Supporting Information

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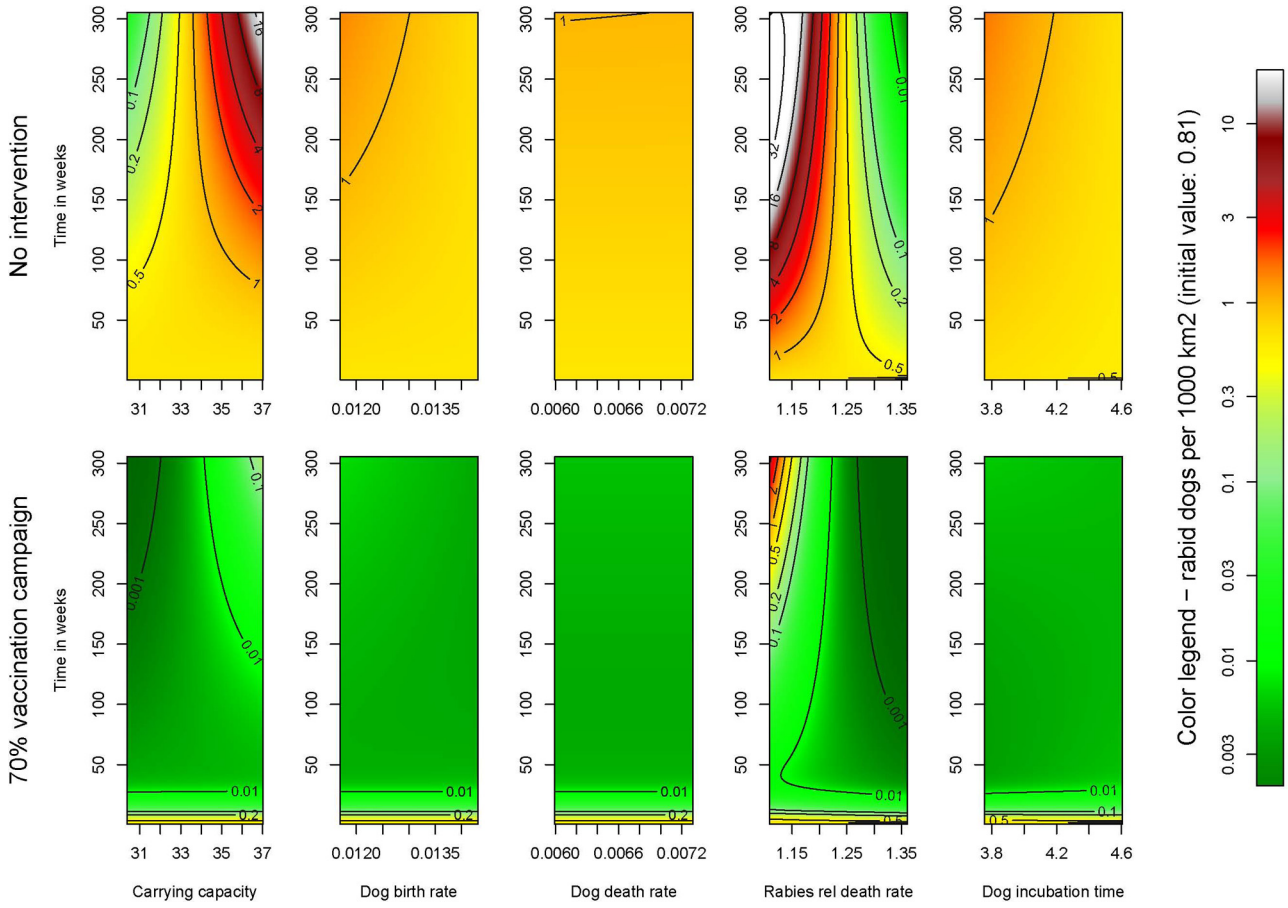

Fig. S1. Sensitivity plots of model parameters show effects of parameter variability over a reasonable range of uncertainty on (*a*) transmission dynamics in dogs and (*b*) transmission dynamics in humans for the no-intervention scenario (human PEP only) and the 70% coverage dog-vaccination campaign and human PEP. The effect of variation of the carrying capacity (κ), dog birth rate (b_d), dog death rate (m_d), dog rabies-related death rate (μ_d), dog incubation period (i_d), the probability of clinical outcome in dogs (r_d), the dog-to-dog transmission rate (β_d), the initial number of rabid dogs/km^2 I_d (0), the initial number of dogs/km^2 S_d (0), human birth rate (b_h), human death rate (m_h), dog-human transmission rate (β_{dh}), and the probability of clinical outcome in humans (see Eq. 10 in *Differential equations of the dog-human rabies transmission model*) and the initial number of persons/km^2 S_h (0) are shown. Contour labels give (*a*) the number of rabid dogs per 1,000 km^2 and (*b*) the number of exposed humans per 1,000 km^2 (source code is available on request).

