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Review Paper

Risk assessment of vector-borne diseases for public health governance

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ABSTRACT

Objectives: In the context of public health, risk governance (or risk analysis) is a framework for the assessment and subsequent management and/or control of the danger posed by an identified disease threat. Generic frameworks in which to carry out risk assessment have been developed by various agencies. These include monitoring, data collection, statistical analysis and dissemination. Due to the inherent complexity of disease systems, however, the generic approach must be modified for individual, disease-specific risk assessment frameworks.

Study design: The analysis was based on the review of the current risk assessments of vector-borne diseases adopted by the main Public Health organisations (OIE, WHO, ECDC, FAO, CDC etc…).

Methods: Literature, legislation and statistical assessment of the risk analysis frameworks.

Results: This review outlines the need for the development of a general public health risk assessment method for vector-borne diseases, in order to guarantee that sufficient information is gathered to apply robust models of risk assessment. Stochastic (especially spatial) methods, often in Bayesian frameworks are now gaining prominence in standard risk assessment procedures because of their ability to assess accurately model uncertainties.

Conclusions: Risk assessment needs to be addressed quantitatively wherever possible, and submitted with its quality assessment in order to enable successful public health measures to be adopted. In terms of current practice, often a series of different models and analyses are applied to the same problem, with results and outcomes that are difficult to compare because of the unknown model and data uncertainties. Therefore, the risk assessment areas in need of further research are identified in this article.

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Introduction

Public Health (PH) can be defined as the activities engaged in by governments and organizations to prevent disease and to ensure a healthy population.[1] This includes the assessment and monitoring of the health of communities and populations at risk, intervention, education, and formulation of public policies, and encompasses all issues that may be detrimental to health.[2] In terms of Public Health, risk has been defined by medical epidemiologists and health organizations as '*the probability of disease developing in an individual in a specified time interval*'.[3] More generally, the Society for Risk Analysis (SRA)[4] defined risk as '*the potential for realization of unwanted, adverse consequences to human life, health, property, or the environment; estimation of risk is usually based on the expected value of the probability of the event occurring times the consequence of the event given that it has occurred*'. In econometrics, risk is quantified by the 'absolute value of expected losses'.[5] Notice that in these latter two definitions the probabilistic concept of risk is conflated with some idea of the (fixed or calculable) economic cost outcome should that risk be realized.

PH risk governance is a framework[6] that includes risk assessment (or risk estimation), risk management and risk communication. This manuscript focusses on one category of public health challenges, the risk assessment of vector-borne diseases (human illness transmitted by arthropods) which, at least in the tropics, have a huge impact on human health and well-being (for example, WHO estimated there were 627,000 deaths among 207 million cases of malaria in 2012[7]). Emerging vector-borne diseases are of increasing concern in Europe[8] and North America (West Nile virus, chikunguya, malaria and dengue for instance) some with autochthonous cases.[9]

Especially in the case of vector-borne diseases and because of their complexity, the metric used for risk is not uniquely defined. Often risk is synonymous with vector or host suitability,[10] the basic reproduction number R0,[11] vector capacity,[12] vector presence/absence,[13] prevalence or incidence of the disease[14] or many others. The same diversity is found in model selection, data resolution, the predictor variables, their transformation, and the input parameters (e.g. models coefficients applied to different areas/events) used to model risk, even for the same disease (e.g.[15] for Lyme disease). Hence a deep understanding of the various metrics and models used for estimating risk is of primary importance, especially when previously obtained parameters, values and models are applied outside the domain of the original model fitting[15] (e.g. in the case of newly emerging diseases).

The goal here is to integrate risk assessment or estimation theory (and models) for vector-borne diseases with the present regulatory, and sometimes mandatory, system of risk governance, as defined by the main health organizations.

Risk governance in international public health organizations and some national agencies

Table 1 presents some key contributions to general risk-related policy over the last fifty years. From the initial basic statements of risk governance guidelines, procedures have developed into clear conceptual frameworks allowing a standard approach to be adopted. Most recently the complementary roles of quantitative and qualitative methods have been directly addressed along with the understanding that an estimation of uncertainty is vital to any risk analysis.

The concept of risk governance as a combination of risk assessment, risk management and risk communication (or 'translating knowledge'[16] into advice for informative/legal actions[17]) originated in the 1960s and 1970s when concerns were raised over environmental carcinogens and food additives.[18–22] Subsequently risk governance concepts were formulated by individual scientists,[19] and by national and international agencies,[20] with a concentration on cancer and harmful chemicals.[21,22] In the 1990s, risk assessment became mandatory in Europe for environmental, epidemiological and food health threats (i.e. Council Directive 89/391/ECC, the Decision

Table 1 – Main documents defining risk analysis for public health purposes.

Year	Agency	Document
1960–1970	Various US agencies	Recommendations, Guidelines, standards[76]
1981	The Society for Risk Analysis (SRA)	Vision Statement[4]
1983	National Research Council of the US (NRC)	Red Book[22]
1995	Food and Agriculture Organisation of United Nations (FAO)	Risk analysis and food: the experts' view[23]
2002	European Commission	Regulation 178/2002[77]
2002	World Organisation for Animal Health (OIE)	Terrestrial Animal Health Code[41]
1999–2005	World Health Organisation (WHO)	Health Impact Assessment[78]; International Health Regulations[79]; Comparative Quantification of Health Risks[80]
2005	European Commission	Regulation 851/2004[81]
2005	International Risk Governance Council (IRGC)	White paper on risk governance (towards an integrative approach).[43]
2007	European Commission	White paper on the health strategy for years 2008-2013.[82]
2009	National Research Council of the US (NRC)	Science and Decisions: Advancing Risk Assessment[46]
2012	European Food Safety Authority	Guidance on risk assessment for animal welfare[44]

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