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### **The Revenge of the Birds - Avian Influenza Epidemic in Hong Kong**

Imagine: a few days before Christmas, the street markets are bustling with activity as everybody hustles around to get all the food for the holiday feast. In Hong Kong, it is a tradition to prepare a roast chicken or duck for the table as a sign of prosperity. Hundreds of Hong Kong citizens congregate in front of the poultry stand to pick out their live birds, which are killed and cleaned right before their eyes to ensure freshness. Suddenly, big men in hazmat suits storm into the market and tell everyone to evacuate immediately. They gather all the chicken cages and quickly toss them onto a military truck. They walk around the market and spray some kind of pungent chemical in every corner. Shocked and confused, the vendors are screaming and the buyers are fleeing. Somebody shouted, "Run! It's bird flu!" Does this look like a scene in sci-fi movie? No, this is a real snapshot of Hong Kong near the end of December 1997. Hong Kong, a region that embodies the conflict of urbanization and old tradition, underwent the world's first major outbreak of the avian influenza, which has massive economic and social impact and cannot be completely eradicated.

Located on China's southern coast, Hong Kong consists of a big island, a peninsula, and over two hundred small islands. Hong Kong was under British rule from 1898 to 1997 as a British colony. In July 1997, Hong Kong returned to the sovereignty of China as a Special Administrative Region with a high degree of autonomy. Hong Kong maintains its own government body and monetary system, and only joins forces with China on military and foreign affair issues. ("Hong Kong Health"). The entire area of Hong Kong is 427 square miles, which is less than one-third of Rhode Island. 7.2 million people call this small region home. The population density of Hong Kong is 17,208 per square mile, which is about two hundred times higher than the population density of the United States (Lam and Bell). In fact, Hong Kong is currently the world's fourth most densely populated region. The average family in Hong Kong consists of three people - the mother, the father, and one child ("Distribution of Domestic"). Out of 224 countries in the world, Hong Kong ranked 221 for fertility rate. However, there is a daily influx of immigrants from China that contributes to the annual population growth rate of 0.8%. About 91% of Hong Kong citizens are ethnic Chinese. The other 9% includes a wide variety of races and ethnicities, including the 270,000 South Asians who work in Hong Kong as domestic helpers (Yeh).

Hong Kong has a well-designed and well-operated educational system that emphasizes proficiency of three languages, English, Mandarin, and Cantonese. It is considered the second best educational system in the world ("Hong Kong Literacy"). Hong Kong is also one of the healthiest regions in the world. Even though the region is small, Hong Kong has more than fifty hospitals, some of which are world class. Hong Kong citizens and resident children can get free public healthcare with small co-payments. With the well-developed healthcare system and easy access to healthcare, Hong Kong citizens boast life expectancies of 81.2 years for males and 86.9 years for females, which is the longest life-expectancy in the world. Most people in Hong Kong eat five small meals a day. The main staple foods are rice and noodles. Some of Hong Kong's most famous cuisines are poached chicken and roast duck. Streets are lined with stores that hang some of these chicken and duck delicacies. Poultry is definitely essential in the average Hong Konger's diet ("Women and Men" 1).

A true international metropolis, Hong Kong is a major port for commerce and the most active financial center in Asia. However, underlying the prosperity in appearance, there are many barriers facing the average urban family living in the city. Hong Kong ranks first in income inequality among the world's major economies. The minimum wage in Hong Kong is HK\$32.5 or USD\$4.19. Currently, one in eight people live under the poverty line. Thirty percent of the population lives in subsidized public housing.

The situation is even worse among those aged 65 or above, as one in three lives in poverty. The poor seniors struggle to meet their basic nutritional needs (“Is There Hunger”).

The extreme population density results in high-priced land and housing that poor urban families cannot afford. One square foot of living space costs about USD \$600. The price of a small apartment starts at a half million U.S. dollars! The average Hong Konger has a living space only the size of a Ping-Pong table. Tens of thousands Hong Kongers live in subdivided units including coffins, roof tops, and even six foot by two foot metal cages. In addition, Hong Kong has heavy metal pollution in the soil which leads to low nutritional value in the crops they grow (Ho). The result is that Hong Kong needs to import almost all of its food from outside of the District, mostly from Mainland China (Kong).

