A USER'S GUIDE TO THE GDREP TOOL

A planning aid for the control of dog-mediated human rabies deaths based on dog vaccination

Ryan M. Wallace, Eduardo A. Undurraga, Jesse D. Blanton, M. Meltzer

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Introduction

In 2016, the World Health Organization (WHO), the World Organization for Animal Health (OIE), the Food and Agriculture Organization (FAO), and many non-governmental organizations (NGOs) released a framework to achieve the joint goal of eliminating dog-mediated human rabies by 2030.

To roughly assess the resources needed to achieve the elimination of dog-mediated human rabies deaths by 2030, researchers at the US Centers for Disease Control and Prevention (CDC) developed a framework, the Global Dog Rabies Elimination Pathway (GDREP). This model is based on World Health Organization (WHO) recommendation of vaccinating 70% of the dog population for several years to eliminate dog rabies, and draws on multiple datasets, including national dog vaccination campaigns, rabies literature, and expert opinion. The aim of the GDREP was to describe the global rabies situation, asses the resources needed to reach the 2030 goal and to highlight some of the main challenges that may complicate elimination efforts.

The GDREP focuses of four key factors that determine rabies elimination efforts: country development, the cost of dog vaccination programs, potential demand for dog rabies vaccine, and available vaccinators. But while those global estimates may help stimulate and inform the ongoing discussion about rabies elimination, they may not help inform country-level decision making toward rabies elimination.

This user-friendly GDREP tool, which is derived from the GDREP model, is intended to assist countries in their planning efforts towards the goal of eliminating dog-rabies through mass dog vaccination. It requires only limited country-specific data, and already known default values are provided for where these are not available. Outputs from the planning tool allow program managers to predict workload, budget and capacity needs for an elimination campaign, to enable financing commitments to be made.

The Global Dog Rabies Elimination Pathway (GDREP)

The pathway allows up to 13 years for a country to reach rabies elimination (to reach the 2030 goal) divided into three phases. Countries may enter the pathway during any program year depending on their current dog vaccination and the preparation activities already achieved.

Implementation Phase:	**Phase I: Preparation**			**Phase II: Scale-up dog vaccination**			**Phase III: Sustained 70% dog vaccination**						
Program year	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**
Expected dog vax coverage:	<18%			18% - 35%	35% - 53%	53% - 70%	≥70%						
Activities achieved:	Field studies Workforce training Strengthening lab capacity			Pilot implementation Scaling-up vaccination coverage Logistical improvements Operational equipment			Mass vaccination of dogs Surveillance to establish disease freedom						
Cost estimates:	Current Vaccination Coverage + Infrastructure Improvements*			Expected Vaccination Coverage + Infrastructure Improvements*			Vaccination of 70% of the dog population						

Figure 1. *Global Dog Rabies Elimination Pathway (GDREP): Phases for a dog rabies elimination program based on 70% dog population vaccination coverage.*

Assumptions behind the GDREP tool and data requirements

The outputs of any model depend on both the accuracy of the assumptions made and the quality of the input data.

Key assumptions that underlie the GDREP model

- 70% of the dog population has to be vaccinated annually for 5-7 years to eliminate dog rabies, as per WHO recommendations and some evidence (WHO 2013, Coleman et al. 1996, Cleaveland et la. 2003). There may be some variation by setting that is not considered (Kitala et al. 2001).
- Countries where rabies has been eliminated from specific regions within the country (e.g., Brazil) still require national vaccination coverage until the entire country is free from canine rabies.
- The time frames presented in the GDREP accurately reflect a country's progression towards elimination.
- All countries commit to dog rabies elimination at year one of GDREP and move through the phases as predicted.
- After 7 years of vaccination of 70% of dog population, the model considers the country rabies free. The costs and other requirements to maintain a rabies-free status are not considered in this tool.
- All veterinary public health workers would be willing / able to carry out dog vaccinations, and veterinary workers can move within the country as necessary.
- Any default inputs are subject to the limitations of the originating dataset. User-provided inputs may improve upon the default values, but they should also be critically evaluated when considering the reliability of model output.

Replacing the default data

The model supplies default values for all of the required parameters, for instances where this is not available. These default values are often based on generalised data that may not be accurate for every country. Wherever possible you should use your own country's data to ensure that the model produces the best possible estimates specific to your country.

