

# The Psychology of Pandemics



# The Psychology of Pandemics:

*Preparing for the Next Global  
Outbreak of Infectious Disease*

By

Steven Taylor

Cambridge  
Scholars  
Publishing



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Preparing for the Next Global Outbreak of Infectious Disease

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This book first published 2019

Cambridge Scholars Publishing

Lady Stephenson Library, Newcastle upon Tyne, NE6 2PA, UK

British Library Cataloguing in Publication Data

A catalogue record for this book is available from the British Library

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ISBN (10): 1-5275-3959-8

ISBN (13): 978-1-5275-3959-4

For Anna, Alex, and Meeru



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## FOREWORD

I've admired Dr. Taylor's work since I began reading it as a graduate student in the mid-1990s. His books and research articles on anxiety disorders stood out as particularly brilliant and eloquent. Inevitably, our paths began to cross as we attended the same professional conferences each year and were members of the Obsessive-Compulsive Cognitions Working Group (OCCWG) that formed in the late 1990s. But it was at one particular OCCWG meeting in 2001 in Whistler, British Columbia—and the ensuing World Congress of Cognitive Behavioral Therapy in Vancouver—where we developed the collaborative relationship that has remained to this day. And what a productive relationship it's been! As of this writing, we have published four books, 25 journal articles, and 22 book chapters together (most of them with a third colleague, Dr. Dean McKay). I have collaborated with countless colleagues on many research and writing projects, but Dr. Taylor tops them all when it comes to his astonishing mix of proficiency and efficiency.

So, what's a *psychologist* like Dr. Taylor doing writing a book about pandemics—a seemingly medical conundrum for biologists and physicians to sort out? I'll tell you what: He's synthesizing his interest in history, extensive grasp of research on social psychology and human behavior, and his substantial expertise on anxiety disorders to help us appreciate pandemics as a psychological problem as much as a medical one.

Communicable diseases existed during humankind's hunter-gatherer days. But it wasn't until about 10,000 years ago when we began living in communities and domesticating animals, that outbreaks of sicknesses such as malaria, tuberculosis, leprosy, influenza, smallpox, and others first appeared. Humans were blindsided, having little or no immunity to these viruses, and certainly no knowledge of how they could spread so easily (no one would propose that microorganisms caused these diseases until after 1000 AD). The more interactive human civilizations became—forming cities and establishing trade routes to connect with other cities—the more the probability of pandemics increased.

Fast forward to modernity, where people are exceedingly mobile and more likely to live in densely populated cities—factors that increase the risk of viruses spreading. Where hasty communication through a dizzying array of media also escalates the risk of panic and the chance that people who may be infected will travel in an attempt to avoid illness—potentially contributing to the spread of the virus. Months or years would go by before vaccines become available. In the meantime, clinics and hospitals would be overburdened, and there could be a lack of human resources to provide crucial services, due to both the demand and illness.

My point is that our behavior increases the chances of a pandemic... and our chances that if one occurred, it could be catastrophic.

And then there's the health anxiety factor—which Dr. Taylor knows so well from his decades of research on the topic. Such psychological elements often receive short-shrift when considered within the context of medical diseases. But the information age in which we currently live exposes us to so much data (and *distortions*) about health and illness it's not surprising we're vulnerable to overestimating our risk of, and vulnerability to, disease. Many of us try to cope with inaccurate beliefs about health and disease in ways that only strengthen such fears and lead them to persist and even spread. In turn, this leads to the kinds of unhealthy practices that may ironically aid the spread of the next pandemic.

Other clinical and social psychological factors that Dr. Taylor shows us are relevant for understanding pandemics include prejudices, the way we name diseases, the role of the media (not surprisingly, including social media), attitudes toward vaccinations, how we manage rumors, and the psychology of conspiracies. Synthesizing all of this, Dr. Taylor gives us a picture of how human factors impact the spreading of disease and emotional disturbance. He convinces us that knowledge of cognition and behavior will be critical for managing it—or, more optimistically, *preventing* it. Further, he proposes changes to public health policies and for how we can best exchange information about health risks.

