Rabies control in KwaZulu-Natal, South Africa

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Introduction

Rabies is a fatal zoonotic disease, causing tens of thousands of human deaths each year.1 Most human rabies cases worldwide are caused by dog bites2 and are preventable through canine vaccination and the provision of rabies postexposure prophylaxis to exposed persons.3,4 Many rabies-endemic countries lack the finances and infrastructure to sustainably vaccinate dogs, conduct surveillance or provide communities with access to rabies vaccines.

Vaccinating 70% of the canine population is currently recommended to interrupt transmission of rabies.3,5 However, the scale of this task can be a deterrent to setting up control programmes. Furthermore, quality baseline data on dog populations are viewed as necessary to target canine vaccination campaigns effectively and to measure vaccination coverage accurately.6 In many rabies-endemic countries reliable data are scarce.7

People exposed to rabies require timely prophylaxis including wound cleaning, vaccines and sometimes rabies immunoglobulins. Effective delivery of postexposure prophylaxis relies on good public awareness of rabies, and access to treatment.

Canine rabies has persisted in KwaZulu-Natal province of South Africa since its introduction in 1976.9 Since then, urbanization, large dog populations and failed control efforts have contributed to continuing endemicity of dog-mediated rabies in KwaZulu-Natal province, South Africa.

Approach

From 2007 to 2014 we used a OneHealth approach to rabies prevention, involving both the human and animal health sectors. We implemented mass vaccination campaigns for dogs to control canine rabies, and strategies to improve rabies awareness and access to postexposure prophylaxis for people exposed to rabies.

Lesson learnt

Starting small and scaling up enabled us to build strategies that fitted various local settings and to successfully apply a OneHealth approach. Important to the success of the project were employing competent, motivated staff, and providing resources, training and support for field workers.

Abstracts in العربية, 中文, Français, Русский and Español at the end of each article.

Problem

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Local setting

A rabies-endemic region, KwaZulu-Natal is one of the smallest and most populous South African provinces (estimated population 10 900 000). Canine rabies has persisted since its introduction in 1976, causing an average of 9.2 human rabies cases per annum in KwaZulu-Natal from 1976 to 2007, when the project started.

Relevant changes

Between 2007 and 2014, the numbers of dog vaccinations rose from 358 611 to 395 000 and human vaccines purchased increased from 100 046 to 156 996. Strategic dog vaccination successfully reduced rabies transmission within dog populations, reducing canine rabies cases from 473 in 2007 to 37 in 2014. Actions taken to reduce the incidence of canine rabies, increase public awareness of rabies and improve delivery of postexposure prophylaxis contributed to reaching zero human rabies cases in KwaZulu-Natal in 2014.

Lesson learnt

Starting small and scaling up enabled us to build strategies that fitted various local settings and to successfully apply a OneHealth approach. Important to the success of the project were employing competent, motivated staff, and providing resources, training and support for field workers.
The first objective was to collect or estimate baseline data on dog populations. To understand the communities at risk of rabies we obtained national human census data, supported by disease data and local knowledge of the area. Additionally, we supported a study of local dog ecology to better understand canine populations, dog-human interactions and factors preventing access to dogs for vaccination. This used surveys and community interviews to identify high-risk characteristics of canine populations, and dog ownership and management related to rabies endemicity in the province. We also created a database to record laboratory-confirmed human and canine rabies cases and used historic and current rabies data to inform campaign planning.

We initially measured canine rabies vaccination coverage in two villages of KwaZulu-Natal in a census to estimate the dog population. Once the effectiveness of our vaccination strategy was established, we did not expend further resources to evaluate this and thereafter we used rabies incidence in dogs and people as an indicator of the success of the project.

The second objective was to improve the systems for treating exposed people. Awareness of rabies in KwaZulu-Natal was already high, but we aimed to improve the public’s awareness of rabies, and to encourage them to seek treatment after a suspected exposure. We did this through rabies action groups and locally produced pamphlets, posters, radio broadcasts and newspaper advertisements directed towards medical professionals and the public. To avoid inappropriate use of post exposure treatment we trained medical staff in how to perform risk assessments of exposed patients. Among the different training interventions were orientations for new staff (conducted by hospitals throughout the province) on assessing and prioritizing animal-bite patients, supported by the materials generated by the project for healthcare workers on managing dog bites.

The third objective was to improve the control of rabies in domestic dogs. We initially used sterilization of domestic dogs for canine population control. However, this proved slow and expensive, with little overall impact on dog population size. This is consistent with reports that rabies control cannot be achieved without population management. Instead, we used existing knowledge of the local rabies epidemiology to implement targeted vaccination campaigns. For example, we vaccinated dogs in potential source areas to halt disease transmission to adjacent areas. This approach was informed by project staff who understood the local conditions and by sound surveillance systems that identified areas where rabies was more prevalent.

