

Andy Gibson, Mission Rabies

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Rabies is a lethal viral infection characterised by an acute encephalomyelitis, causing roughly 59,000 human deaths each year.¹ It is caused by an ancient group of viruses, the Lyssaviruses, which are thought to have originated in Old World bats before spilling into human, dog and other wildlife populations.² The earliest record of rabies infection in humans dates back to the 18th or 19th century BC on Eshnunna law scrolls from Ancient Mesopotamia.² Over many years, we have gained a greater understanding of rabies infection and transmission, with many countries, such as the UK, achieving a rabies-free status. However, the rabies virus still greatly impacts many countries, with the virus being endemic in many areas. Rabies has been categorised as a 'neglected zoonosis' by the World Health Organization (WHO), acknowledging that the disease mainly affects poor, vulnerable and marginalised populations.^{1,3} Within these communities, education surrounding rabies infection and access to medical care is very limited. For this reason, it is thought that the number of rabies-related deaths are widely under-reported each year, due to a lack of awareness of the symptoms which occur during rabies infection and under-diagnosis.³ However, many of the deaths due to rabies are preventable; for the last 138 years we have had access to an effective vaccine.³ Additionally, 99% of all rabies-related deaths occur due to rabid dog bites.^{3,4} For this reason, many organisations believe that it will be possible to eliminate rabies infection from human populations, and the WHO hopes to achieve 0 rabies-related deaths in people by 2030.⁵ Due to the zoonotic nature of the rabies virus and stray dogs acting as the main reservoir population of the disease, vets and medics will need to work together to implement control strategies within these vulnerable populations.^{3,5} Mass vaccination campaigns within stray dog populations, improving education surrounding rabies infection and ensuring there is greater medical care and access to vaccinations within these vulnerable populations will be crucial to prevent rabies infections within humans.⁵

Many organisations have been working towards the goal of eliminating rabies infection in humans by working to establish many of these strategies to reduce rabies infection. One of the large contributors working to prevent rabies infection in humans and dogs is Mission Rabies. Mission Rabies is a charity which

was set up in September 2013 to work towards saving both human and canine lives in rabies hotspots around the world, working alongside local governments and its sister organisation the Worldwide Veterinary Service. The charity has set up mass vaccination projects across many countries, vaccinating over 2 million dogs and educating 5 million children globally. It is headed by a team of vets and supported by many volunteers helping to implement these campaigns. Andy Gibson, one of the vets working on the vaccination campaigns with Mission Rabies, very kindly chatted with me about his work with the charity and how vet students and medics can get involved in working towards the goal of preventing rabies-related deaths in human populations.

How did you end up working for the charity and what inspired you to work on this issue?

To give you a bit of background about myself, I studied as a vet and then went up to the RSPCA, working in Manchester for a bit. I then went back and did an internship in London and after that I didn't really know what to do career wise. I was quite into clinical medicine, and I went out and volunteered with the charity [Mission Rabies]. When I was out there, Luke the CEO really set out the premise that it's on vets to sort out the issue of rabies. There are children dying of rabies being bitten by dogs and no matter how much the human medical sector vaccinates people against rabies, they will still be bitten by dogs, and there will still be deaths due to rabies. It's always treating the symptom of the problem. So, I went out to India and began leading vaccination campaigns. It's a really simple problem to fix; compared to other diseases it is a simple epidemiological situation. There are no insect intermediary vectors and it [rabies] passes from dog to dog before spilling into the human population. The typical rabid dog is often not what you'd expect. They're often not foaming at the mouth or charging around the streets. They often look subdued or completely normal. But seeing the impact rabies had through meeting the families of children who had been really badly bitten drew me to this issue. As vets we can make a difference. And so, I got involved with the vaccination campaigns, working on the development of technology to try and improve the coordination of vaccination teams, making it more efficient to direct them in the

field. This has become a real foundation of our work, and I've gone on to do a PhD at Edinburgh University, which has allowed me to dive deep into the issue of rabies and technology development within this area.

That's so interesting and I completely agree; with the majority of human deaths from rabies being caused by rabid dog bites, it seems that mass dog vaccination is really important in preventing human deaths caused by rabies. What are the main considerations of your team when starting the various mass vaccination projects you currently run and what are the aims of your projects going forward?

There are three main pillars of any project we run: mass dog vaccination, which involves understanding the dog population and its composition, such as owned dogs versus strays, how to access the dogs, and how to plan the campaign to achieve herd immunity; surveillance, which involves establishing good surveillance systems to see the true situation; and education, where we are trying to get rabies included in the school curriculum so that children who are in high risk groups are being made aware of rabies and what to do when they get bitten. In all of our projects we try to engage the government and try to form a partnership, particularly on our larger projects. Our two largest projects are in Goa, where we work as the implementing party under the government's leadership, and Malawi, where we are working alongside the government in the south to implement mass dog vaccination campaigns. We also have other projects that we run and, recently, we ran a campaign in Cambodia where we vaccinated 75,000 dogs in 10 days, working alongside local NGOs and the government as an implementing partner. Our aim at Mission Rabies is to set up huge campaigns to vaccinate hundreds of thousands of dogs in just a few days, working alongside local governments and NGOs to better control rabies.



