The risk of rinderpest re-introduction in the post-eradication era

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Background

A major global eradication effort has eliminated all natural transmission of rinderpest virus, and in 2011 the Food and Agriculture Organization of the United Nations (FAO) and the World Organisation for Animal Health (OIE) jointly declared Global Freedom from Rinderpest. Rinderpest and smallpox are the only diseases to have been globally eradicated.

However, as long as viable rinderpest virus continues to be held by vaccine producers or research/diagnostic laboratories, there is risk of accidental or deliberate virus release. FAO therefore commissioned a study to assess the risk of rinderpest re-introduction.

Objectives

Aim: to assess the risk of rinderpest re-introduction.

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- to identify the potential sources of virus;
- to identify potential pathways leading to release of rinderpest virus and exposure of a susceptible host;
- to estimate the probability of each pathway occurring, and the potential consequences of host exposure.

Methods

A semi-quantitative risk assessment was conducted to assess the risk of rinderpest re-introduction. This risk was defined as the probability of at least one host becoming infected and infectious outside a laboratory within a one year period anywhere in the world.

Through literature review and expert consultation, potential pathways leading to rinderpest re-introduction were defined (Figure 1). It was assumed that there was no longer any rinderpest virus circulating in wildlife or domestic animal populations based on 10 years of syndromic and serological surveillance data with negative results.

The number of virus and vaccine stocks was assessed through a questionnaire survey in 2011 involving national veterinary authorities and laboratory staff.

The probability of pathway steps occurring was estimated qualitatively through expert opinion elicitation using 7 categories (negligible, extremely low, very low, low, moderate, high, very high).

Qualitative risk estimates were translated into numerical ranges and the risk was modelled as a multilevel binomial process. The results were converted back to the seven qualitative risk categories.

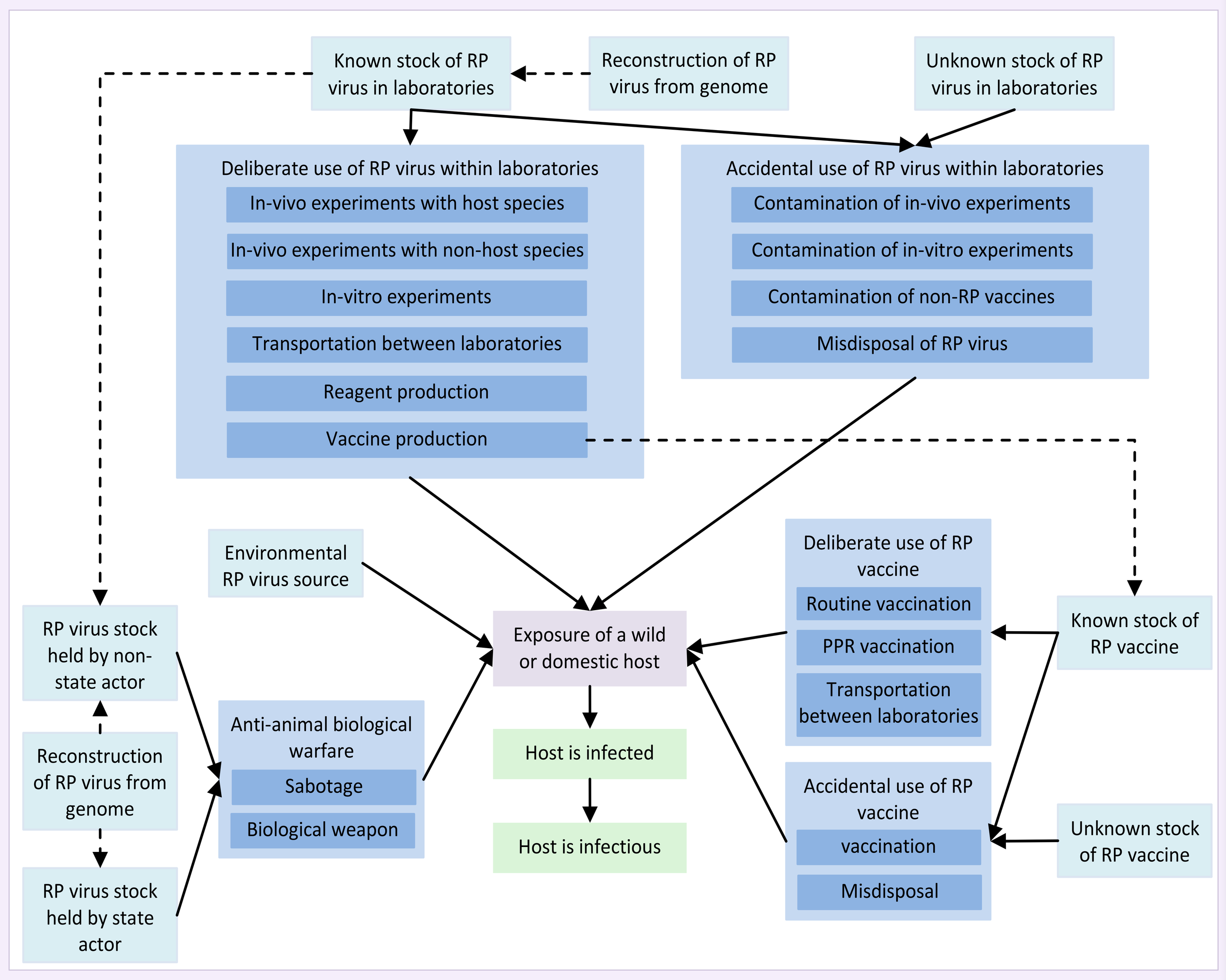
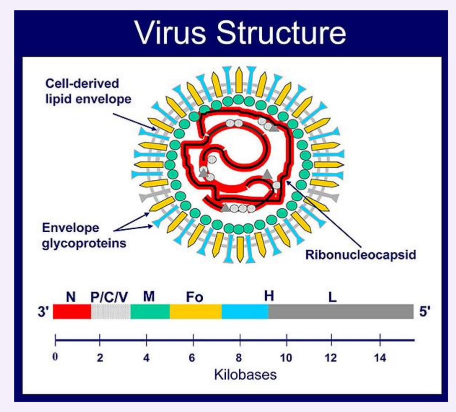