Table S1. Description, values, reference source and, if applicable, probability distribution used in the sensitivity analysis for each model variable, parameter, and constant

Symbol	Description	Estimate	Unit	Source and other details	Sensitivity analysis
T	Time	-	Week		
$S_d(0)$	Initial susceptible dogs per km^2	33.6	Dogs / km^2	Dog population (1) divided through city surface (700 km^2)	
$E_d(0)$	Initial exposed dogs per km^2	0.006155	Dogs / km^2	Fitted value (Poisson distributed errors)	95% confidence limits 0.006151; 0.006158
$I_d(0)$	Initial rabid dogs per km^2	0.00081	Dogs / km^2	Recorded data LRVZ: Average number of rabid dogs per km^2 and week	
$R_d(0)$	Initial immunized dogs per km^2	0	Dogs / km^2	Assumption	
N_d	Dog population			$N_d = S_d + L_d + I_d + R_d$	
b_d	Dog birth rate	0.013	Week^{-1}	Household survey	Normal distribution: mean = 0.013, SD = 0.0009 (CI estimate from survey data)
λ_d	Dog loss of vaccination immunity rate	0.0081 until week 26 + 0.102 until week 52	Week^{-1}	(2)	
i_d	Dog incubation period	4.18	Week	(3, 4)	Normal distribution: mean = 4.18, SD = 0.27
σ_d	Auxiliary variable	$1/i_d$			
r_d	Risk of clinical outcome of exposed dogs	0.49	Dimensionless	Personal communications (K. Hampson)	Triangular distribution: min = 0.485, mode = 0.49, max = 0.495 (+/– 1% for min/max assumed)
m_d	Dog mortality rate	0.006638	Week^{-1}	Household survey	Normal distribution: mean = 0.006638, SD = 0.0007 (CI estimate from survey data)
β_d	Dog- to- dog transmission rate	0.0807154	km^2/ (dogs··week)	Fitted values	Normal distribution: mean = 0.0807154, SD = 0.000031 (CI estimate from fitted model)
Γ	Dog density-dependent mortality		km^2/ (dogs··week)	$(b_d\text{-}m_d)/K$	
K	Dog carrying capacity	33.6	Dogs / km^2	(1) City surface: 700 km^2	Triangular distribution: min = 33.26, mode = 33.6, max = 33.93 (+/– 1% for min/max assumed)
v_d	Dog vaccine efficacy	0.94	Dimensionless	(5)	
α_d	Dog vaccination rate	70% coverage: decay rate 0.12 from week 1 to 10; 50% coverage: 0.069 from week 1 to 10	Week^{-1}	Simulated in model as a campaign with 70% and 50% coverage of the dogs, in 10 weeks, represented as a step function	
c_d	Dog culling rate	5% culling: decay rate 0.00513 from week 1 to 10; 10% culling: 0.0105 from week 1 to 10	Week^{-1}	Simulated in model as culling of 5% and 10% of the dog population during 10 weeks, represented as a step function	
μ_d	Rabid dogs mortality rate	1.2345	Week^{-1}	(4)	Triangular distribution: min = 1.2115, mode = 1.2345, max = 1.2463 (+/– 1% for min/max assumed)
$S_h(0)$	Initial susceptible humans per km^2	1,108	Humans / km^2	Human population (1) divided by city surface (700 km^2)	