In classic Steven Taylor style, this work is comprehensive, fusing viewpoints from multiple diverse disciplines. It is thoughtful and persuasive, grounded in scientific facts. And it has clear societal implications for us to heed. It also provides a call (and outline) for future research in medicine and clinical, health, and social psychology. As such, this book more than accomplishes its goals—it makes an

exceptional contribution and fills a crucial gap in the literature on pandemics.

Jonathan S. Abramowitz, PhD  
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## PREFACE

There have been numerous pandemics over the past century and earlier, typically arising from some form of influenza. Pandemic influenza is widely considered to be one of the leading public health threats facing the world today. Virologists predict that the next influenza pandemic could arrive any time in the coming years, with potentially devastating consequences. People do not have pre-existing immunity to the pathogens causing pandemics. Effective drug treatments are not always available. Vaccinations, if available, and behavioral methods are first-line interventions for reducing morbidity and mortality. Behavioral methods include hygienic practices (e.g., hand-washing) and social distancing methods (e.g., limiting large social gatherings).

The question arises as to how best apportion healthcare resources for managing pandemics. Such resources, by definition, are limited. It is important that resources be apportioned to essential services and to the development and distribution of vaccines and other methods for halting or limiting the spread of infection. Remarkably, public health agencies have devoted few resources for specifically dealing with the psychological factors that influence pandemic-related emotional reactions (e.g., fear, anxiety, distress) and behavioral problems (e.g., nonadherence, avoidance, stigmatization of out-groups). Healthcare authorities neglect the role of psychological factors in pandemic-related infection even though these factors are important for many reasons. They play a vital role, for example, in adherence to vaccination and social distancing, both of which are vital for stemming the spread of infection. Nonadherence to vaccination is a widespread problem even during pandemics.

Psychological factors also play an important role in the way in which people cope with the threat of pandemic infection and its sequelae, such as the loss of loved ones. Although many people cope well under threat, many other people experience high levels of distress or a worsening of pre-existing psychological problems, such as anxiety disorders and other clinical conditions. Psychological factors are further important for understanding and managing broader societal problems associated

with pandemics, such as factors involved in the spreading of excessive fear. People may fear for their health, safety, family, finances, or jobs. Psychological factors are also important for understanding and managing the potentially disruptive or maladaptive defensive reactions, such as increases in stigmatization and xenophobia that occur when people are threatened with infection.

The purpose of this volume is to fill an important gap in the literature on pandemics. Goals are to (1) describe the psychological reactions to pandemics, including maladaptive behaviors and emotional and defensive reactions, (2) review the psychological vulnerability factors that contribute to the spreading of disease and emotional distress, (3) discuss empirically supported methods for addressing these psychological problems, and (4) outline the implications for public health policy, including implications for risk communication. Influenza pandemics are used as prototypic examples because they have been the most common pandemics over the past century and influenza is likely to be a source of future pandemics. Other disease outbreaks are discussed where relevant.

To achieve the aims of this volume, the author draws on sources from multiple disciplines, including virology, epidemiology, public health, sociology, history of medicine and, of course, psychology. Numerous subdisciplines within psychology are drawn upon, including clinical psychology, health psychology, and social psychology. In addition to drawing extensively from the research literature, case examples are included throughout this volume to highlight important issues.



## ABOUT THE AUTHOR

Steven Taylor, Ph.D., is a Professor and Clinical Psychologist in the Department of Psychiatry at the University of British Columbia, Vancouver, Canada. He received his B.Sc. (Hons.) and M.Sc. at the University of Melbourne, and Ph.D. at the University of British Columbia. Dr. Taylor's research and clinical work focuses largely on anxiety disorders and related clinical conditions, including fears and phobias, health anxiety, posttraumatic stress disorder, and obsessive-compulsive disorder. He has authored over 300 scientific publications and more than 20 books, which have been translated into several languages. His books include *Understanding and treating panic disorder* (John Wiley & Sons), *Treating health anxiety* (Guilford Publications), and *Clinician's Guide to Posttraumatic Stress Disorder* (Guilford Publications). Dr. Taylor was a member of the anxiety disorders committee for the text revision of the fourth edition of the *Diagnostic and Statistical Manual of Mental Disorders*. He has also served as Editor or Associate Editor of several academic journals, including *Behaviour Research and Therapy*, *Journal of Cognitive Psychotherapy*, and the *Journal of Obsessive-Compulsive and Related Disorders*. Dr. Taylor has received a number of awards for his scholarly work, including awards from the Canadian Psychological Association, Association for Advancement of Behavior Therapy, and the Anxiety Disorders Association of America. In addition to teaching and research, Dr. Taylor maintains a clinical practice in Vancouver, BC, specializing in mood and anxiety disorders.