Figure 1. Rinderpest virus sources and risk pathways.
Key:
Pale blue: virus source;
Deep blue: steps leading to virus release and host exposure;
Purple: host exposure;
Green: consequences.



Results

1. Questionnaire survey

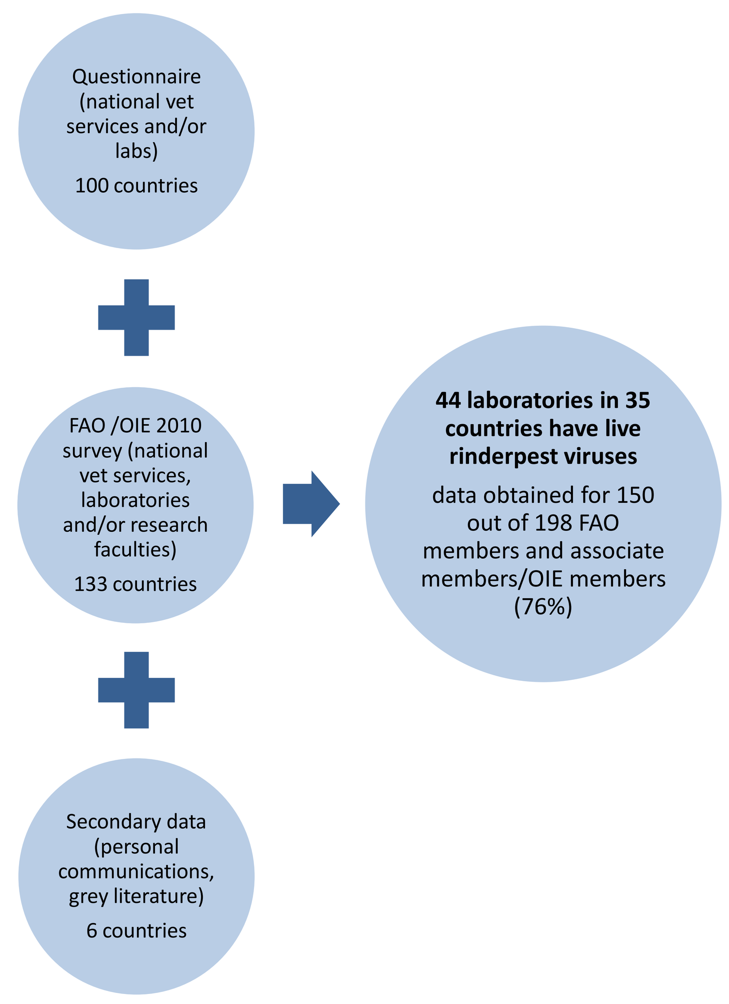


Figure 2. Stocks of rinderpest virus and vaccine (June 2011)