To conduct the vaccination campaigns, we trained and equipped technicians to use humane animal-handling equipment to catch and handle dogs. Printed and broadcast media informed the public on why, how and where to participate. We equipped field workers with vehicles and public address systems allowed staff to call the public to the nearest road to have their dogs vaccinated. By reducing travel distances for owners, we aimed to improve turnout and allow technicians to follow up on animals that were easier to handle at home. We equipped vaccinators to catch and restrain unmanageable dogs; however, free-roaming dogs that could not be caught were left alone. Finally, we created a canine rabies vaccine bank at the provincial veterinary laboratory to provide stability of vaccine supplies, lower prices for bulk orders and a base for expansion of the project.

The fourth objective was to improve the surveillance and diagnostics of rabies. We aimed to increase the submission of samples from suspect animals for laboratory diagnosis by raising awareness, and improving sample transport systems. The same transport infrastructure required to deliver vaccines to communities was used to transport samples from communities to laboratories for diagnosis.

To complement traditional surveillance methods we also used tools such as typing of viruses and sequencing, to determine transmission histories and enhance our understanding of disease causes and spread.

**Relevant changes**

In 2014, when the project concluded, the annual numbers of dog vaccinations performed and human vaccines purchased in KwaZulu-Natal had increased to 395,000 and 156,996 respectively (Fig. 1). The number of canine rabies cases reported in the province had fallen...
Lessons learnt

We defined success of the project as reaching zero human rabies cases. However, measuring the impact of each intervention is complex. For example, improving the public’s awareness of rabies involved multiple measures over a period of years, and helped to increase turnout in vaccination campaigns, demand for postexposure prophylaxis and submission of samples for surveillance.

We started activities in one area and scaled them up to build systems that fitted the local settings. This allowed rabies awareness, postexposure prophylaxis delivery, dog vaccination and surveillance to improve as the project grew. Local successes generated data, interest and investment, allowed for adaptation, and drove expansion. Effective human management, such as engaging local champions, and training, motivating and equipping field staff, was key to successfully implementing these related interventions (Box 1).

Understanding rabies epidemiology within KwaZulu-Natal allowed for targeted interventions in areas where disease transmission was highest. Our experience demonstrates that knowledge and data can be generated while interventions are being implemented; lack of data should not preclude control efforts.

We found that sustained, targeted, high-coverage dog vaccination in potential source areas consistently halted disease transmission to adjacent areas. Thus, fewer vaccinations were needed to achieve control. The dog vaccination campaigns also generated training materials and standard operating procedures, enabling neighbouring provinces and countries to implement similar campaigns.

In KwaZulu-Natal, high levels of rabies awareness, and established transport systems, including a dedicated courier service and training on transport packaging, contributed to the soundness of the surveillance system. Good surveillance systems are integral to control; however their absence should not preclude implementation of control programmes.

Improving the public’s access to post exposure prophylaxis was likely a factor in reaching zero human rabies deaths in KwaZulu-Natal, as it provides protection even when a low level of disease continues to circulate in dogs. However, we found that increasing the public’s awareness led to increased use of human vaccines, as dog bites continued to occur and be treated as potential exposures even when the incidence of animal rabies was reduced. Therefore, we renewed our focus on bite prevention education. Bite prevention education became a focus of the project towards the end, but was limited by lack of funds, and aims to educate communities on how to interpret dog behaviour to avoid bites. We have yet to evaluate the potential of such education to reduce rabies exposure and demand for postexposure prophylaxis.

Intradermal vaccination would reduce the cost of rabies treatment. However, it is not currently registered in South Africa or included in label recommendations on rabies vaccines. In the long term, the costs of postexposure prophylaxis could be reduced by provision of intradermal vaccines; risk assessments of animal bite patients to prevent unnecessary use of prophylaxis; and bite prevention education to prevent potential rabies exposures.

Fig. 2. Annual numbers of human and canine rabies cases in KwaZulu-Natal province, South Africa, 1976–2014

Notes: KwaZulu-Natal province has an estimated human population 10,900,000. Mass canine vaccination campaigns were implemented in the province from 2007 to 2014. The increases in cases in 2012 correspond to interrupted canine vaccination campaigns in 2011.

Box 1. Summary of main lessons learnt

- Starting small and scaling up enabled us to apply the OneHealth approach successfully and to build strategies that fitted the local setting.
- Important to the success of the project were employing competent, motivated staff, and providing resources, training and support for field workers.
- Our rabies vaccination campaigns generated training materials and standard operating procedures, enabling neighbouring provinces and countries to implement similar campaigns.

No. of human rabies cases

0 5 10 15 20 25 30 35 40

Year 1976 1978 1980 1982 1984 1986 1988 1990 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014

No. of canine rabies cases

0 50 100 150 200 250 300 350 400 450 500

Human rabies --- Canine rabies

2007 2008 2009 2010 2011 2012 2013 2014

Start of project

• Our rabies vaccination campaigns generated training materials and standard operating procedures, enabling neighbouring provinces and countries to implement similar campaigns.

• Important to the success of the project were employing competent, motivated staff, and providing resources, training and support for field workers.

• Starting small and scaling up enabled us to apply the OneHealth approach successfully and to build strategies that fitted the local setting.

