensing of dogs, responsible pet ownership and notification of rabies cases. It is also proposed to carry out proper surveillance and collect authentic data on rabies. Efforts are at hand to involve the Department of Animal Husbandry at the Centre and State Level, which is considered critical for success of mass immunization and sterilization of street dogs. So far these organisations have focused only on animal diseases affecting livestock productivity and dogs have not been included in the livestock list. We look to OIE for help in this regard.

Mission Rabies

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Rabies is a fatal zoonotic disease estimated to cause between 40,000 and 100,000 human deaths annually worldwide.[1] Over a third of these deaths occur within India, the widely acknowledged global hotspot for rabies in the world, and a country which has annually reported an estimated 25,000–30,000 human deaths from rabies since 1984.[2]

Sadly, the majority of people who die of rabies are people of poor or low-income socioeconomic status[3], 30–60% being children under the age of 16[4]. In India, rabies is not a notifiable disease and with no organized surveillance system of human or animal cases, compounded by the fact rural families will not always insist on the cause of death being officially registered, it is difficult to ascertain the exact scale of the problem.

The main cause of transmission is through dog bites[3]. In a country with a population exceeding 1.02 billion, it is estimated that 15 million people in India are bitten by animals annually.[9] This statistic equates to at least one person being bitten by a dog every two seconds. Additionally, the impact to the Indian economy is significant, with an estimated annual cost of post-bite treatment totalling approximately $25 million.[2]

It is suggested that India has approximately 25 million dogs, with an estimated dog:man ratio of 1:36.[2] Until 1998 the population of stray dogs in India was kept under check by civic authorities, by impounding and euthanising unclaimed dogs. The pressure from animal welfare activists, combined with a humane and progressive government under the direction of the Animal Welfare Board of India (AWBI) has ensured this approach was replaced by a policy of animal birth control.

Anecdotally, the success of this programme relies on the sterilization of at least 70% of the strays in a given geographic area within 6 months. This target is difficult to achieve, given the large number of stray animals, large litter sizes they can produce and the limited resources. Hence the success of the animal birth control programme in controlling the stray dog population is a continued subject of dispute and doubt.[6] Conversely, there is evidence that national vaccination campaigns to reduce the incidence of rabies in environmental reservoirs have been successful[8, 10] and these are universally accepted as the most sustainably and effective, long-term disease control strategies, far outweighing mass cull approaches in their effectiveness.

Notwithstanding the detailed academic debates around rabies and its control, the current situation can be summarized as follows:

- India accounts for over a third of all reported global deaths as a result of rabies
- Rabies kills a higher proportion of children than adults
- The main cause of rabies in India is through dog bites
- Many cases of rabies in India are not reported, specifically in rural areas, suggesting the true incidence of this fatal disease is unknown and is likely to be higher than official figures
- Hundreds of dogs are culled regularly, often brutally and indiscriminately, for fear of a rabies epidemic in many areas throughout India (and the world)
- Annual vaccination campaigns, combined with neutering, public education and national surveillance programmes are proven ways to address the endemic crisis and, if implemented efficiently, will save thousands of lives (both animal and human) every year.

Mission Rabies, thanks to the huge support from many charities, sponsors, the WSAVA Foundation and individual volunteers, was launched in September 2013 in an attempt to address the rabies epidemic in India, to promote the welfare of the street dogs and to protect local communities.

Mission Rabies has the following objectives:

1. Establish an India National Rabies Network – supplying effective, subsidised rabies vaccine throughout the country, setting up an epidemiological database to record, who, where and when vaccine has been administered.
2. Thanks to the Dogs Trust and the Animal Welfare Board of India, utilise a unique all-terrain mobile veterinary hospital as a teaching unit to run surgical training courses through the country and educate vets in TNVR.
3. Run an annual rabies vaccination drive through ten selected states to vaccinate 50,000 dogs in 30 days. Unifying NGOs and animal welfare groups, as well as international volunteers in the fight against rabies. The plan is to build this up to achieving a total of 2 million street dog vaccinations in key rabies hotspot areas in the next three years.