## ACRONYMS USED THROUGHOUT THIS VOLUME

BIS	Behavioral immune system
CBT	Cognitive-behavior therapy
CDC	Centers for Disease Control and Prevention
HCW	Healthcare worker
HIV	Human immunodeficiency virus
PTSD	Posttraumatic stress disorder
PVD	Perceived vulnerability to disease
PVDS	Perceived Vulnerability to Disease Scale
SARS	Severe acute respiratory syndrome
WHO	World Health Organization



# CHAPTER 1

## WHAT IS A PANDEMIC?

### Overview

Despite the passage of decades, 96-year-old James S. vividly recalled the 1918 Spanish flu pandemic. He was 8 years old at the time. The city had ground to a halt. Schools and theaters were closed, and dances and other social gatherings were banned. James was not even allowed to go to the local playground because his father feared he would fall ill. Church services were banned, despite protests from the clergy. James recalled the pine caskets in the front room of the family home, containing the bodies of his mother and younger sister. It all happened so quickly; people could fall sick in the morning and be dead by evening. People were afraid to leave their homes, he recalled, although it was necessary for the government to impose fines if an infected person was out in public, because some sick people refused to stay indoors.

Pandemic influenza is one of the leading health threats currently facing the world (World Health Organization (WHO), 2019). The rise of antimicrobial resistance, along with the emergence of new, highly pathogenic viral strains, has fueled fears of another global outbreak of infectious disease (Nerlich & Halliday, 2007). For pandemics in general, the causal elements are manifold and complex. The essential elements are an infectious agent (e.g., a virus or bacterium), a host (e.g., a person), and the environment. The host's resistance to infection depends on several factors including immunocompetence as well as psychological factors that influence how the host copes with or reacts to threatened or actual infection. Environmental factors are numerous and multiform, including factors that promote or hamper the coping strategies of the host.

This book focuses on the psychological factors as they pertain to the host and host-environment interactions in pandemics. Put simply, pandemics of infectious disease are not just events in which some infectious “bug” spreads throughout the world. Pandemics are events in which the population’s psychological reactions to infection play an essential role in both the spreading and containment of the disease, and influence the extent to which widespread emotional distress and social disorder occur. When threatened with infection, people vary widely in their reactions. The complexities of their reactions need to be taken into consideration in order to understand the psychology of pandemics. The present volume aims to explore these issues through a review of the scientific and historical literatures, supplemented by illustrative case vignettes derived from various sources including historical sources and the author’s clinical case files. This book also considers the public health implications for assessing and addressing pandemic-related emotional distress, and for addressing pandemic-related social or behavioral problems, such as vaccination nonadherence.

The focus of this book is on influenza pandemics because influenza is the most likely source of the next pandemic. However, findings from other pertinent outbreaks, such as Severe Acute Respiratory Syndrome (SARS), Bubonic Plague, Ebola virus disease, and others, are discussed where relevant.

## Definition

Pandemics are large-scale epidemics afflicting millions of people across multiple countries, sometimes spreading throughout the globe (WHO, 2010b). For a virus or bacterium to cause a pandemic it must be an organism for which most people do not have preexisting immunity, transmitting easily from person to person, and causing severe illness (Kilbourne, 1977). Diseases causing pandemics are part of a group of conditions known as emerging infectious diseases (Lederberg, Shope, & Oakes, 1992), which include newly identified pathogens as well as reemerging ones.

