Chapter XLIII
A Pandemic Avian Influenza Mathematical Model

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ABSTRACT

Throughout the world, seasonal outbreaks of influenza affect millions of people, killing about 500,000 individuals every year. Human influenza viruses are classified into 3 serotypes: A, B, and C. Only influenza A viruses can infect and multiply in avian species. During the last decades, important avian influenza epidemics have occurred and so far, the epidemics among birds have been transmitted to humans; but the most feared problem is the risk of pandemics that may be caused by person-to person transmission. The present mathematical model deals with the dynamics of human infection by avian influenza both in birds and in humans. Stability analysis is carried out and the behaviour of the disease is illustrated by simulation with different parameters values.

INTRODUCTION

Worldwide, seasonal outbreaks of influenza (also known as flu) affect millions of people, killing about 500,000 individuals every year (WHO, 2005). Human influenza viruses are classified into three serotypes: A, B and C. Only influenza A viruses are known to infect and multiply in avian species. These viruses present 16 HA (haemagluttinin) and 9 NA (neuraminidase) subtypes (H1N1, H2N2, H3N2, H5N1, H7N7,....) (Alexander, 2004).

At the domestic poultries, the infection by viruses of avian influenza provokes two main forms of illness characterized by an extremely weak and extremely elevated virulence. The first form weakly pathogen only provokes some benign symptoms (tousled feather, less frequent punter) and can pass

easily unobserved. The second form pathogen has consequences well more serious. It propagates very quickly in raisings and of which the mortality rate can approach 100%, the death often occurring in the 48 hours.

The wide spread of influenza in poultry and wild birds during the last decade and the occurrence of human influenza infection has raised the question of pandemics. For a pandemic to start, three conditions are required: a novel influenza virus subtype must emerge against which the general population has in its majority no immunity; the virus infects humans and causes serious illness; and the new virus should have a high rate of person-to-person transmission (WHO 2005; Ferguson, 2004). Three major pandemics occurred during the last century. In 1918, the Spanish flu has killed an estimated 40-50 million people, in 1957 the pandemic (Asian flu) killed about 2 million people and the Hong Kong flu killed an estimated one million people in 1968. Although influenza pandemics are considered inevitable, the avian epidemics that occurred during the last decade, starting in 1997 (Hong Kong), have not engendered pandemics. Studies have shown that direct contact with diseased poultry was the source of infection and found no evidence of person-to-person spread of the virus. However, due to the potential for cross-species of avian and human influenza viruses and the possibility of viruses reassortment, the high rates of mortality among the few cases observed recently (Table 1) could lead to devastating pandemics (Yuen, 2005; Kuiken, 2006; Smith, 2006). Consequently, the risk of pandemics and its corollaries remains on the agenda of national and international health bodies.

Table 1. Cumulative number of confirmed human cases of avian influenza A/(H5N1) reported to WHO (last update: 6 June 2007). Total number of cases includes number of deaths. WHO reports only laboratory-confirmed cases. All dates refer to onset of illness. (WHO, 2007).

Country	2003		2004		2005		2006		2007		Total	
	cases	deaths	cases	deaths	cases	deaths	cases	deaths	cases	deaths	cases	deaths
Azerbaijan	0	0	0	0	0	0	8	5	0	0	8	5
Cambodia	0	0	0	0	4	4	2	2	1	1	7	7
China	1	1	0	0	8	5	13	8	3	2	25	16
Djibouti	0	0	0	0	0	0	1	0	0	0	1	0
Egypt	0	0	0	0	0	0	18	10	16	4	34	14
Indonesia	0	0	0	0	20	13	55	45	24	21	99	79
Iraq	0	0	0	0	0	0	3	2	0	0	3	2
Lao People's Democratic Republic	0	0	0	0	0	0	0	0	2	2	2	2
Nigeria	0	0	0	0	0	0	0	0	1	1	1	1
Thailand	0	0	17	12	5	2	3	3	0	0	25	17
Turkey	0	0	0	0	0	0	12	4	0	0	12	4
Viet Nam	3	3	29	20	61	19	0	0	0	0	93	42
Total	4	4	46	32	98	43	115	79	47	31	310	189