This presentation will outline the results of the launch and deliver a progress report.

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Small companion animal disease surveillance: current systems and how they may integrate with the OIE–WAHIS system

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Animals are a hugely important part of human societies globally, fulfilling many different roles. Of course some are kept to provide food, but many others are kept as pets or working animals, providing traction, companionship, protection, livelihood and independence. As well as obvious welfare implications, their diseases can also have considerable impact on their individual owners and society, financially, psychologically and, through zoonotic transmission, as a cause of human disease.

Surveillance programmes have naturally developed globally to quantify disease in some of these animal populations, particularly for notifiable diseases and important zoonoses, in part to facilitate global trade. Historically, with rare exceptions, these have been limited to high profile diseases of farmed species.

As a sector, companion animals (here referring to dogs, cats and other small pet animals) lack coordinated national and international disease surveillance. This is a reflection of the diversification of this sector, and a lack of government regulation for all but the most high profile diseases. Animals in this sector have many roles globally, ranging from pure companionship to food animals. They have played significant roles in the epidemiology of recent global health threats including SARS, coronavirus, and various influenza strains, notably H5N1. Rabies virus remains an ever-present and serious zoonotic threat.

Any attempt to fill this gap in companion animal surveillance will require simple implementation in a cost-effective manner. This is just beginning to happen as individual countries seek to capture clinically useful data largely from electronic health records. Here we will review these initiatives and describe one being developed in the UK. The Small Animal Veterinary Surveillance Network (SAVSNET) is a charity set up by the British Small Animal Veterinary Association and the University of Liverpool. It seeks to capture demographic and disease data from two sources: diagnostic laboratories and veterinary surgeons in practice.

Laboratory data are collected quarterly and include signalment, sample type, diagnostic methodology, test result and a proxy for geographical origin. From **veterinary surgeons** we collect data in near real time from practice management software, including signalment, reason for visit, treatment and the full postcode of where the animal resides. We also append a novel short syndromic questionnaire to each consultation, making SAVSNET both a scanning and a targeted surveillance system. Compliance with these methods has been very high, an important factor for future recruitment. This allows us to collect data on any animal presented to a participating veterinary surgeon, whether by an owner or, in the case of an unowned animal, by an animal welfare charity. Using these approaches, we can identify risk factors for diagnosis (laboratory data) and syndromes (veterinary data).

At the time of writing we have collected data on over 135,000 veterinary consultations, with questionnaire data on diarrhoea, respiratory disease, tumours and pruritus. This is beginning to shed new light on species, breed and age susceptibility to disease, and seasonal variation. Antibacterial consumption and resistance is a global health priority, and we have developed novel ways to describe in real time the use of these medicines in veterinary practice.

The open Standards and API (application programming interface) we are developing have been designed specifically for software-independent participation and are both scalable and transferable globally into any setting where companion animal health records are electronically recorded. The simple data capture methods means the hurdle to veterinary practice and laboratory participation is very low, and compliance high. Results can be searched spatially and temporally, and could be mapped to other national and international disease databases of human and animal health. We believe SAVSNET offers an efficient method for internationally harmonised companion animal surveillance.

The challenge going forward will be to imbed companion animal surveillance initiatives in the diverse settings in which small pet animals are kept globally, to generate meaningful international coverage.