## Notable Pandemics

The most famous pandemic was the Bubonic Plague (e.g., 1346-1353), attributed to *Yersinia pestis*, which killed an estimated 50 million people worldwide (Johnson & Mueller, 2002). Over the past century,

there have been many other pandemics of varying degrees of contagiousness and lethality. Examples include HIV/AIDS (1981 to present), the Spanish flu (a strain of the H1N1 influenza virus; 1918-1920), Russian flu (H2N2 or H3N8, 1889-1890), Asian flu (H2N2, 1957-1958), Hong Kong flu (H3N2, 1968-1969), a second Russian flu pandemic (H1N1, 1977-1978), Swine flu (H1N1, 2009-2010), and the Zika virus pandemic (2015-2016) (Belshe, 2005; Crosby, 2003; Doherty, 2013; Honigsbaum, 2014; Morens & Fauci, 2017; WHO, 2010b). Avian flu has been widespread in recent years but at the time of writing has not reached pandemic proportions.

## Nomenclature

The notation system for influenza, H<sub>x</sub>N<sub>x</sub> (e.g., H1N1, H3N8) refers to the virus's hemagglutinin (H) and neuraminidase (N) membrane proteins. Terms such as “Swine flu” and “Asian flu” have become standard labels for pandemics. Such names are used here because readers will likely be familiar with them. However, as we will see later, such terms should be used with caution. The terms “flu” and “influenza” also can be sources of confusion. With the exception of the established names for pandemics (e.g., “Swine flu”), the term “influenza” rather than “flu” will be used throughout this book because “flu” is a vague, broad term used to describe symptoms and signs that may or may not be caused by an influenza virus (e.g., fever, cough, runny nose, muscle aches; Doshi, 2013).

## Pandemic Influenza

Pandemics are usually viral in nature, typically arising from animal influenza viruses that spread to humans (WHO, 2010b). It is difficult to predict when the next influenza pandemic will occur.

Despite continuing progress in many areas, including enhanced human and animal surveillance and large-scale viral genomic screening, we are probably no better able today to anticipate and prevent the emergence of pandemic influenza than 5 centuries ago, as shown by the completely unexpected emergence of the 2009 novel H1N1 pandemic virus. (Morens, Taubenberger, Folkers, & Fauci, 2010, p. 1444)

It has been speculated that future pandemics will arise from some strain of Avian influenza (e.g., H5N1 or H7N9) or from combinations of

Avian and other influenza strains (Kelland, 2017; Li et al., 2010; Webster & Govorkova, 2006; Wildoner, 2016). The next influenza pandemic is inevitable and serious (Laver & Webster, 2001; Webby & Webster, 2003).

The world's population would have no immunity to this "new" virus. Because of today's crowded conditions and with modern rapid transportation facilities, the epidemic would spread like wildfire, reaching every corner of the globe. Many millions of people would become ill and there would certainly be many deaths. (Laver & Webster, 2001, p. 1813)

The frequent genetic mutation and genetic reassortment of influenza viruses make it difficult, if not impossible, to prevent influenza pandemics from occurring (Kelland, 2017). Compounding the problem, viral pandemics, just like comparatively smaller-scale epidemics, are often followed by secondary bacterial infection (e.g., hospital-acquired pneumonia), thereby complicating treatment and increasing the risk of mortality (Morens et al., 2010). Indeed, 95% of post-mortem samples from the Spanish flu pandemic showed bacterial infection complications, and the majority of deaths likely resulted from secondary bacterial pneumonia caused by common upper respiratory tract bacteria (Morens, Taubenberger, & Fauci, 2008).

Influenza pandemics and seasonal influenza have some similarities but important differences. Pandemic influenza can arise during the usual influenza season—that is, the winter months in temperate climates—but can also occur during the summer (Taubenberger & Morens, 2006). Pandemic influenza, by definition, spreads globally (i.e., is more transmissible; Fraser et al., 2009), is often (but not always) more lethal (Doherty, 2013), and can differ from seasonal influenza in terms of the people most severely afflicted. Seasonal influenza tends to be most dangerous to the elderly and medically frail, whereas some influenza pandemics have taken the greatest toll on other age groups. To illustrate, consider the Spanish flu, which killed 20% of those infected (Taubenberger & Morens, 2006), with an estimated death toll of 35-100 million people worldwide, or 2-6% of the world's population (Barry, 2009; Johnson & Mueller, 2002). The Spanish flu was most lethal to children and young adults (Taubenberger & Morens, 2006). Similarly, young adults were more susceptible to Swine flu than older adults (Crum-Cianflone et al., 2009).



