

Viral and vector zoonotic exploitation of a homo-sociome memetic complex

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Abstract

As most newly characterized emerging infectious diseases are considered to be zoonotic, a modern pre-eminence ascribed within this classification lies clearly within the viral taxonomic realm. In particular, RNA viruses deserve special concern given their documented impact on conservation biology, veterinary medicine and public health, with an unprecedented ability to promote an evolutionary host–pathogen arms race from the ultimate infection and immunity perspective. However, besides the requisite molecular/gross anatomical and physiological bases for infectious diseases to transmit from one host to another, both viral pathogens and their reservoirs/vectors exploit a complex anthropological, cultural, historical, psychological and social suite that specifically defines the phylodynamics within *Homo sapiens*, unlike any other species. Some of these variables include the ecological benefits of living in groups, decisions on hunting and foraging behaviours and dietary preferences, myths and religious doctrines, health economics, travel destinations, population planning, political decisions on agricultural product bans and many others, in a homo-sociome memetic complex. Taken to an extreme, such complexities elucidate the underpinnings of explanations as to why certain viral zoonoses reside in neglected people, places and things, whereas others are chosen selectively and prioritized for active mitigation. Canine-transmitted rabies serves as one prime example of how a neglected viral zoonosis may transition to greater attention on the basis of renewed advocacy, social media, local champions and vested international community engagement. In contrast, certain bat-associated and arboviral diseases suffer from basic ignorance and perpetuated misunderstanding of fundamental reservoir and vector ecology tenets, translated into failed control policies that only exacerbate the underlying environmental conditions of concern. Beyond applied biomedical knowledge, epidemiological skills and biotechnical abilities alone, if a homo-sociome memetic complex approach is also entertained in a modern transdisciplinary context, neglected viral zoonosis may be better understood, controlled, prevented and possibly eliminated, in a more holistic One Health context. *Clinical Microbiology and Infection* © 2015 European Society of Clinical Microbiology and Infectious Diseases. Published by Elsevier Ltd. All rights reserved.

Keywords: Conservation medicine, ecohealth, emerging infectious diseases, neglected tropical infections, one health, viral zoonoses

Article published online: XXX

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Viral zoonotic underpinnings

All major human viral diseases once originated in other animal species and formed unconnected prehistoric biological islands, but now, new pathogens are being characterized at an

unprecedented level with the potential for dramatic pandemics, due both to ecological perturbations and to technological improvements in detection [1]. Nevertheless, at a recent international biomedical conference, one speaker reminded the audience of the statistical ‘irrelevance’ of emerging infectious diseases, by categorical comparisons to major causes of human death today. Put simply, even populations in the developing world are approaching levels of cardiovascular disease, stroke, cancer and other chronic maladies, that were previously only found in developed countries. Although this may certainly be true, if an individual evades acute viral diarrhoea, pneumonia, haemorrhagic fever, hepatitis, encephalitis, etc. and survives out

of infancy to adolescence, those more modern facets of chronic illness are largely associated with a personal lifestyle elevated gradually to a community level. In contrast, zoonoses per se, are largely not a matter of conscious public choice, although the exposures that lead to a productive infection are often provoked directly by the individual. Irrespective of surreptitious media bragging rights to causality behind any fictitious 'zombie apocalypse' or its preparedness (<http://www.cdc.gov/phpr/zombies.htm>; http://www.cracked.com/article_15643_5-scientific-reasons-zombie-apocalypse-could-actually-happen.html) in the growing collective consciousness (for which a discerning scientific audience would have to ascribe not to bacteria, fungi or protozoa, but to a viral aetiology objectively), the image of a post-SARS world is only too real in the not-too-distant memory, given the actual extremes of current global headlines of translocated viral infections from one continent to another. Moreover, regardless of the magnitude of long-term lifestyle choices behind major human mortality trends, most health professionals should agree that the probability would be highly unlikely that a traveller today would be screened, detained and possibly quarantined against their will at an international port of entry, because of being a smoker, alcohol-user or obese, as opposed to a suggestion of an infection with a viral infectious aetiology, with obvious immediate consequences for the perceived greater public good. Hence, many would argue that viral zoonoses are indeed still relevant, based upon the evidence at hand.

Why are viral zoonoses relevant, but neglected? Considering the ultimate origins of historical pathogens as diverse as the eradicated smallpox and the much debated 1918 pandemic influenza, viruses are a highly relevant focus group when considering the general concept of zoonoses as a whole, from obvious biodiversity, to the sheer magnitude of their resultant cumulative morbidity and mortality in the animal kingdom writ large and the concomitant host–pathogen arms race [2]. Such viruses are the quintessential obligate microbiological parasites, whose diversity across all life on earth is unmatched. Rates of evolution, particularly among RNA viruses, excel at real-time orders of magnitude [3]. Antibiotics are useless, antiviral drugs remain limited and proper discovery requires a requisite twenty-first century laboratory sophistication, relatively far from the ecosystems where these zoonoses perpetuate, from urban mega-slums to increasingly fragmented Old World rain forests, supporting both viral specialists and generalists within multi-host assemblages [4]. Within the 'mind's eye', unlike multicellular organisms and bacterial/fungal colonies, viral existence and growth are typically unseen and often asymptomatic. 'Out of sight, out of mind', in the sense of the virome, is taken to an extreme from the perspective of neglect with most viruses in the primary host, unless frank disease and mortality

are manifest. To the evolutionary biologist, all extant human viruses rose from more humble origins. Bereft from an appreciation of animal ecology, viruses, by definition, are neglected, in a circumspect fashion, and undergo a pattern of subtle repetition over time (Fig. 1). What began as a largely one-sided accident before animal domestication millennia ago proceeds to a 'reverse-zoonosis' paradigm, as expanding interconnected human communities become the drivers back to other animals, often with disastrous consequences for threatened and endangered species [5].

Critically ignored macroscopic attributes

Broadly speaking, any RNA or DNA virus transmitted to a human from a member of the Kingdom Animalia is open to partitioning as a viral zoonosis. Of the hundreds of potential viral candidates, what constitutes a 'neglected viral zoonosis' (NVZ)? To be considered a NVZ, a disease is not equivalent to being merely odd or rare, objectively, from the stand point of concentration, which does not diminish the public health concern for any malady, per se. Hence, as one example, obviously simian herpesvirus is a serious viral infection, but not a NVZ. Similarly, a NVZ does not necessarily mean that no diagnostics or vaccines or practical mitigation options exist or that little is known about pathogen epizootiology. In fact, ironically, many NVZ have pragmatic solutions for investigation, prevention and control—exacerbating the overall philosophy of neglect. Rather, operationally defined subjectively, NVZ should be associated with significant 'negative' attributes, including: substantive human morbidity and mortality; broad distribution; serious economic costs; selective opportunity to spread if ignored; a lack of concentrated long-term efforts focused at the source; and a disproportionate burden on the poor [6,7]. So defined, most NVZ occur in developing countries with a subtropical to tropical occurrence.

To a finite extent, biomedical introspection related to entry, reception, replication, transcription, assembly and exit from one species to a human may provide a great deal of inference to various NVZ. However, beyond the descriptive 'who, what, where, when and how' of the original animal virion and the secondary human host, these qualitative insights will always be wanting to a greater epidemiological understanding of the 'why things are'. Ultimately, besides an anatomical and physiological basis for a viral infection to transmit interspecifically, both pathogens and their reservoirs/vectors must exploit a complex anthropological, cultural, historical, political, psychological and social landscape that uniquely defines *Homo sapiens*, unlike any other animal population [8–12]. Some of these facets include the ecological benefits (and limitations) of living in groups as a

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