Canine leishmaniosis: the disease, the problem and current approach to control and elimination

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Human leishmaniosis is the third most important vector-borne disease worldwide, after malaria and filariasis. A total of 98 countries and three regions on five continents have reported endemic leishmaniosis transmission. Among the leishmaniosis syndromes, the official numbers add up to more than 58,000 cases of visceral leishmaniosis (VL) per year. Based on these recent estimates, and considering the lack of reports from several endemic countries, approximately 0.2 to 0.4 million VL cases occur each year. The disease is an anthroponosis in India and Central Africa and a canid zoonosis (ZVL) in the Americas, the Middle East, Central Asia, China and the Mediterranean. It is a severe and frequently lethal protozoal disease of increasing incidence and severity due to infected human and dog migration, new geographical distribution of the insect vector due to global warming, co-infection with immunosuppressive diseases and poverty. *Leishmania donovani* and *L. infantum/L. chagasi* are the major species responsible for VL. They home in on visceral organs and result in a pentad of clinical signs: fever, weight loss, splenomegaly, hepatomegaly, and anaemia. If left untreated, the disease has a high human mortality rate mainly due to T lymphocyte immunosuppression (mainly $CD4^+$ T cells) and secondary infections.

Over the last two decades many factors have led to an increase in the incidence of VL. Among these are: the geographical spread of VL in Europe, Africa, America and Asia caused by human migration carrying infected dogs to areas where the specific insect vector was already present; the expansion of the phlebotomine habitats due to global warming; the increase in dog cases with a travel history; the urbanization of the disease after deforestation; and the frequent co-infection in HIV-positive individuals.

The most common clinical manifestations and clinicopathological abnormalities found in canine ZVL include: skin lesions, generalized lymphadenopathy, loss of weight, altered appetite, lethargy, mucous membrane pallor, splenomegaly, polyuria and polydipsia, fever, vomiting and diarrhoea, dermatitis, onychogryphosis, blepharitis, conjunctivitis, keratoconjunctivitis, uveitis, oral, genital and/or nasal mucocutaneous and mucosal lesions, epistaxis, and vascular, renal and neurological disorders. Among the main laboratory abnormalities, hypergammaglobulinaemia, hypoalbuminaemia, decreased albumin/globulin ratio, anaemia, leucopenia, thrombocytopenia, proteinuria, renal azotaemia and elevated liver enzyme activities are described.

The ZVL epidemic has been controlled by one or more measures including the culling of infected dogs, treatment of human cases and insecticidal treatment of homes and dogs. Mathematical models proposed that the insecticide treatment and the use of vaccines would be the most effective control tools for human and canine disease. Since the severity of the disease is related to the generation of T cell immunosuppression, effective vaccines should be capable of sustaining or enhancing T cell immunity. Recent experimental data obtained by the dog culling–epidemiological control campaigns is controversial about the effectiveness of this approach on VL eradication. Three vaccines are at present licensed for prophylaxis of canine ZVL. This presentation will summarize and review the state-of-the-art of current approaches to control and elimination of this zoonosis.

Bartonellosis: a One Health approach to an emerging infectious disease

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Bartonella species are recently rediscovered, fastidious Gram-negative bacteria that are highly adapted to a mammalian reservoir host within which the bacteria usually cause a long-lasting intraerythrocytic bacteraemia. These facts are of particular importance to physicians, veterinarians and other health professionals, as an increasing number of *Bartonella* species known to induce persistent bacteraemia in animal reservoir hosts are being documented as a cause of disease in animals and people. Among numerous other examples, *Bartonella henselae* has co-evolved with cats, *Bartonella vinsonii* subsp. *berkhoffii* has co-evolved with dogs and wild canines, and *Bartonella bovis* has co-evolved with cattle. Importantly, the list of reservoir-adapted *Bartonella* species, including a large number of species in rodents that might serve as 'pocket pets', continues to grow exponentially, as new *Bartonella* spp. are discovered in wildlife species. Prior to 1990, there was only one named *Bartonella* species, while there are currently 30 named and numerous yet to be named or *Candidatus* species.

