Introduction

New developments in major vector-borne diseases


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Vector-borne diseases are a real public health and animal health problem. For example, between 50 and 100 million people worldwide are infected by the dengue virus every year [1]. Malaria kills between one and two million people annually [1]. To this tally we have to add the morbidity associated with other mosquito-transmitted diseases, such as chikungunya, Rift Valley fever or yellow fever, and those transmitted by ticks and fleas [2]. Diseases of veterinary importance include bluetongue, which recently spread to southern and then to northern Europe [3], tick-transmitted diseases such as babesiosis, anaplasmosis and rickettsiosis, and diseases transmitted by flies, e.g. trypanosomosis, which is transmitted by the tsetse fly. The economic consequences can be severe for affected countries; for example, the European Commission has spent more than 200 million euros just on helping European Union Member States to finance monovalent vaccines against bluetongue virus serotype 8 [3].

The optimism of the late 1960s led to decreased vigilance, in the belief that most vector-borne diseases (apart from malaria) were no longer a threat. Their subsequent resurgence, re-emergence or emergence in areas previously spared have profoundly changed the situation [1].

The return of vector-borne diseases to the spotlight reflects the favourable conditions for their spread: intensive movement of people and goods, combined with environmental changes driven by human activities and climatic factors. These infections have no respect for national borders and it is likely that their transmission dynamics will be significantly affected by the global climate change that will take place over the coming decades.

A report by the French Research Institute for Development states that a vectorial system involves populations of vectors, pathogens and vertebrates in a given environment, with a population comprising a set of individuals of the same species located in the same place at the same time and reproducing indiscriminately with each other [1]. The success of a system, in other words the transmission of a pathogen (virus, bacterium, protozoan, nematode), depends on contact between the different partners in the cycle and on their compatibility. Contact depends on the ability of individuals of a species to live in a given ecosystem, characterised by its biotic and abiotic (including climatic) components.

Vector systems are far from set in stone. They are perpetually evolving, and the three populations involved (vectors, pathogens and vertebrates) also react to these changes. For example, a genetic change in populations of the chikungunya virus was observed in Reunion Island when it was transmitted by *Aedes albopictus*; before then, in the Comoros and East Africa, it had been transmitted by *Aedes aegypti* [1, 4]. The selection of mechanisms of resistance to insecticides in the case of vectors (or to drugs in the case of parasites) is nothing more than an adaptation...
by the system to a new environment. Any change (in the components of the vectorial system, in
their biotic or abiotic environment, etc.) inevitably alters the risk of transmission.

One of the scientific challenges is, therefore, to understand the transmission mechanisms –
from animal to animal, from animal to human and from human to human. One problem is the
indirect nature of such mechanisms and the number of vectors/hosts involved; often there are
several vectors, possibly several hosts, or the presence of a reservoir (vertebrate or invertebrate
population). In addition, as for any infectious disease, the probability of transmission of a
vector-borne disease depends on how long the host remains infectious (including incubation
and latency periods). The longer this period, the higher the probability that it will be bitten by a
vector and that this vector will become infected, thus increasing the probability of transmission
to other individuals (5).

Immunity clearly plays a major role in the transmission dynamic, especially for vector-borne
diseases (6). For example, epizootic outbreaks of Akabane virus infection occur periodically
in Australia, but rapidly developing immunity among affected animals quickly controls
transmission. In the absence of protection measures, a very large proportion of the susceptible
population is affected, but it develops immunity within a few months. This helps to control
virus transmission simply because the number of susceptible individuals becomes too low to
perpetuate it. As a result, quite a long time then needs to elapse before there is a further risk of
epizootics (reconstitution of generations of susceptible species) (5, 6).

Assessment of the risk of vector transmission is based on an analysis of indicators and of
characteristics of the ‘vectorial system’ within a complex context (hosts, infectious agent,
vectors, environment, society, etc.) and attempts to ascertain the transmission dynamic and the
consequences of changes to one or more elements of the system and/or its interactions. In
addition, to facilitate decision-making in the fight against vector-borne diseases, it is necessary
to study the potential consequences, both positive and negative, of any action that might
be taken before a disease event has an impact on health (anticipation) or during an alert or
epidemic (analysis of management options).

In recent years, a number of vector-borne diseases have hit the headlines. The many examples
include West Nile virus in the Americas, bluetongue serotype 8 and Schmallenberg virus in
Europe. Some of these viruses have emerged unexpectedly in regions of the world where they
had never previously been identified (e.g. bluetongue serotype 8), while others have been
reported for the first time (such as the Schmallenberg virus).

The purpose of this publication is to describe the main vector-borne viral, bacterial and parasitic
diseases affecting animals (and sometimes humans) and to highlight recent advances in the
fields of epidemiology, detection, and the prevention and treatment of diseases transmitted by
arthropod vectors.
References