Hong Kong is often depicted as a place where “East meets West” because the country is extremely urbanized; yet, the people manage to maintain many traditions passed down from past generations. One of the prominent examples is a “wet market”, which is a market where vendors sell dead and live animals for meat consumption in the open street. For Hong Kongers, it is important to see the animals live before they are butchered. They like to pick out an animal such as a chicken that looks the most alert, healthy, and plump. The vendors usually butcher the animals on the floor in front of the customers. This traditional practice does not meet today’s hygiene standards. The chickens or ducks are squished into small cages. The carcasses and guts are strewn everywhere. Flies hover over the meat and renderings. These traditional wet markets are most frequented by the older generation and the low-income residents. Recently, it has become a tourist attraction, causing a lot of traffic and contact between people and live animals (“Central Abattoir Set”). Before the epidemic, Hong Kongers did not know that sick birds can spread avian influenza virus through their saliva, nasal secretion, and feces, which can remain active on any surface for a period of time. The wet markets are major contamination sources.

Hong Kong, struggling between extreme urbanization and century-old traditions, provides a hot-bed for the inevitable outbreak of the deadly avian influenza. It is not uncommon for birds to catch the bird flu; however, the 1997 outbreak in Hong Kong was unprecedented because this is the first-time avian flu transmitted to humans and caused human fatalities. Eighteen Hong Kong citizens were confirmed to have contracted the disease. The ages of the infected individuals ranged from one to sixty, with half of them under twelve years of age. They were scattered in different residential districts, and they had different occupations. The symptoms were similar to human influenza – fever, headache, sore throat, and coughing. However, some developed severe pneumonia and multiple organ failures. Six of these individuals died, but twelve made a full recovery. Thus, the mortality rate of avian flu was 33%. Scientists isolated the virus strains from these infected individuals, and through sequencing data, they confirmed that the virus passed directly from poultry to humans. This was supported by the fact that a majority of the infected individuals had had exposure to live poultry in the week before the onset of illness. More disconcertingly, scientist found that human-to-human transmission can occur through close physical contact with already infected individuals as children were infected by their parents and health care workers infected by patients.

When the scientist confirmed that the source of the virus came from poultry, they tested the chickens in wet market and found 20% of the chickens in the markets carried the virus. Immediately the Hong Kong government made a decision to slaughter all the poultry in farms and markets in the region. Live chickens were mercilessly tossed into big garbage bins which were pumped full of carbon dioxide to suffocate the birds. The complete culling took an entire four days and resulted in the removal of 1.5 million chickens from the territory. At the same time, imports of live poultry from mainland China were temporarily banned. Wet markets were closed for about twenty-one days. Fortunately, these extreme measures successfully stopped the further spread of the epidemic. Hong Kong did not see another case of humans infected with avian flu until 2003 (“Hong Kong Culls”).

The impacts of the avian influenza epidemic in Hong Kong were all-encompassing. Not only did the disease threaten human lives, but it also caused great distress in agriculture, economy, and social aspects

of everyday lives for people in Hong Kong and throughout the world. The group that was hit first was the small chicken farmers and the vendors in the wet markets. The Hong Kong government provided compensation for culled poultry, but it was way below market value. Overnight these families lost all sources of income. Women were especially vulnerable because they are often the ones who take care of chickens in small farms. Related businesses were affected in a chain reaction, feed dealers, equipment sales, packing workers, and restaurants. The wholesale prices of chickens dropped to a low point because Hong Kongers were scared to consume chicken. Even though the scientists attempted to educate the public that chicken was safe to eat as long as it was cooked, people still hesitated to consume poultry. People turned to other sources of protein such as beef, pork, and fish, which were usually more expensive than chicken. As the demand for these alternative proteins went up, the prices went up as well. This put a lot of financial strain on the low-income families, who relied on poultry as their primary source of protein (Burns, Mensbrughe, and Timmons).