Symbol	Description	Estimate	Unit	Source and other details	Sensitivity analysis
$E_h(0)$	Initial exposed humans per km^2	0.00168	Humans / km^2	Recorded data LRVZ: Average number of exposed people per km^2 at first week	
$I_h(0)$	Initial rabid humans per km^2	0	Humans / km^2	Assumption	
$R_h(0)$	Initial immunized humans per km^2	0	Humans / km^2	Assumption	
b_h	Human birth rate	0.00076	Week^{-1}	(6)	Triangular distribution: min = 0.00072, mode = 0.00076, max = 0.0008 (+/– 5% for min/max assumed)
λ_h	Human loss of vaccination immunity rate	0	Week^{-1}	Not further dealt with further	
m_h	Human mortality rate	0.00029	Week^{-1}	(6)	Triangular distribution: min = 0.00028, mode = 0.00029, max = 0.0003 (+/– 5% for min/max assumed)
v_h	Human vaccine efficacy	0.95	Dimensionless	Product information Sanofi-Pasteur, Novartis vaccines	
α_h	Human prophylactic vaccination rate	0	Week^{-1}	Intervention-related parameter. Not dealt with further.	
β_{dh}	Dog-human transmission rate	0.0002054	km^2/ (dogs··week)	Fitted value	
P10	PEP vaccination rate	0	Week^{-1}	Intervention-related parameter. Not dealt with further.	
P2	Probability of bite to the head	0.07	Dimensionless	(7)	
P3	Probability of bite to the arm	0.384	Dimensionless	(7)	
P4	Probability of bite to the trunk	0.06	Dimensionless	(7)	
P5	Probability of bite to the leg	0.486	Dimensionless	(7)	
P6	Probability of developing rabies after bite to the head	0.45	Dimensionless	(7, 8); Mode taken	Triangular distribution: min = 0.3, mode = 0.45, max = 0.6 ((according to ref. [98]))
P7	Probability of developing rabies after bite to the arm	0.275	Dimensionless	(7, 8); Mode taken	Triangular distribution: min = 0.15, mode = 0.275, max = 0.4 (according to ref. 9) (according to [8])
P8	Probability of developing rabies after bite to the trunk	0.05	Dimensionless	(7, 8); Mode taken	Triangular distribution: min = 0, mode = 0.05, max = 0.1 (according to ref. 9) (according to [8])
P9	Probability of developing rabies after bite to the leg	0.05	Dimensionless	(7, 8); Mode taken	Triangular distribution: min = 0, mode = 0.05, max = 0.1 (according to ref. 9) (according to [8])
i_{head}	Human incubation period after bite to the head	3.14	Week	(10); Median value taken	Triangular distribution: min = 2.98, mode = 3.14, max = 3.31 (+/– 5% for min/max assumed)
i_{arm}	Human incubation period after bite to the arm	8.57	Week	(10); Median value taken	Triangular distribution: min = 8.14, mode = 8.57, max = 9.02 (+/– 5% for min/max assumed)

Symbol	Description	Estimate	Unit	Source and other details	Sensitivity analysis
i_{trunk}	Human incubation period after bite to the trunk	6.43	Week	(10); Median value taken	Triangular distribution: min = 6.11, mode = 6.43, max = 6.77 (+/– 5% for min/max assumed)
i_{leg}	Human incubation period after bite to the leg	10.71	Week	(10); Median value taken	Triangular distribution: min = 10.17, mode = 10.71, max = 11.27 (+/– 5% for min/max assumed)
μ_h	Rabid humans mortality rate	1	$Week^{-1}$	(11)	

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Table S2. List of input variables for the cost-benefit and cost-effectiveness analyses

Cost item	US$ Average /most likely	US$ Variation	@Risk function
Private cost			
Dog vaccination			
Dog vaccination			
Unit lost work time for dog vaccination cost (societal)	1.03	Max estimate	Part of societal cost
Private cost			
Human post exposure treatment			
Unit local transport cost	5.01	Min.; max.:2.06;8.64	Triangular (min, most likely, max)
Unit lab fee (dog examination)	11.73	Min.; max.:11.52;11.94	Uniform (min, max)
Unit human vaccine cost	90.03	Min.; max.:77.17;102.9	Uniform (min, max)
Unit drug cost	19.04	Min.; max.:15.43;22.64	Uniform (min, max)
Unit outpatient cost	4.12		State fixed value
Unit loss of income	10.29	Min.; max.:4.12;18.52	Triangular (min, most likely, max)
Public cost			
Dog vaccination			
Unit dog vaccination (public)	1.16	Min.; max.:1.14;1.21	Uniform (min., max.)
Unit dog vaccination cost (societal)	2.61	Min.; max.:2.57;2.66	Uniform (min, max)
Transmission related parameters			
Exposed persons	Model output		Lognormal (mean; SD)