How to use the tool

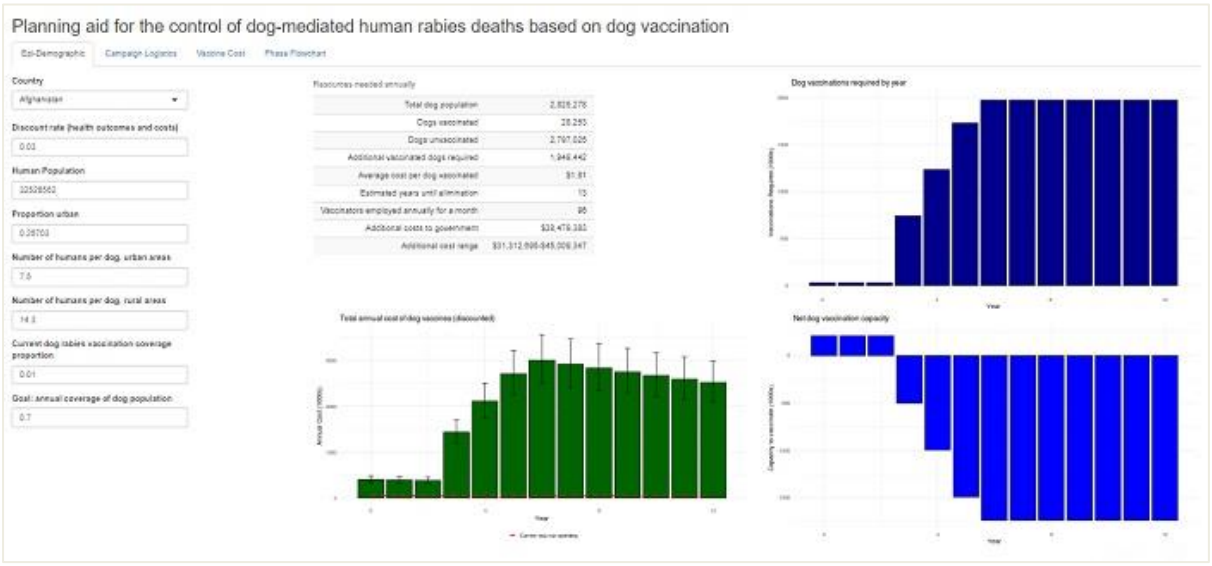
The online tool is available via the Global Alliance for Rabies Control website at:

https://rabiesalliance.org/capacity-building/gdrep

The tool itself consists of four inter-related worksheets that will automatically generate summary tables and graphs of the outputs. Data updated on one sheet may update input fields on others.

The first worksheet: Epi-Demographic data

The main worksheet is where the basic data on the human population, human:dog ratios and the vaccination goals for the program are entered and the key model outputs are summarised and visualised.



Screenshot of the first worksheet

Inputs:

The sheet is prefilled with data for every country, and listed in alphabetical order.

First select your country from the drop-down menu in the first box. The default values used in the GDREP model for your country will appear in the boxes in the left hand column and the summary tables and graphs will update automatically.

You should update these with your own data where possible, by overriding the data, or using the up-down arrows at the right hand side of each box to alter the value. The tool can also be run for any sub-region of a country so long as the parameters are adjusted accordingly.

Input parameters:

Parameter	Notes
Discount rate (health outcomes and costs)	The discount rate renders benefits and costs that occur in different time periods comparable by expressing their values in present terms. The model default is always 3%, but this can be varied on the third worksheet.
Human Population	The human population of the area of interest
Proportion urban	The proportion of people living in urban environments within your selected area
Number of humans per dog, urban areas	Inputting this ratio will allow the program to calculate the total dog population in urban areas
Number of humans per dog, rural areas	Inputting this ratio will allow the program to calculate the total dog population in rural areas
Current dog rabies vaccination coverage proportion	This is the best estimate of the proportion of all dogs that have received a rabies vaccine within the past 1 year
Goal: annual coverage of dog population	This is the proportion of dogs you want to reach eventually, and will generally be 0.7 to follow WHO guidance. This can also be altered if epidemiological factors such as high dog population turnover, or very low dog densities warrant it.

Model Outputs:

The outputs shown in the middle column, and the graphs are updated automatically as input values are altered. They depend on both user-entered and default values (some in later sheets) used in the model, so wait until all sheets have been worked though before interpreting them.

OUTPUT	NOTES
Total dog population	Calculated from the human population (urban and rural) and the number of humans per dog (urban and rural)
Dogs vaccinated	This is the calculated estimate of the number of dogs vaccinated in the past 1 year
Dogs unvaccinated	
Additional vaccinated dogs required	
Average cost per dog vaccinated	This is calculated from the Vaccine cost sheet, where the best cost estimate (and lower and upper bounds) can be entered, or calculated from your own data.
Estimated years until elimination	This output depends on the initial dog vaccination coverage, and the years needed to first reach and then maintain 70% vaccination coverage (see Figure1)
Vaccinators employed annually for a month	This is the minimum number of dog vaccinators that would be needed annually when the vaccination program is operating at its goal of dog population coverage (e.g., 70%) at the dog vaccination rate estimated (dogs per vaccinator per day)
Additional costs to government	This represents the mean estimated additional funds required (beyond those currently being spent) to compete an elimination campaign
Additional cost range	The range reflect the difference in cost between the minimum and maximum vaccination cost per dog.