Combined Results

- 43 labs have lab-attenuated strains
- 12 labs have field strains (and 4 labs have undetermined strains)
- RPV still used for vaccine and reagent production
- RPV still used for in vivo and in vitro research
- 16 countries hold vaccine stocks (up to 4 million doses)

2. Risk of rinderpest re-introduction

The risk of rinderpest re-introduction was estimated to range from *negligible* to *high*, with a median of *very low* (Figure 3). The uncertainty associated with each risk estimate was *high*.

The accidental use of laboratory virus stocks was the highest risk pathway.

The impact of rinderpest vaccination on risk of rinderpest re-introduction was associated with major uncertainty due to disagreement amongst experts in relation to incidents of possible but unproven reversion to virulence.

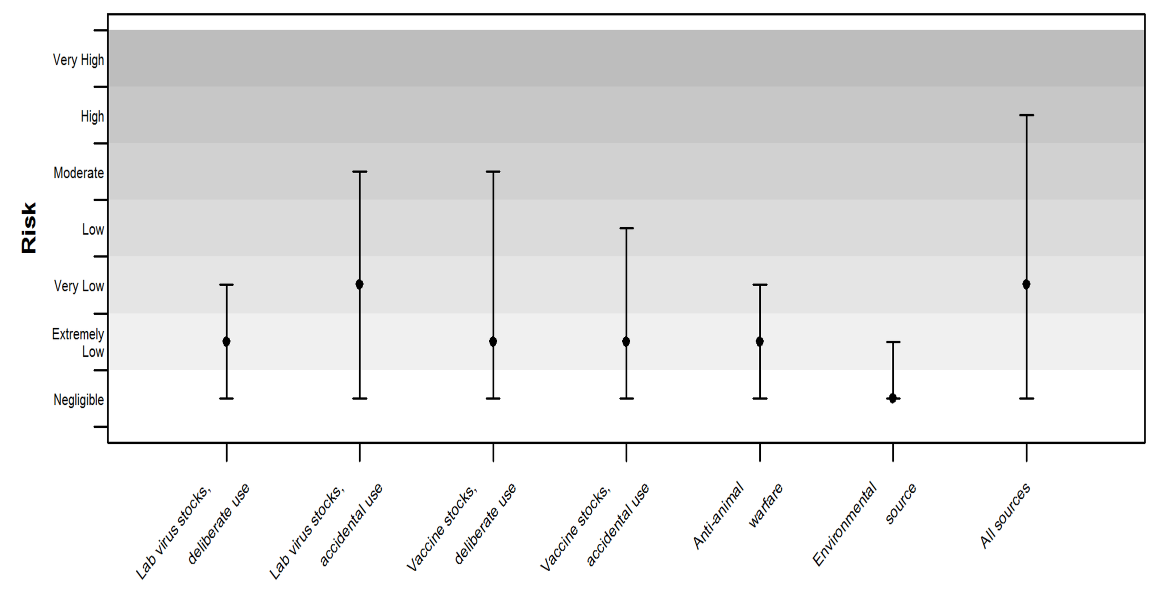


Figure 3. Risk of rinderpest re-introduction within a one year period, showing median (circle), minimum and maximum risk estimates.

Scenarios with varying time periods, numbers of labs holding rinderpest virus, and bio-safety level were explored (Figure 4):

- destroying all field strains or all virus strains held in low-biosafety labs or upgrading low biosafety labs could reduce the median risk (scenarios 1-3).

-restricting the number of labs holding virus to only 5 or only 1 high-biosafety labs could reduce median and maximum risks for all time periods (scenarios 4 and 5).