Table S3. Passive routine surveillance of dog rabies cases (I) and human exposure (Y) in N'Djaména, Chad, from January 2001 to November 2006

	Observed data	
Time, weeks	Rabid dogs	Exposed humans
1	0.00142857	0.00142857
2	0	0
3	0.00142857	0.00428571
4	0	0
5	0.00142857	0.00714286
6	0	0
7	0	0
8	0	0
9	0	0
10	0	0
11	0.00142857	0.00142857
12	0	0
13	0	0
14	0	0
15	0.00142857	0.00428571
16	0.00142857	0.00142857
17	0.00285714	0.00571429
18	0	0
19	0	0
20	0	0
21	0.00285714	0.00428571
22	0	0
23	0	0
24	0	0
25	0.00142857	0.00142857
26	0.00142857	0.00142857
27	0	0
28	0	0
29	0	0
30	0.00142857	0.00142857
31	0	0
32	0	0
33	0.00142857	0.00285714
34	0.00285714	0.00428571
35	0.00142857	0.00285714
36	0.00142857	0.00142857
37	0.00142857	0.00142857
38	0	0
39	0.00142857	0.00285714
40	0	0
41	0.00142857	0.00285714
42	0.00142857	0.00571429
43	0	0
44	0.00142857	0.00285714
45	0.00142857	0.00571429
46	0	0
47	0.00428571	0.00571429
48	0.00428571	0.00285714
49	0	0
50	0	0
51	0.00285714	0.00142857
52	0	0
53	0	0
54	0.00142857	0.00285714
55	0	0
56	0.00142857	0.00142857
57	0	0
58	0	0
59	0	0
60	0	0
61	0.00142857	0.00142857
62	0	0

Time, weeks	Observed data	
	Rabid dogs	Exposed humans
63	0	0
64	0	0
65	0	0
66	0	0
67	0	0
68	0	0
69	0.00142857	0.00571429
70	0.00285714	0.00285714
71	0	0
72	0	0
73	0.00285714	0.00285714
74	0	0
75	0.00142857	0.00142857
76	0.00142857	0.00428571
77	0	0
78	0	0
79	0	0
80	0	0
81	0	0
82	0	0
83	0	0
84	0.00142857	0.00142857
85	0	0
86	0.00142857	0.00428571
87	0	0
88	0.00142857	0.00428571
89	0	0
90	0.00142857	0.00142857
91	0.00285714	0.00571429
92	0	0
93	0.00142857	0.00428571
94	0	0
95	0	0
96	0	0
97	0	0
98	0	0
99	0.00142857	0.00285714
100	0.00142857	0.00142857
101	0.00142857	0.00714286
102	0	0
103	0.00142857	0.00285714
104	0.00142857	0.00285714
105	0	0
106	0	0
107	0	0
108	0.00142857	0.00571429
109	0	0
110	0	0
111	0	0
112	0	0
113	0.00142857	0.00142857
114	0	0
115	0	0
116	0	0
117	0.00285714	0.00428571
118	0	0
119	0.00142857	0.00571429
120	0.00142857	0.00428571
121	0	0
122	0	0
123	0.00142857	0.00428571
124	0	0
125	0	0
126	0	0

Time, weeks	Observed data	
	Rabid dogs	Exposed humans
127	0.00142857	0.00571429
128	0	0
129	0.00428571	0.01
130	0.00142857	0.00142857
131	0	0
132	0	0
133	0	0
134	0.00285714	0.00285714
135	0	0
136	0	0
137	0	0
138	0	0
139	0.00142857	0.00142857
140	0	0
141	0	0
142	0	0
143	0.00142857	0.00142857
144	0	0
145	0	0
146	0	0
147	0.00285714	0.00285714
148	0	0
149	0.00285714	0.00714286
150	0	0
151	0.00142857	0.00571429
152	0	0
153	0	0
154	0	0
155	0	0
156	0.00142857	0.00142857
157	0	0
158	0.00142857	0.00142857
159	0	0
160	0.00285714	0.0114286
161	0	0
162	0	0
163	0	0
164	0	0
165	0	0
166	0	0
167	0	0
168	0	0
169	0	0
170	0	0
171	0	0
172	0.00142857	0.00714286
173	0	0
174	0	0
175	0.00142857	0.00142857
176	0	0
177	0	0
178	0	0
179	0.00142857	0.00142857
180	0	0
181	0	0
182	0.00285714	0.00571429
183	0.00142857	0.00285714
184	0	0
185	0	0
186	0	0
187	0.00142857	0.00285714
188	0	0
189	0.00285714	0.0142857
190	0	0