Seventeen *Bartonella* spp. have been associated with an expanding spectrum of animal and human diseases. Epidemiological evidence and experimental transmission studies support an important role for fleas in the transmission of these bacteria among cats, which can be chronically bacteraemic for months to years with five zoonotic *Bartonella* spp. Recent reports have identified an intra-endothelial, as well as intra-erythrocytic localization for these bacteria, which represents a unique strategy for bacterial persistence within the host. In addition to fleas, an increasing number of arthropod vectors, including biting flies, keds, lice, mites, sandflies, spiders and ticks have been implicated in the transmission of *Bartonella* spp. among animals and people. Considering the diversity of newly discovered *Bartonella* spp., the large number and ecologically diverse reservoir hosts, and the spectrum of arthropod vectors, the clinical and diagnostic challenges posed by *Bartonella* transmission in nature may be much more complex than is currently appreciated in human and veterinary medicine. Clearly, a **One Health Approach** is needed to better define the medical relevance of this genus of bacteria as a cause of disease in animals and human patients and to develop preventive strategies so as to avoid *Bartonella* spp. infections in pets and their owners.

Because conventional microbiological techniques lack sensitivity, bartonellosis is usually diagnosed by PCR amplification of organism-specific DNA sequences and/or through serological testing, which also lacks diagnostic sensitivity in dogs, horses and humans. Recently, the development of a more sensitive isolation/PCR approach, using BAPGM (*Bartonella* alpha *Proteobacteria* growth medium) followed by PCR amplification and DNA sequencing of organism-specific gene targets has greatly facilitated the isolation or molecular detection of *Bartonella*. DNA from the blood, tissues or other biological fluids of sick or healthy animals, including cats, cows, dogs, horses, pigs and human beings. Most importantly, the use of this insect cell culture-based enrichment growth medium prior to PCR testing has allowed our research group to confirm that immunocompetent human patients, in particular veterinarians and animal workers, can have chronic intravascular infections with *Bartonella* spp. Information relative to the validation and diagnostic availability of this novel testing platform for animal and human patients can be found at www.galaxydx.com.

Due to extensive contact with a spectrum of animal species, veterinary professionals and others with arthropod and animal exposure appear to have an occupational risk of infection with *Bartonella* spp. Therefore, these individuals should exercise increased precautions to avoid arthropod bites, arthropod faeces (particularly fleas and lice), animal bites or scratches and direct contact with bodily fluids from sick animals. As *Bartonella* spp. have been isolated from cat, dog or human blood, cerebrospinal fluid, joint fluid, aqueous fluid, seroma fluid and from pleural, pericardial and abdominal effusions, a substantial number of diagnostic biological samples collected on a daily basis in veterinary practices could contain viable bacteria.

In the context of disease causation, *Bartonella* spp. have been implicated in association with endocarditis, granulomatous inflammatory lesions, persistent bacteraemia and vasoproliferative tumours in animals and people. Recently, in the context of **One Health** and global infectious disease prevention, we proposed that an additional postulate, the Postulate of Comparative Infectious Disease Causation, be added to the original Koch's postulates[1]. The increasing number of named *Bartonella* spp., in conjunction with the high level of bacteraemia found in reservoir-adapted hosts, which represent a portion of the typical veterinary patient population, ensures that most veterinary professionals will experience frequent and repeated exposure throughout their careers to animals harbouring these bacteria. Therefore, personal protective equipment, frequent hand washing and avoiding cuts and needle sticks have become more important for veterinary professionals, as our knowledge of this genus has improved and various modes of transmission have been defined.

Physicians should be educated as to the large number of *Bartonella* spp. in nature, the extensive spectrum of animal reservoir hosts, and the diversity of confirmed and potential arthropod vectors, the potential for persistent bacteraemia, current limitations associated with diagnosis and treatment efficacy, and the ecological and evolving medical complexity of these highly evolved intravascular, endotheliotropic bacteria.

Reference

[1] Breitschwerdt EB, Linder K, Day MJ, Maggi RG, Chomel B, Kempf VAJ (2013) Koch's postulates and the pathogenesis of comparative infectious disease causation associated with *Bartonella* species. *Journal of Comparative Pathology*, **148**,115-125.

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