Wow, that's a lot of dogs vaccinated! Could you explain a little bit about the problem of rabies and how it circulates within the dog population?

To give some context, from the time of exposure, dogs will get the virus from a dog bite and there's a long incubation period while the virus is tracking through the peripheral nerves and the central nervous system. This typically takes three weeks in dogs depending on where they receive the bites. Once the virus enters the brain, the virus then replicates and disseminates back to other parts of the body. From that point, death is inevitable, and typically progresses in three days, so the infectious period is quite short. The reproduction number for the rabies virus is between one and two. This means that each rabies-infected dog generally passes on the virus to one or two dogs before it dies. So, the virus slowly propagates through the population and is not very transmissible. Because of the long incubation period you never get a surge in infection. When you start mapping those dogs and surveilling infections, you begin to see that it's everywhere, but as the infection is not very apparent, it flies under the radar. So, it's [rabies] hugely under-reported and therefore the public and political awareness of this issue isn't there.

How do you decide on in which regions to vaccinate dogs?

Some recent work we've been doing is high resolution mapping of dog populations, trying to get better data before we start working somewhere on the distribution of dogs, the number and the geography. We then use this information to help plan the strategy and help the government to plan a strategy which is likely to succeed. We've also now developed an app which enables us to direct teams in a much more spatially defined way. We want to avoid patchy 'Swiss cheese' coverage; it is important to achieve homogeneous, even coverage of a region. If you have pockets where you don't vaccinate, you have virus present which stays within those regions. The app that we've created tries to direct teams region by region. Each day, teams will get assigned a new area where they need to vaccinate, and we have black GPS points on the map which represent the dogs we've vaccinated. You can see the teams moving across the area week by week, comprehensively vaccinating every community. This helps us to see if we've missed a patch, and so we can assign those areas and send the teams back to those regions to vaccinate and continue. You get nice repeat coverage, and this helps us to prevent the virus from continuing to circulate in these areas.



That sounds really efficient and important to ensure you vaccinate enough dogs! How many dogs do you aim to vaccinate in a campaign to achieve herd immunity?

When it comes to achieving herd immunity, we actually only need 40% coverage to interrupt transmission. So, the vaccine number needed is really low. And for this reason, when it comes to rabies elimination, it is actually very achievable. We can vaccinate 40% of the population and interrupt that cycle so the virus disappears. But the problem is we usually vaccinate the population once a year. However, there's not a common veterinary practice vaccinating puppies, especially strays, between our campaigns. As more puppies are born and some of the vaccinated population die, the number of unvaccinated dogs increases in between our campaigns. Although our threshold is 40%, if we only vaccinate 40% each year, we could drop below that threshold in between our vaccination campaigns and the virus will circulate between these periods. So, the current recommendation is 70% to maintain the high coverage throughout the period and disrupt transmission even if the coverage depletes between your campaigns. However, the coverage we need may vary between regions, and we are currently beginning to carry out research into what factors may affect this.

How do you estimate the number of dogs you need to vaccinate in each specific region before carrying out your campaigns?

Currently, we are looking at existing data and using this to predict the dog population in that area. There's a balance between putting resources into running lots of surveys and running campaigns where you also get data about the population. We know that dog populations are very closely related to human populations; where there are people there is a predictable relationship with the dog

population. So, we have created maps of human populations which we can then apply a human dog population ratio to which we can extrapolate from other study sites. And we've done this for many countries. We can then start to prioritise areas. We're really trying to use technology and data to guide what we are doing.

It does seem like technology and data will play a crucial role in controlling rabies. How important do you think research will be in tackling this problem and forming your campaigns?

There's been 100 years of research into rabies. We've known that vaccination has been effective for over 100 years, so the question now is, how do we actually do it and get into the nuts and bolts of vaccinating a large number of dogs efficiently through local infrastructure and capacity? So that's where our research is really focused: on the applied aspect of it and the operations of campaigns, planning campaigns and evaluating them. That is probably where there is the greatest need; how do we run these programs, as well as understanding dog populations and how we can make accessing dogs more efficient. Some of the work we've done recently is looking at how oral vaccines could play a role in dogs which are harder to vaccinate. We've shown that for dogs which are difficult to catch, it is much more efficient to drop a bait and allow them to receive a vaccine that way. But then for dogs which are community dogs or have a guardian, we want to encourage that guardian to handle that dog for parenteral vaccination. That's the best and most efficient way of vaccinating, and we want to encourage responsible ownership so that the majority of dogs can be brought for vaccination or held for it when the teams come round. It also builds trust in the communities. If you are vaccinating everywhere ideally, through the animal husbandry department, it's gaining that engagement with dog owners to encourage them to sterilise their dog as well as vaccinate, reducing the issue of stray dogs.