The entire society of Hong Kong experienced extensive economic losses. Schools were closed for long periods of time. Many offices and stores were closed. People were simply reluctant to leave their homes for fear of being infected which led to a great disruption in public services, transportation systems, and information technology systems. During the avian flu outbreak, tourism virtually came to a halt. Tourism accounts for 5% of the country's GDP, and approximately 270,000 people are employed in the tourism industry (Brahmbhatt). Tourist guides, bus drivers, and hotel workers faced lay-offs. Asian airline companies lost about USD \$34 billion or around one-third of their revenues. The insurance industry was another victim in the epidemic. Countless claims arose due to business interruption, property loss, health and medical needs. The claims strained the money flow in the financial sector and almost caused a breakdown of the financial system in the entire Asian region. It is difficult to estimate exactly how much loss has occurred from the avian flu outbreak in Hong Kong because the impacts are too wide and long-lasting (McLeod et al).

Avian flu created psychological turmoil in Hong Kong society as well. Fear and panic dominated the lives of citizens. Many people stockpiled supplies in fear of a long-term pandemic. Therefore, not only the prices of meat skyrocketed, but also the prices of all groceries and necessities (McLeod et al). Again, the poor urban families were at a greater disadvantage in a societal turmoil because they had limited access to food and daily supplies. The scare of the avian flu also led to many individuals seeking information about the disease, but they found fabricated information and false advertisements of cures instead. Assisted by the internet, fear-mongering companies created commercials that targeted these individuals and made a profit selling "life-saving" accessories from special masks and herbal drinks that boost immunity to bird flu survival kits. (Conly and Johnston).

Since the disastrous 1997 outbreak, the government of Hong Kong has developed a set of policies to prevent another avian flu epidemic. It established standards for hygiene and management practices for farmers. Government officials closely monitor the farms, and many flocks are randomly tested during the growing period. Before any live poultry can be imported into Hong Kong, the birds have to be segregated in designated check points in mainland China for five days and are tested for the presence of the avian flu virus. Poultry in the wet markets are also tightly monitored and tested for the virus. For example, in 2001, the virus was detected in the live chickens in the market. The government quickly carried out a second territory-wide culling of all poultry and banned all import of live birds. No humans were infected, and the society was kept in order and the economy quickly recovered. (Burns, Mensbrughe, and Timmons).

Also, the Hong Kong government banned the vendors from keeping the live poultry overnight in the wet market. By clearing the poultry from the market overnight, scientists found that the percentage of birds testing positive for the avian flu dropped from 5.11% to merely 0.09%. In 2001, the Hong Kong government implemented a monthly rest day policy in the market. On one day each month, all stalls have to be free of live poultry and cleaned and disinfected. In 2003, the Hong Kong government increased the number of market rest days to two. Furthermore, the Hong Kong government aggressively bought out

traditional live poultry vendors. The number of poultry stalls fell from more than 800 to 133. The amount of poultry farms dropped from 192 farms to thirty farms. Hong Kong consumers began buying more frozen or chilled chicken rather than live poultry. Today, the traditional live chicken retail accounts for only 6% of the total chicken supply (Koh et al).

Despite the government's strong public policies to prevent sick birds from coming into the country and to the retail market, Hong Kong continues to see outbreaks of avian flu. Outbreaks occurred in 2001, twice in 2002, 2003, and almost every year after ("Information"). Every year, the Hong Kong government culled tens of thousands of birds in attempt to stop the epidemic. Unfortunately, since 2003, waves of avian flu outbreaks had swept across Asian poultry farms and eventually travelled west into Europe and North America. In 2008, eleven outbreaks of avian flu were reported in five countries—China, Egypt, Indonesia, Pakistan, and Vietnam (McKenna). Avian flu is now present in more than sixty countries in the world. Scientists found that many migratory birds and ducks that were previously immune to the virus, now can contract the disease and many die from it (Hui et al 2). A zoo tiger in Thailand that was fed infected fresh chicken carcasses contracted the virus and died. China has also reported over a thousand cases of human avian influenza, with 38.5% of them resulting in death, according to a report from the World Health Organization. It appears that the harder humans try to fight off the virus, the stronger the avian flu attacks the human race ("Return").