Some pandemics killed with great rapidity. In the case of the Spanish flu, there were numerous accounts of people waking up sick in the morning and dying later that day, on their way to work, for example (Crosby, 2003; Pettigrew, 1983). The deaths were sometimes gruesome. Some victims of the Spanish flu developed pulmonary edema and became so anoxic that their faces turned blue. Some of these patients hemorrhaged from the mucous membranes, particularly the nose, stomach, and intestines, and there was also bleeding from the ears and petechial (skin) hemorrhages (Taubenberger, Reid, Janczewski, & Fanning, 2001).

### **Pandemic-Related Stressors**

Pandemics are “frequently marked by uncertainty, confusion and a sense of urgency” (WHO, 2005, p. 1). Prior to, or in the early stages of a pandemic, there is widespread uncertainty about the odds and seriousness of becoming infected, along with uncertainty, and possible misinformation, about the best methods of prevention and management (Kanadiya & Sallar, 2011). Uncertainty may persist well into the pandemic, especially concerning the question of whether a pandemic is truly over. Pandemics can come in waves (Barry, 2005; Caley, Philp, & McCracken, 2008; Herrera-Valdez, Cruz-Aponte, & Castillo-Chavez, 2011). Waves of infection are caused, in part, by fluctuations in patterns of human aggregation, such as seasonal movements of people away from, and then into contact with, one another (e.g., schools closing for the summer and then reopening), as well as other fluctuations in social aggregation (Caley et al., 2008; Herrera-Valdez et al., 2011). The Spanish flu, for example, came in three waves (Barry, 2005). Accordingly, there may be uncertainty as to whether a pandemic has truly run its course.

Pandemics are associated with a score of other psychosocial stressors, including health threats to oneself and loved ones. There may be severe disruptions of routines, separation from family and friends, shortages of food and medicine, wage loss, social isolation due to quarantine or other social distancing programs, and school closure (Shultz, Espinel, Flynn, Hoffmann, & Cohen, 2008). Families may become malnourished if no one in the house is well enough to shop or cook (Schoch-Spana, 2004). Personal financial hardship can occur if a family’s primary wage earner is unable to work because of illness. During the Spanish flu, for example, merchants suffered hardship

because of staff absenteeism and because shoppers were either too ill or too frightened to venture out to the stores (Pettigrew, 1983). The personal financial impact of a pandemic can be as severe and stressful as the infection itself, especially for people who are already experiencing financial hardship. This is illustrated by the following account of one American family during the Spanish flu pandemic.

In December 1918 influenza struck, infecting Mr. D. and then his wife and five children. By late December he had been out of work for three weeks due to his own illness and then that of his family. For the first few weeks the family had managed on their meager savings and on money sent from a relative. After that, the family became frantic and approached the *Society of the Friendless* for aid. Mr. D. was unable to go to work because he dared not leave his sick family unattended. The situation became increasingly desperate. They had run out of coal for heating and there was no food in the house. Having no money, Mr. D. attempted to get credit at the grocery store but was declined. Compounding his problems, Mr. D. lost his job because of his absence from work. (Bristow, 2010, pp. 139-140)

During a pandemic, people may be exposed to the death of friends and loved ones, including exposure to the death of children. The latter can be especially traumatizing (Taylor, 2017). Caring for the sick can be highly stressful, especially if this burden falls on children, as illustrated by the following example from Britain, during the Spanish flu.

Writing from Coventry in 1973, Ethel Robson recalled how at the age of nine she was suddenly thrust into the role of sole caretaker for her family when her eight brothers and sisters, ranging in ages from 10 months to 15 years, contracted the flu together with her mother. For some reason, Robson writes, "I was the only one out of all the family that didn't have the virus." Although a doctor visited twice a day, no one else was allowed into the house, "therefore I was doing my best to help the others." (Honigsbaum, 2009, p. 86)

Most of Robson's siblings recovered but her seven-year-old sister and mother died. "It really was a terrible time not knowing who we were going to lose next," she recalled (Honigsbaum, 2009, p. 86).

The following account from northern Labrador (Canada), during the Spanish flu pandemic, was provided by the Reverend Walter Perrett, concerning an eight-year-old girl, whose parents and siblings had died from influenza, leaving the young girl alone to fend for herself for five weeks before being found.