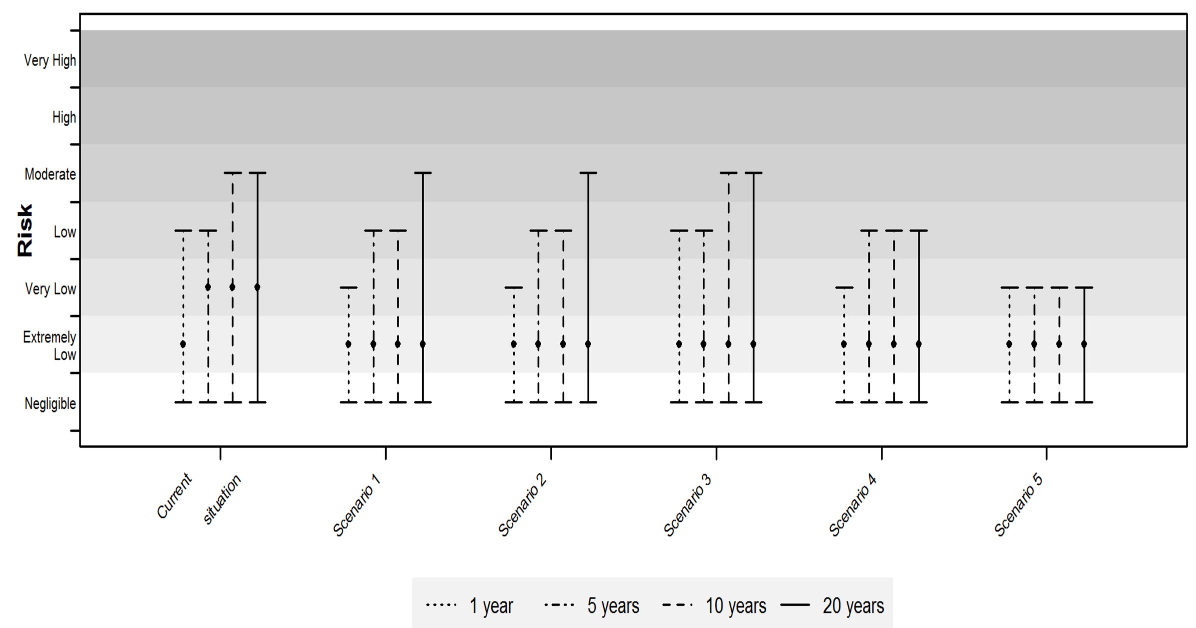


Figure 4. Risk of rinderpest re-introduction through various scenarios involving accidental use of lab virus stocks, during 1, 5, 10 and 20-year periods, showing median (circle), minimum and maximum risk estimates.
Current situation; number of virus stocks was as shown in Figure 2.
Scenario 1; field strains held by low-biosafety labs destroyed.
Scenario 2; all strains held by low-biosafety labs destroyed.
Scenario 3; low biosafety labs with RPV upgraded to high biosafety
Scenario 4; only 5 high-biosafety laboratories held RPV
Scenario 5; only 1 high-biosafety laboratory held RPV

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Discussion

Data on stocks of rinderpest virus and vaccine were not obtained for all countries nor for all labs, vet faculties and other institutions within countries, therefore the number of labs holding virus is likely to have been underestimated.

Risk estimates for individual pathway steps depended on expert opinion, but many were rare events with incomplete or absent data relating to past occurrence from which to extrapolate future predictions, or were highly dependent on human behaviour. The estimated risks are therefore associated with a high degree of uncertainty.

Reducing the number of labs holding rinderpest virus, restricting the use of rinderpest virus, as well as upgrading laboratories to a higher biosafety level, is likely to decrease the maximum and median risks of rinderpest re-introduction.

Ensuring that remaining vaccine stocks are not used and either destroyed or relocated to a limited number of regional repositories would also reduce these estimates.

Verification of absence of rinderpest virus or vaccine stocks is difficult and depends on transparency of national veterinary services, laboratories and other institutions.

Even if all sources of rinderpest virus are eliminated globally, the virus can be genetically reconstructed, therefore no risk mitigation measures will completely eliminate the risk of rinderpest re-introduction - vigilance and emergency preparedness must be maintained.