Avian flu is extremely difficult, if not impossible, to eradicate because of its continuous mutations, and its ability to exist in a large variety of host animals. There are many subtypes of avian influenza viruses. Some are highly pathogenic, like the ones seen in Asia; while some are low-pathogenic, such as the ones seen in North America. Highly pathogenic strains spread quickly and can destroy an entire flock within twenty-eight hours. The low pathogenic strains affect egg production but are much less deadly. The particular strain of virus that caused the first Hong Kong bird flu epidemic was highly pathogenic H5N1. The 'H', short for Haemagglutinin, and 'N', short for Neuraminidase, stand for the different types of proteins found on the surface of the influenza viruses. There are fifteen known types of Haemagglutinin and nine types of Neuraminidase, creating many different combinations of the virus. To make things more complicated, there are many minor variations within each type ("Avian Influenza"). When two subtypes of avian flu viruses infect a single host, usually a pig, the two types of virus trade proteins and mutate into a more infectious and lethal influenza. The H5N1 strain in Hong Kong was so lethal because it was unfamiliar to the human race, who had virtually no immunity to the virus (Haibo). The newest strain found in Hong Kong is H7N9. H7N9 is a particular worry for authorities as it does not kill infected chickens. Often times the manifestation in chicken are just a few dropped feathers or no symptoms at all. It is very difficult to identify sick birds, and the virus often spreads undetected until it is contracted by humans (Chan).

Two major issues – population grown and international trade, play an important role in the development of avian influenza in Hong Kong and the food security of urban families in the region. First, as the world population grows, people need more food, and chicken is the most popular meat across cultures and religions. It is estimated that the world's poultry population grew 76% in developing countries and 23% in developed countries in the 1990s. In rural areas, many small farms are set up to fill the market demands created by large urban centers like Hong Kong. Rearing poultry is a relatively easy business with very little start-up costs, thus an ideal business for poor families. However, the rapid expansion of backyard farms has not been accompanied with better infrastructure or preventative measures. The poor farmers are at great risk of contracting avian influenza due to their proximity with the birds on a daily basis. After the outbreaks, the poor farmers in the rural area were negatively affected by the market crash. However, they don't have the money and support system to improve their rearing practices and prevention programs. Many of these farmers never recover from the losses because their poultry cannot meet the new standards and are not marketable. In contrast, in developed countries such as the United States, mega-poultry farms are producing record tons of chicken meat to feed the growing population. These large producers keep

thousands of birds in one building. The confined conditions are a “time bomb” for the outbreak of avian influenza (Chan).

Second, bustling international trade, especially that between Hong Kong and China, is a major factor that promotes the spread of avian influenza. Scientists believe that the virus is more likely spread by trade, legal and illegal, than by the migration of wild flocks although that is possible as well. They found little correlation between increased infections and migrating birds. However, they found that outbreaks often followed transportation routes such as railroads, highways, and country borders. The virus can travel not only with live birds, but also with poultry by-products, water, and soil on vehicles, contaminated clothes and shoes. There is a huge international trade in poultry – both legal and illegal, because developed countries are becoming more urbanized. High rise buildings replace farms and lands for livestock. These urban areas overly depend on developing countries to produce food (“Avian Flu”). Millions of eggs and poultry are shipped to consumers worldwide. After the tightening of regulation, illegal trade is even more rampant. Italy, the UK, and Spain have all intercepted poultry smuggled into their countries from China. Extensive smuggling of live chickens take place on the border between China and Vietnam. Many of the smuggled chickens are in poor health, and three-quarters of poultry in Vietnam have tested positive for avian flu virus. Unfortunately, many rouge business people put their own monetary gains above the public’s health and survival (Claas).

Despite government efforts, avian flu outbreaks continue to occur in Hong Kong. The most recent one was in 2015. Is the existence of wet markets worth the risk of another disastrous epidemic? Avian flu is highly contagious, and the consequences are too costly for a society to undergo continuous losses. My recommendation is to eradicate all wet markets and establish central slaughtering facilities. A central slaughtering facility is where all live poultry are killed and processed into meat products, which are shipped to retailers. The facilities would be bio-secured; no one except trained staff could come into contact with any live poultry. The workers at the central slaughtering facilities would be properly trained and suited up with protective gear. Moreover, the slaughter facility would adopt protocols such as Hazard Analysis and Critical Control Point (HACCP) to ensure food safety. For example, the chicken carcasses must be transferred into a chilling cooler immediately after slaughtering to suppress bacteria growth. The processed poultry would be stored in freezers at a specific temperature, and there must be recall procedures in case of an avian influenza outbreak. This organized and closely monitored central slaughtering facility, is for the best interest of the health of the millions of people living in a small and densely populated region such as Hong Kong.