The huskies (dogs) now began to eat the dead bodies, and the child was a spectator of this horrible incident. So mad did the beasts become, upon taking human flesh, that they attacked the child herself, biting her arm. ... It was thirty degrees below zero. The little girl had used the last of the Christmas candles to melt snow for drinking water (Pettigrew, 1983, pp. 29-30).

A pandemic can impede a community's ability to bury the dead according to accepted cultural and religious practices. During the Spanish flu pandemic, there were shortages of coffins and insufficient funeral staff to prepare and bury bodies (Johnson, 2006). Handling of the deceased is an emotionally charged issue, and neglect of customary, culturally prescribed, funerary practices can be experienced as abhorrent and dehumanizing (Schoch-Spana, 2004).

Indirect exposure to trauma, such as graphic media depictions of fatalities, can also contribute to distress (Neria & Sullivan, 2011). Other stressors include the loss or destruction of possessions. When people are forced to evacuate their homes, leaving their possessions behind, looting can occur (Staino, 2008).

Cultural minorities residing within a larger mainstream culture, such as new immigrants, may experience stressors that are not encountered by people from the majority culture, such as unfamiliarity with community support systems, difficulty accessing services due to language difficulties, discrimination, and immigration status issues. Thus, during times of pandemic, some ethnic minorities may experience more adverse psychological consequences than members from the majority culture (Shultz et al., 2008).

## **Effects on the Healthcare System**

Pandemics can exceed the capacities of healthcare systems to care for the sick. This is for various reasons including widespread infection, lack of effective treatment, and breakdown of the healthcare system due to healthcare workers (HCWs) becoming infected and unable to care for the ill (National Academy of Medicine, 2016). Failure to manage the surge of people into hospitals and clinics can create unnecessary exposure to disease as infected and non-infected persons congregate to seek services and treatments (Shultz et al., 2008). Sick people may be turned away from overcrowded, short-staffed hospitals, thereby necessitating home care (Schoch-Spana, 2004). This can create a financial burden in arranging home care for a sick family member.

## **Economic Costs**

Pandemics can have major effects on the broader economy and societal infrastructure. As people become ill and unable to fulfill their occupational roles, essential services may break down (Shultz, Baingana, & Neria, 2015). In Baltimore during the Spanish flu, for example, garbage piled up in the streets due to absenteeism of sanitation personnel (Schoch-Spana, 2004). This created further public health problems. Even with effective vaccines and antiviral medications, it has been estimated that the next influenza pandemic could result in economic losses of over US\$34 billion in the United States (Prager, Wei, & Rose, 2017). Worldwide, it has been estimated that the next pandemic could cost over US\$6 trillion in economic losses (National Academy of Medicine, 2016).

## **How do Pandemics Spread?**

Human networks are the major means of pandemic disease transmission (Wald, 2008). Influenza is readily spread by inhaling airborne cough or sneeze droplets, and by touching one's mouth, nose, or eyes after touching fomites. The latter are contaminated surfaces in public spaces, such as doors, railings, or tabletops, or contaminated objects such as toys, doorknobs, and banknotes (Nicas & Jones, 2009; Thomas et al., 2008). Airborne transmission, combined with high population densities in urban areas and the availability of modern rapid transportation, makes it easy for influenza infection to spread rapidly.

Some people disproportionately contribute to the spreading of infection. These people are known as superspreaders (Galvani & May, 2005). In prototypic cases of superspreading as few as 20% of infected people may be responsible for 80% of transmissions (Woolhouse et al., 1997). A superspreader is likely to be someone who (1) is not immunized or is immunocompromised and therefore particularly susceptible to infection, (2) does not engage in basic hygiene (e.g., covering coughs) and therefore likely to transmit influenza, (3) comes into contact with a great many people, through some combination of their social and occupational roles (e.g., a flight attendant, cafeteria worker, or someone with a highly active social life), or comes into regular contact with sick people that are particularly susceptible to infection (e.g., a hospital worker that deals with patients but refuses to

be vaccinated) (Galvani & May, 2005; Shen et al., 2004; Temime et al., 2009).

Superspreading is also shaped by other factors, including the nature of the infectious agent and herd immunity. Herd immunity, also known as community immunity, refers to the indirect protection from infectious disease that occurs when a large proportion of the population becomes immune to infection, which provides a degree of protection to people who are not immune (Fine, Eames, & Heymann, 2011). This impedes the spread of infection by disrupting the chains of contagion.