Output Figures:

These graphs present an overview of the needs for the planned campaign. The maximum timeperiod is 13 years, but if the campaign is not starting from year 1 of Phase 1 this will be shortened.

Dog vaccinations required per year. This is derived from the calculated dog population, the final vaccination coverage goal and the starting year and phase when the elimination campaign begins.

Net dog vaccination capacity. This shows the maximum vaccination capacity of the country (total dogs per year) minus the number of dogs that the country needs to vaccinate each year. Thus if the number is positive, the country has enough capacity; if the number is negative, the country needs more vaccinators, increased vaccination efficiency, or more campaign days.

Total Annual cost of dog vaccinations (discounted). The estimated annual costs are based on the cost per dog vaccinated; excess vaccinator capacity is not included in the aggregate costs

The second worksheet: Campaign Logistics

Here you input basic data on the campaign logistics staff and the rate of vaccinations

Parameter	Notes
Vaccinators available	The default from the OIE's database of veterinary and para-veterinary workers and assumes that all are available to work on rabies vaccination campaigns.
Dogs vaccinated per vaccinator per day	The default is a general assumption, but this value is heavily dependent on the type of vaccination campaign structure (fixed point, door to door etc). Users may wish to increase this value to reflect a better trained workforce, utilization of more effective vaccination methods, or a more engaged public sector; all of which should improve the rate at which dogs can be vaccinated and make rabies elimination more feasible. Varying this value can heavily influence the output and should be carefully considered before altering.
Campaign vaccination days	Enter the planned duration of the annual vaccination campaign. The default is 25 days.

Below the data input is a table of outputs that describe with the current dog vaccination needs how the number of vaccinators, or their dogs vaccinated per day needs to be increased to avoid a shortfall in vaccination capacity.

The third worksheet: Vaccine cost

Screenshot of the third worksheet

This worksheet can be used in two different ways. You can either

(i) enter your best estimate, including lower and upper bounds, of the average cost to vaccinate a dog in your country into the 'Total cost per dog' section at the top.

Some previously published data on this are provided below:

Examples of cost estimates of cost per dog vaccinated from previous studies

Location	Author	Estimate (US$)
N'Djamena, Chad	Kayali et al 2006	$2.38
Rural Tanzania (pastoralist and agro-pastolarist villages)	Kaare et al 2009	$2.39
Petchabun, Thailand	Knobel et al 2005	$1.60
Dar es Salaam, Tanzania	Hatch et al 2016	$8.67
Bohol, Visayas Islands, Philippines	Lapiz et al 2012	$1.76
Bhutan	Tenzin et al 2012	$1.93

All costs shown in this table are in 2015 US dollars using US GDP implicit price deflators.

or (ii) use the tables lower down the worksheet can be used with data from a pilot dog vaccination campaign.

The values in the tables by default are a worked example for costing a vaccination campaign. The numbers used largely correspond to publish literature, but do not represent any specific country.

You can use them as a guide as to how to use your own pilot vaccination campaign data to derive a cost for each dog vaccinated in your setting. The tables allow all the costs for workers, transportation, equipment and vaccine to be collated and a cost per dog output.

The required input data are the total number of dogs vaccinated in pilot campaign (entered into the first box), and full costs of each component of the campaign (entered into the relevant tables). To obtain a range of possible vaccination program costs, users of this tool should include an upper and lower estimate of the potential range of costs per cost category.

Costs have two components: (1) a measurement of the quantity used and (2) the unit cost of the resource. A pragmatic way of thinking about the costs in this sheet is to use the market prices for the resource used, i.e., the price one would have to pay for a resource during the dog vaccination campaign.

One useful way of thinking about the value of vehicles is to estimate how much would it cost to rent a vehicle for the duration of the campaign (e.g., rental of a pick-up truck for 20 days could be a good proxy because it includes maintenance, insurance, and depreciation).

Where workers participate only part-time on the vaccination campaign, one pragmatic way of estimating this cost would be to take the person's salary/wage + fringe benefits and multiply by the proportion of time dedicated to the vaccination campaign.

The output table at the top of the worksheet automatically calculates the cost per dog for each component category, and the total cost per dog. This sheet can therefore be used to explore how reductions in certain types of costs could impact the overall cost per dog vaccinated.

Note that the default costs are in US dollars. Costs in any currency unit can be entered into the tables so long as the currency unit is consistent throughout the worksheet, and the $ in the outputs will represent that currency.

The fourth worksheet: Phase Flowchart

This provides some guidance on how to plan for the different phases of an elimination campaign, from preparation to sustained high vaccination coverage, as shown in Figure 1.

Errors

An error message may occur if an input parameter is out of a valid range for the model to run. Replace the values with more realistic values and the error should go away.

References

Full description of the GDREP model and tool:

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