• Successful interventions are being implemented; lack of data should not preclude control efforts.

• Understanding rabies epidemiology within KwaZulu-Natal allowed for targeted interventions in areas where disease transmission was highest. Our experience demonstrates that knowledge and data can be generated while interventions are being implemented; lack of data should not preclude control efforts.

• We found that sustained, targeted, high-coverage dog vaccination in potential source areas consistently halted disease transmission to adjacent areas. Thus, fewer vaccinations were needed to achieve control. The dog vaccination campaigns also generated training materials and standard operating procedures, enabling neighbouring provinces and countries to implement similar campaigns.

• In KwaZulu-Natal, high levels of rabies awareness, and established transport systems, including a dedicated courier service and training on
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et améliorer l'accès des personnes exposées à la rage à la prophylaxie post-exposition.

Environnement local Le KwaZulu-Natal, où la rage est endémique, est l'une des provinces d'Afrique du Sud les plus petites et les plus peuplées (population estimée à 10 900 000 habitants). La rage canine persiste depuis son apparition en 1976, ayant provoqué en moyenne 9,2 cas de rage humaine par an au KwaZulu-Natal entre 1976 et 2007, année qui a marqué le lancement du projet.

Changements significatifs Entre 2007 et 2014, le nombre de vaccinations pratiquées sur des chiens est passé de 358 611 à 395 000, tandis que le nombre de vaccins humains achetés est passé de 100 046 à 156 996. La vaccination stratégique des chiens a permis de faire reculer la transmission de la rage au sein des populations canines, le nombre de cas de rage animale passant de 473 en 2007 à 37 en 2014. Les actions prises pour réduire l'incidence de la rage canine, sensibiliser la population à la rage et améliorer l'accès à la prophylaxie post-exposition ont permis qu'aucun cas de rage humaine ne soit déclaré au KwaZulu-Natal en 2014.

Leçons tirées En démembrant notre projet sur une petite échelle, puis en lui donnant une ampleur accrue, nous avons pu élaborer des stratégies adaptées aux différents contextes locaux et appliquer avec succès l’approche « Un monde, une santé ». Le succès du projet a reposé en grande partie sur le recrutement de professionnels compétents et motivés, et la mise à disposition de ressources, de formations et d'un soutien pour les agents locaux.
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References

1. Hampson K, Coudeville L, Lembo T, Sambo M, Kieffer A, Attlan M, et al. Correction: estimating the global burden of endemic canine rabies. PLoS Negl Trop Dis. 2015 May 11;9(5):e0003786. Corrected and republished from: PLoS Negl Trop Dis. 2015 Apr 16;9(4):e0003709.

2. Knobel DL, Cleaveland S, Coleman PG, Fève EM, Meltzer MI, Miranda ME, et al. Re-evaluating the burden of rabies in Africa and Asia. Bull World Health Organ. 2005 May;83(5):360–8. PMID: 15976877.

3. Manning SE, Rupprecht CE, Fishbein D, Hanlon CA, Lumleytdacha B, Guerra M, et al.; Advisory Committee on Immunization Practices Centers for Disease Control and Prevention (CDC). Human rabies prevention – United States, 2008. Recommendations of the Advisory Committee on Immunization Practices. MMWR Recomm Rep. 2008 May 23;57 RR-3:1–28. PMID: 18496505.

4. Coleman PG, Dye C. Immunization coverage required to prevent outbreaks of dog rabies. Vaccine. 1996 Feb;14(3):185–6. doi: http://dx.doi.org/10.1016/0264-410X(95)00197-9 PMID: 8920697.

5. Zinsstag J, Dürr S, Penny MA, Roth F, Menendez Gonzalez S, et al. Transmission dynamics and economics of rabies control in dogs and humans in an African city. Proc Natl Acad Sci USA. 2009 Sep 1;106(35):14996–5001. doi: http://dx.doi.org/10.1073/pnas.0904740106 PMID: 19706492.

6. WHO Expert consultation on rabies: second report. [WHO Technical Report Series No. 982]. Geneva: World Health Organization; 2013. Available from: http://apps.who.int/iris/bitstream/10665/85346/1/9789240690943_eng.pdf [cited 2018 Mar 22].

7. Mid-year population estimates 2015. Pretoria: Statistics South Africa; 2015. Available from: https://www.statssa.gov.za/publications/P0302/P03022015.pdf [cited 2018 Mar 22].

8. Hergert M, Nel LH. Dog bite histories and response to incidents in canine rabies-enzootic KwaZulu-Natal, South Africa. PLoS Negl Trop Dis. 2013 04 4;7(4):e2059. doi: http://dx.doi.org/10.1371/journal.pntd.0002059 PMID: 23593511.

9. Morters MK, Restif O, Hampson K, Cleaveland S, Wood JL, Conlan AJ. Evidence-based control of canine rabies: a critical review of population density reduction. J Anim Ecol. 2013 Jan;82(1):6–14. doi: http://dx.doi.org/10.1111/j.1365-2656.2012.02033.x PMID: 23004351.