Superspreading is especially likely to occur for diseases that have substantial incubation periods; that is, periods in which infected people are contagious but asymptomatic, meaning that the person may be unknowingly spreading disease to others. Incubation periods for influenza may vary from person to person (Virlogeux et al., 2016) and may depend on the strain. During the 2009 Swine flu pandemic, the incubation period was 1-4 days (Nishiura & Inaba, 2011; Tuite et al., 2010). A study conducted in China during the Avian flu epidemic found that the median incubation period was 8 days (Huang et al., 2014). Such a long incubation period means that a person may infect many other people before becoming symptomatic.

The 2003 SARS outbreak is an example in which superspreading was well-documented (Shen et al., 2004). SARS, which spreads in a manner similar to influenza, can have an incubation period of 2-10 days (Shen et al., 2004). In one case of SARS superspreading, a 62-year-old woman was admitted to a Beijing hospital for treatment of diabetes mellitus. While in hospital, her SARS symptoms became apparent (e.g., fever, headache) but were misdiagnosed as tuberculosis. Her clinical condition deteriorated and she died. During her hospital stay, she had 74 close contacts, including 25 HCWs, 11 relatives, 36 co-patients in the same ward, and 2 people who accompanied other patients on the ward. Among these close contacts, SARS developed in 33 (45%) of the 74 people (Shen et al., 2004). Superspreaders have also been reported for many other outbreaks of infectious disease, such as the Middle East Respiratory Syndrome Coronavirus (e.g., Al-Tawfiq & Memish, 2016; Lau et al., 2017).

Historically, the most famous superspreader was Mary Mallon, dubbed “Typhoid Mary” by the news media (Soper, 1939). Typhoid is a highly contagious infectious disease caused by *Salmonella typhi*. People can be chronically asymptomatic carriers (Wain, Hendriksen, Mikoleit, Keddy, & Ochiai, 2015). At the turn of the 20<sup>th</sup> century, typhoid epidemics were commonplace, with no effective treatment (Soper,

1939). From 1902-1909, Mallon, a chronic but asymptomatic carrier, infected more than 50 people with typhoid before she was involuntarily quarantined in a hospital for communicable diseases in New York. What made her case tragic was that she stubbornly refused to give up working as a cook, despite being infected, which led to her involuntary confinement. It was quite obvious that Mallon was infecting people. Each time she moved to a new house to serve as a household cook, the occupants became sick. Never staying long, she moved from house to house, gaining her employment through job placement agencies. Mallon adamantly denied being infected, even after infecting so many people and being involuntarily quarantined.

The authorities offered to release Mallon [from quarantine] if she would agree to give up professional cooking or have her gall bladder removed, since it was believed [erroneously] to be the site of her chronic infection. She rejected both offers, and denied that she was responsible for anyone's sickness or death. She refused to recognize the authority of science or government to label her a menace to society. ... "I never had typhoid in my life, and have always been healthy," Mallon told one reporter. "Why should I be banished like a leper and compelled to live in solitary confinement with only a dog for a companion?" (Brooks, 1996, p. 916)

Mallon was released on the proviso that she promised not to work as a cook, not to handle the food of others, observe various other precautions, and report to the New York City Department of Health every three months (Soper, 1939). But on release, she promptly disappeared, changed her name, and resumed working as a cook in hotels, restaurants, and sanatoria. While working at a maternity hospital she infected 25 people. She was later apprehended and returned to the quarantine hospital, where she spent the remainder of her life (Brooks, 1996).

The case of Typhoid Mary is relevant to a future influenza pandemic in that it is possible that some people will be asymptomatic carriers of influenza. As many as 36% of people infected with seasonal influenza may be asymptomatic and never show symptoms, possibly due to preexisting partial immunity (Furuya-Kanamori et al., 2016). Such people can inadvertently transmit the virus to other people, but not at the same rate as symptomatic people (Bridges, Kuehnert, & Hall, 2003).

Mary Mallon adamantly denied that she was infected with typhoid, and so her spreading of typhoid did not appear to be intentional. But what about the intentional spread of infection? There have been