In fact, the Hong Kong government debated the implementation of a central slaughtering facility but decided to not go forward with the plan. Even though the society as whole would probably benefit from this, there are many obstacles that need to be overcome first. Who will pay for these costly central slaughtering facilities? The buildings and equipment will cost millions to construct, and the cost will be reflected in the price of chicken products in supermarket. The price hikes will have the highest impact on the low-income population who rely on chicken as their main protein source. My suggestion is that, instead of using tax dollars to build the slaughterhouses, let private companies bid on the right to build and operate them. For their investment in the infrastructure, the private companies would gain exclusive right to sell poultry products. It’s a win-win situation. The land that wet market used to sit on can be converted into government housing, further benefitting low-income families who cannot afford to buy a tiny apartment in Hong Kong. Another major obstacle is that the poultry vendors, the local farmers, the truckers who transport live chickens, and many workers involved in the traditional wet market trade would lose jobs once central slaughtering facilities are established. My suggestion is to give these workers priority hiring in the new facilities. They should be provided adequate training for a career change. Overall, the cost of transitioning wet market to central slaughtering facilities may seem high, but the money and resources saved from preventing another avian influenza outbreak are astronomical. Without

the potential infection of the virus, the health care cost should be lower, and businesses should not suffer the losses seen in the 1997 outbreak.

The other recommendation I have is to encourage more scientific research into understanding and treating avian influenza. Many questions still remain about how exactly the virus jumps from birds to humans, and why some people are more susceptible to the viruses than others. Currently, there are great efforts to produce vaccines against the viruses, however the viruses are also going through continuous and rapid mutations. A vaccine might not work effectively after a few months, and the entire stockpile of vaccines would be wasted. In addition, the production of vaccines is a lengthy process which cannot be sped up. The development of vaccines cannot be the responsibility of the Hong Kong government alone. This important task must be a joint effort with WHO, private sectors, and international research agencies.

The problem in Hong Kong may seem far away for people in the United States. I spoke to Dr. Jeff Kaisand, the Assistant State Veterinarian of the Iowa Department of Agriculture and Land Stewardship. According to Dr. Kaisand, Iowa encountered a major outbreak of avian influenza between April and June of 2015. The strain of flu was a highly pathogenic strain (H5N2), and roughly 32 million birds were affected. As long as there are wild birds that can harbor the flu and potentially come in contact with commercial flocks, what happened in Hong Kong can happen in Iowa or any other state in America. Dr. Kaisand said that Iowa controlled the spread of the virus by quickly euthanizing sick birds and increasing biosecurity. Interestingly, Dr. Kaisand told me that it is not legal to vaccinate poultry in the United States against avian influenza, "Permission to vaccinate must first come from the USDA and then must be approved by each state... One of the main reasons it is not used is so you can easily prove a negative status for avian influenza... If you don't vaccinate, then any antibodies should be from natural infection. Influenza vaccines are also not generally cross protective for all strains and you can't put all strains in one vaccine." (Kaisand). Apparently, a lot more research needs to be done in order to develop an effective yet affordable vaccine that can be administered in a large scale.

Hong Kong, a region that struggles to balance rapid urbanization and traditional practices, underwent the world's first outbreak of avian influenza involving human fatalities. The impact reached all levels of Hong Kong society and even around the world; however, there is still no answer on how to completely eradicate the disease. Even though the outbreak happened in Hong Kong, the epidemic is a threat to the whole world and to the entire human race. WHO declared that, "It is only a matter of time before an avian flu virus acquires the ability to be transmitted from humans to humans" (Conly). Nature is taking her revenge against human civilization, and Nature has the high ground at this moment. If we do not aggressively combat bird flu, the horrific scene of soldiers in hazmat suits storming into the city will be a sci-fi movie coming to life. The strength of our civilization lies in the cooperative power of all men and women on this planet. In the face of the unprecedented challenge of avian influenza, all nations and all the citizens must fully understand the facts about the avian flu virus, implement preventative measures to control the virus from spreading, and strive to maintain a healthy environment where the virus cannot replicate out of control. Nature is powerful, but mankind is resilient and adaptive. Avian influenza will be another challenge that proves that "If we are together, nothing is impossible" -Winston Churchill.

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