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

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**Rabies**

- A fatal disease in all mammals caused by Lyssaviruses
  - Rabies virus major cause of problems worldwide
- Public health (mortality, morbidity, psychological impacts)
- Companion animal and livestock health
- Economic burden
- Conservation impacts
- Animal welfare
- ~100% preventable disease

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**A disease of the rural poor**

- Often unable to seek medical attention
- Often unable to afford high costs of post-exposure prophylaxis (PEP)
- Considerable financial hardship for families raising funds for PEP
- Vaccine often not available in rural health centres

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**Large variety of reservoir species**

...but >98% human infections due to dog bites and vast majority of human rabies deaths occur in Asia and Africa where dog rabies is endemic...and is still widely under-reported.

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**Emerging threats**

- Pet animal movements and the re-introduction of canine rabies  
- No. of dogs legally imported into UK has increased by 65% since 2011  
- Illegal movements?

Rabies introduction can result in very high costs associated with contact tracing and post-exposure prophylaxis.
Rescues and adoptions

Risks of importing rabies highly dependent on compliance with regulations

Canine rabies and wildlife conservation

Ethiopian wolf

African wild dog

~500 individuals

Rabies poses most immediate threat to the survival of the species

~5,000 individuals

Rabies epidemics have resulted in major population declines and local extinctions

Canine rabies can be controlled and eliminated through mass dog vaccination

Some reasons why rabies not yet tackled effectively in Africa

- Perception of too many dogs or too many 'stray' dogs
- Perception that dogs are not easily accessible for vaccination
- Perception that dog vaccination is too costly to implement within government veterinary services
- Perception that infection in wildlife would prevent successful dog rabies control/elimination

Phylogenetic analyses: A single variant of canine rabies

No sustained chains of wildlife infection. Transmission dominated by dog-to-dog infection.

Metapopulation models: Spread from external dog populations not from national park.

**Intervention studies**

Can rabies cycle in wildlife independently of dogs?

Is dog rabies control feasible and cost-effective?

**Central Point Vaccination**

Engagement of school children is critical.

Coverage high irrespective of socioeconomic status.

Vast majority of dogs are owned and accessible for vaccination.

- Chad: 1%, 8%, and 11% of dogs were unowned in three study sites in N’Djamena (Kayali et al. 2003).
- Zimbabwe: All dogs in communal lands were owned (Butler and Bingham, 2000).
- Tanzania: < 1% of dogs were unowned in an urban site using mark-recapture observations (Gsell et al. 2013).
- No evidence for unowned dogs in any of the communities around the Serengeti (Kaare et al., 2009).
- The proportion of unowned dogs is unlikely to be high enough to prevent target vaccination thresholds to be reached.

**More good news…**

*R*_ for rabies is VERY low

~1.1-1.3

On average each rabid dog infects 1.2 others.

Low value of *R*_ suggests that elimination should be feasible.

The problem for rabies control is generally not about ‘too many dogs’... but
- There is demand among dog owners for sterilisation
- Aggression and nuisance behaviour is problematic and can be a greater concern than rabies in some communities
- Improving primary health care important for animal welfare, enhancing life expectancy and reducing demand for puppies
- Important opportunity for engagement with private practitioners

Dog vaccination highly cost-effective
- 70% coverage optimal scenario at ‘very cost-effective’ levels of investment
- Fitzpatrick et al. (in press) Cost-effectiveness of canine vaccination to prevent human rabies in rural Tanzania, Annals of Internal Medicine

At what age should pups be vaccinated?
- In mass vaccination campaigns for control of rabies in endemic areas of Africa and Asia, vaccination of pups is important for herd immunity
- However, movement of pups associated with re-introduction of rabies into rabies-free areas
- Importation and movement of pups should be discouraged
- Dogs must be vaccinated in line with vaccine marketing authorization of importing company

Rabies control can be achieved quickly
- Several studies indicate significant declines in rabies can be seen after two campaigns (Schneider et al., 2007)
- Dog population density reduction not very effective for rabies control
- Can result in marked decline in demand for costly PEP
- Protects vulnerable communities unable to access life-saving PEP promptly

Coverage high in adult and juvenile dogs, but lowest in puppies
- Good response to vaccination regardless of body condition or clinical status (McNabb, 2008)
- Young pups all responded with high titres

Dog population density

70% of dogs is feasible in most settings through vaccination
- Vaccination of puppies important for herd immunity
- Vaccination regardless of body condition or clinical status
- Importation and movement of pups should be discouraged
- Dogs must be vaccinated in line with vaccine marketing authorization of importing company

Consistently low value of \( R_0 \) suggests that elimination of canine rabies through vaccination of 70% dogs is feasible in most settings
Dog rabies can be controlled when achieving a vaccination coverage of ~70% during campaigns.

Population immunity remains sufficiently high in interval between campaigns.

The order and speed of campaigns has little effect on the time it takes for rabies elimination to occur.

Simulation models of rabies in Bali, Indonesia

Reached all villages 100% success

3 villages missing 99% success

Clusters of unvaccinated villages and patchy coverage jeopardise rabies control and elimination.

Time to elimination depends on completeness of vaccination coverage and rate of re-introductions.

Frequent introductions from outside vaccinated area led to resurgence of cases.

Low vaccination coverage in just 6 out of 75 villages led to resurgence of cases.

Afya Serengeti Project

WSAVA dog collar-wrist band study

- To determine vaccination coverage in free-roaming dog populations
- To determine impact on vaccination turn-out
- To assess duration of collar survival
- To determine % ownerless dogs

Supported by MSD Animal Health
Collars and wristbands have increased turnout in all districts

Preliminary results

Estimates of coverage from observations of free-roaming dogs higher than figures from household census

=> Ownerless dogs are not a problem

How long does it take before an area can be declared rabies-free?


2.5 years without cases (6 months for control + 2 years for elimination) should be sufficient to declare successful elimination of rabies, even in areas where surveillance is poor (probability of detection <10%)

Working towards the global elimination of canine rabies

- Rabies Elimination Demonstration Projects
  - WHO/Gates Foundation projects in Tanzania, South Africa and Philippines
  - GARC/UBS - Philippines, Indonesia, Chad

- Development of regional strategies with target dates for elimination
  - Latin America – 2015
  - SE Asia - 2020
  - Africa - 2030

- Building partnerships, building confidence, breaking down barriers

www.worldrabbiesday.org

Rabies Blueprint

- Online tool to support the planning and implementation of rabies control and elimination programmes

  - www.rabiesblueprint.com

Global Rabies Elimination

- “To solve the problem of rabies would be a blessing for humanity”
- Can we fulfill Pasteur’s vision?
- Global elimination of canine is feasible
- Concerted efforts are needed and vigilance is still required
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For more information

- Global Alliance for Rabies Control
  - [www.globalrabiescontrol.org](http://www.globalrabiescontrol.org)
- World Rabies Day Campaign
  - [www.worldrabiesday.org](http://www.worldrabiesday.org)
- Rabies blueprint
  - [www.rabiesblueprint.com](http://www.rabiesblueprint.com)