Time, weeks	Observed data	
	Rabid dogs	Exposed humans
191	0.00142857	0.00428571
192	0	0
193	0.00285714	0.00571429
194	0.00142857	0.00285714
195	0.00285714	0.00571429
196	0	0
197	0	0
198	0.00142857	0.00142857
199	0	0
200	0.00285714	0.00428571
201	0.00142857	0.00142857
202	0	0
203	0.00285714	0.00571429
204	0.00142857	0.00142857
205	0.00142857	0.00428571
206	0.00285714	0.0114286
207	0.00142857	0.00428571
208	0.00142857	0.00285714
209	0.00142857	0.00285714
210	0.00285714	0.00285714
211	0.00142857	0.00142857
212	0.00142857	0.00142857
213	0.00142857	0.00142857
214	0.00285714	0.00571429
215	0	0
216	0.00142857	0.00571429
217	0.00142857	0.00285714
218	0.00142857	0.00142857
219	0	0
220	0	0
221	0.00142857	0.00142857
222	0.00142857	0.00571429
223	0	0
224	0.00142857	0.00714286
225	0	0
226	0	0
227	0.00142857	0.00142857
228	0	0
229	0.00285714	0.00571429
230	0.00285714	0.0157143
231	0	0
232	0	0
233	0	0
234	0	0
235	0.00285714	0.00285714
236	0.00285714	0.00285714
237	0.00142857	0.00285714
238	0	0
239	0	0
240	0	0
241	0	0
242	0.00142857	0.00142857
243	0	0
244	0.00142857	0.00142857
245	0.00285714	0.0171429
246	0.00142857	0.00142857
247	0	0
248	0.00142857	0.00285714
249	0.00142857	0.00285714
250	0.00142857	0.00428571
251	0.00285714	0.00571429
252	0.00142857	0.00714286
253	0	0
254	0	0

Time, weeks	Observed data	
	Rabid dogs	Exposed humans
255	0.00285714	0.00285714
256	0	0
257	0.00142857	0.00285714
258	0.00285714	0.00857143
259	0.00142857	0.00142857
260	0	0
261	0.00142857	0.00571429
262	0.00142857	0.00142857
263	0.00142857	0.00142857
264	0.00285714	0.00285714
265	0	0
266	0.00142857	0.00142857
267	0.00142857	0.00428571
268	0.00285714	0.00285714
269	0	0
270	0.00285714	0.00428571
271	0	0
272	0.00142857	0.00428571
273	0.00142857	0.00428571
274	0.00285714	0.00428571
275	0	0
276	0.00142857	0.00285714
277	0.00285714	0.00714286
278	0	0
279	0	0
280	0	0
281	0	0
282	0	0
283	0	0
284	0.00142857	0.00428571
285	0.00142857	0.01
286	0	0
287	0.00142857	0.00142857
288	0.00142857	0.00142857
289	0	0
290	0	0
291	0.00142857	0.00285714
292	0	0
293	0	0
294	0	0
295	0	0
296	0	0
297	0.00142857	0.00142857
298	0	0
299	0.00142857	0.00142857
300	0	0
301	0	0
302	0	0
303	0.00142857	0.00142857
304	0	0
305	0.00142857	0.00142857

Rabies cases were recorded passively during the study period. At the beginning of our work, meetings were held with local authorities in all administrative districts to inform them about rabies. Posters advertising the diagnostic work at the LRVZ were distributed to each local chief (who represents traditional authority and the city administration). Collaboration with health institutions and the only veterinary clinic was established to refer suspected cases in animals to the LRVZ. At the beginning of the observation period, over a period of 2 weeks, radio broadcasts were used to inform the population on clinical signs of dog rabies, the steps to be taken, and the availability of improved diagnosis. Diagnostic services were not free. The sensitivity of IFAT is 99%, and specificity is 99.5% (Swiss Rabies Centre, unpublished data).

Other Supporting Information Files

SI Appendix