衞生防護中心
Centre for Health Protection

Working Group on Japanese Encephalitis (WGJE)
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Working Group Report on
The Transmission of Japanese Encephalitis in Hong Kong

Summary

What is already known? Japanese encephalitis (JE) is often present in Hong Kong and requires either pigs or wild birds to sustain transmission.

What does this report add? The recent increase in human case numbers is cause for some concern. Detailed data on the appropriate mosquito population is required to predict the impact of swine vaccination in reducing risk of JE to human health. The wild bird population in Hong Kong is small and is unlikely to contribute substantially to JE transmission.

What is the public health/policy relevance? Detailed data on the population size, seasonality and feeding behavior of mosquitoes capable of transmitting JE should be gathered as a priority.

Introduction

Japanese encephalitis virus (JEV) is transmitted by mosquitoes, principally *Culex tritaeniorhynchus*, during feeding. It requires an amplifying vertebrate host to complete its lifecycle. Although humans can be infected, they are not amplifying hosts as the degree of virus concentration in peripheral blood during the acute stage of infection is not sufficient to infect mosquitoes. Pigs are the principle amplifying host in most settings, with two species of *Ardeids* (herons) also thought to play a role: the black-crowned night heron (*Nycticorax nycticorax*) and the Asiatic cattle egret (*Bubulcus ibis coromandus*) (Innis, 1995). All three amplifying host species are present in Hong

Kong.

How can we interpret the recent rise in case numbers?

2. The recent increase in reported cases of Japanese encephalitis (JE) in Hong Kong (1 in 2003 and 5 in 2004) is cause for some concern. With a low but constant risk to humans, we would expect some degree of random fluctuation in the numbers of cases of JE. However, there have been too many years with no cases (Chung and Lam, 2003) prior to the six cases in 2003-2004 for the data to be considered as consistent with a low constant risk. We note that the increase in case numbers may be due to a change in the behavior of clinicians in reporting suspected infectious disease after the 2003 outbreak of severe acute respiratory syndrome in Hong Kong.

3. The distribution of ages of cases is different for those after 1990 than for those prior to 1990. Cases prior to 1990 were mainly in the young, whereas those after 1990 have been more evenly distributed across ages. This observation suggests that the disease was more widespread, perhaps only in a sub population, prior to 1990 than it is now, but that reporting of JE is now more accurate. There is no reason to suspect that changes in reporting sensitivity would be different for different ages.

4. To be conservative, we should assume that there has been an increase in levels of JEV transmission to humans since 2003 and that the new level is consistent with 5 cases per year. Given the reported ratio of 300 infections to each case (The World Health Organisation, 2005) we estimate that 1503 people were actually infected with JEV during 2004 (95% confidence interval: 490, 3509).

What is the relative risk from pigs and from wild birds?

5. Each of these people were infected through a bite from a mosquito, which was itself infected by either a pig or a wild bird. The pig population in Hong Kong is fairly constant at 330,000 of which 50,000 are breeding sows and 280,000 sucklings. The sucklings are slaughtered for meat at 6 months of age. There were less than 900 nests of wild birds possibly capable of transmitting JEV, and less than 200 nests (Anon, 2004) of those thought most likely to play a significant role (Halstead and Tsai, 2003). If these nests produce two fledglings per year and the birds live for 15 years on average then this would result in a maximum population of 31,000 migratory wild birds capable of transmitting JEV born in Hong Kong. It is possible that wild birds born in other locations may spend time in Hong Kong. However, direct counts of these species of wild birds find far less than 30,000. (Annon, 2004, Yu, 2004).

6. Given the short lifespan of pigs compared to that of wilds birds

and the size of the pig population, analyses using a mathematical model suggest that the mosquitoes capable of transmitting JE would have to have 100 times the affinity for wild birds as they do for pigs for the two species to play similar roles in transmission. The model simulates the mosquito, pig and wild bird populations with realistic demographic structures for each (as described above) (Riley et al., 2005 – in preparation). The long lifespan of the wild birds ensures that at all times a large proportion of their population has been infected and is not capable of becoming infectious again. Although very little is known about the population of mosquitoes capable of transmitting JEV in Hong Kong, we believe it to be unlikely that this degree of difference in affinity exists. Therefore, it is likely that pigs are the principle source of JE infection in mosquitoes that infect humans.

How will swine vaccination affect the transmission?

7. Unfortunately, without detailed data on the local mosquito population capable of transmitting JEV, it is not possible to predict the likely success or failure of a swine vaccination program as an intervention to reduce the risk to human health from JE. Piglets in Hong Kong are born with maternal antibodies which protect them from JE for the first 8 – 12 weeks of life (Ellis, 2004). The time at which they lose their protection varies greatly across this range of ages. We assume that vaccines will not take during the period that the pigs are protected by maternal antibodies.

8. Analyses using a mathematical model suggests that even the most strictly adhered-to 2-dose vaccination policy may fail to substantially reduce levels of infection from pig to mosquito. The model simulates the detailed age structure of the livestock pig population, their maternal antibody protection, the days of vaccination and the seasonal nature of the mosquito population (Riley et al., 2005 - in preparation). In some scenarios, which cannot be excluded using currently available data, the average duration between loss of maternal protection and successful vaccination is long enough that a large proportion of mosquito infections would continue to occur. A well designed field trial, using levels of circulating virus in pigs as a primary end point, could address this issue directly.

What data should be gathered on the mosquito population?

9. There is an urgent requirement for detailed data on the mosquito species thought most likely to conduct JEV, *culex triteaniorhynchus*. The seasonal variation of the population density of these mosquitoes should be gathered as a matter of course. Also, detailed analyses of the blood found in engorged females of this species should be conducted. The affinity of the vectors to feed on wild birds versus pigs and humans can then be established. We note that other species of mosquitoes are capable of transmitting JEV (Halstead and Tsai, 2003) and that any systematic capture programs should be

able to identify these other species.

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