Running these campaigns must come with many different costs, what are your main sources of funding for campaigns?

There is a global community trying to support the elimination effort across the world. We're very lucky to have Dogs Trust funding us for the last 10 years and MSD Animal Health (a veterinary pharmaceutical and technology company) is donating large numbers of dog vaccines. Another benefit of this partnership is the thermostability of those vaccines; the cold chain is less of a concern, so the hotter temperatures are less of a concern when we are out in the field, and we don't have to be quite so worried. Most of the cost of running a campaign is in the staff salaries, the transport, the logistics and only 10% of the cost is in the vaccine itself (it costs around £2 per dog vaccinated and only 20p of that is in the vaccine) and so after having gone to all that effort, the last thing you want is to inject something which doesn't work. We always advocate for using good quality vaccines. So, we're very fortunate to get support from MSD. Volunteers and fundraisers help us to expand our work, provide more education and more vaccination campaigns. We also have a partnership with the CDC (Centers for Disease Control) and they've been supporting our app development and technology.



There seems to be many parties working on this issue and a large amount of success being achieved. What do you think the likelihood of eliminating the virus will be?

It's a big undertaking eliminating the virus and that's one of the major concerns of these big corporations supporting these efforts, but in the modern world it's terrible that we've got this ancient virus which we've known how to eliminate for so long. We've got modern technologies which make it easier and more efficient and yet it's still rampant and not even under control. As human populations increase there will be more dogs, and if we don't act now the issue will be worse. We can take a step towards combating the disease and reducing the burden in many places and protecting people who already have such a difficult circumstance. The virus mostly impacts on people at the fringes of society; whether you are geographically isolated or socioeconomically isolated, you are far more likely to die from rabies as you either have to travel a long way to get vaccinated or you can't afford the vaccine which is available. It's not the wealthy people who die of rabies, therefore, the prioritisation and big push to address this problem isn't there. Of all issues it's of huge humanitarian benefit starting to get on top of this. It will be a long journey, it is incredibly complicated to run campaigns of that scale but with oral vaccination especially, that will be a game changer in increasing the ease of vaccinating those types of dogs. If that comes through, certainly India would be able to mount a very comprehensive vaccination program. Beyond India, I believe it could scale out in Asia. In Africa, it's a slightly different situation with dog availability. But if governments get on board with this, it is certainly possible.



I completely agree, it really is an issue which we need to work on globally, especially with its humanitarian impact. With rabies being a zoonotic disease, how have vets and medics been working together to prevent rabies infection and what improvements do you think we will need to have to work towards elimination of human infection?

There's been so much push on the medical side. The medics have done so much work on the efficiency of vaccinating people, for example intradermal vaccination decreases the dose required tenfold and they're looking at dermal patches to improve the accessibility of vaccination. They have also improved the accessibility to monoclonal antibodies. Instead of the old school immunoglobulins, they've developed new ways to develop stable immunoglobulins. But if we continue with that approach of just improving access to post exposure treatment, there's still going to be people bitten by rabid dogs and rabid dogs in communities, so I feel that the veterinary sector needs to step up and address our area of the problem too. Access to post exposure treatment depends on where you are; if you are in a city, hospitals will have access to the vaccination, but there are still shortages across Africa and India. Globally there are always shortages. In rural areas access is typically poor. As I've said, they are trying to make it easier to get vaccine to different places and make it cheaper and so that is an improvement and will save people's lives but that doesn't get to the root of the problem. No matter how

easy we make it for people to get access to the vaccine, there are still people getting bitten. The bites alone are a horrible thing to go through. That's the bit we [Mission Rabies] want to address.



How can vet and medical students begin to get involved in this issue?

We have volunteer opportunities all over the place. Recently in Cambodia we had around 100 volunteers come out and get involved in that project. We have volunteer programs in Tanzania, Uganda and Ghana, and this really expands our capacity. Volunteers really help to bring additional training capacity especially with the use of technology. It makes a huge difference. Coming out and seeing the work is how I got involved! You just get a totally different experience of a place than visiting as a tourist; you're working alongside people from the country, going through every nook and cranny of a community to find dogs to vaccinate and speaking to people in the community. You just get such an exposure to that culture. A lot of our volunteers find it a very formative experience and a great thing to be a part of. Otherwise, just being a part of the conversation is important. We need more vets and medics to take an interest in this issue. For me, I see it as a generational opportunity to try and influence this problem. Obviously, there are loads of problems in the world, but as vets and medics this is an issue which affects people where we can make a difference. Even if you are working in the UK, just supporting campaigns through liking and sharing stories about rabies can help. Increasing the discussion on this issue is a really important thing. Also, getting into research and carrying out research will be important. I hope that the next generation of vets and medics will be inspired to work on this issue, improving our control of the disease and preventing human deaths.

For more information about Mission Rabies, go to missionrabies.com or find the charity on social media. Photographs kindly reproduced with permission from Mission Rabies and Andy Gibson.

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