The threat of infectious harm to the population is well documented throughout recorded history. The development of germ theory in the late 19th Century by Louis Pasteur alerted us to the presence of microbial pathogens and led to the development of combative measures such as antibiotics, anti-virals, asepsis and vastly improved sanitation.¹ These advancements aside, the severe acute respiratory syndrome (SARS) epidemic of 2003 serves as a very recent reminder of the continual threat that opportunistic pathogens place on public health and society in general. At a clinical level, a practising optometrist must be informed on the epidemiology and aetiology of the various threats to prevent micro-epidemics, that is, the transmission of disease from patient to patient or between patient and practitioner in his or her practice. Given the ease with which highly transmissible diseases are spread, the considerations are far from trivial.

**SARS OUTBREAK OF 2003**

The multi-national SARS outbreak of 2003 alerted the world to the new face of pandemic disease: highly contagious and fatal infections for which no vaccines are available and current drugs are largely ineffective. As a practitioner providing primary care, the optometrist must be familiar with new and evolving infections present in today’s society. Though they may be viewed as extreme events, scenarios such as the re-emergence of SARS, the affliction posed by the H5N1 strain of avian influenza and the threat of a bioterrorist attack have all been described. In the event that such events occur, there is the potential for the spread of some highly virulent, transmissible disease.

This paper highlights these public health threats and discusses several areas that the optometrist may want to consider regarding infection control in an era in which a highly transmissible disease is being spread from person to person.

The outbreak of severe acute respiratory syndrome (SARS) in 2003 alerted the world to the new face of pandemic disease: highly contagious and fatal infections for which no vaccines are available and current drugs are largely ineffective. As a practitioner providing primary care, the optometrist must be familiar with new and evolving infections present in today’s society. Though they may be viewed as extreme events, scenarios such as the re-emergence of SARS, the affliction posed by the H5N1 strain of avian influenza and the threat of a bioterrorist attack have all been described. In the event that such events occur, there is the potential for the spread of some highly virulent, transmissible disease.

This paper highlights these public health threats and discusses several areas that the optometrist may want to consider regarding infection control in an era in which a highly transmissible disease is being spread from person to person.

Key words: avian influenza, biological terrorism, disease outbreaks, infection control, SARS virus
remain vigilant to reduce the risk of infection.

Patient-to-patient transmission of the disease is of concern to optometrists. One particularly significant finding from 2003 was the discovery of the coronavirus in tear samples taken from several patients testing positive for SARS. This discovery, coupled with the fact that almost all of the disease transmissions in 2003 occurred through contact with bodily secretions of an infected individual, highlights the particular risk tears can impose. Reusable equipment, such as tonometers, trial contact lenses, and handheld occluders potentially serve as vectors for transmission from patient to patient. The examiner’s hands, often used to widen palpebral fissures or invert eyelids, are obvious vehicles for inadvertent patient inoculation.

In hindsight, one benefit the world medical community derived from the acute but brisk SARS epidemic is the knowledge that the current infection control measures for such highly transmissible diseases were inadequate. The lessons learned from 2003 may prove invaluable for the inevitable future emergence of a highly contagious airborne pathogen that many experts fear will become the next flu pandemic.

**AVIAN FLU AND THE NEXT INFLUENZA PANDEMIC**

Despite the considerable death toll and societal disruption SARS precipitated during the epic of 2003, the effects of the next global flu pandemic may be equally or more profound. In the past century, worldwide influenza pandemics occurred in 1918, 1957, 1968 and 1977, with estimates of the 1918 pandemic alone suggesting upwards of 40 million casualties. Most virologists concur that a future pandemic is a ‘virtual certainty’, whether it be from the current H5N1 strain of avian influenza that is devastating poultry stocks all over Asia and Eastern Europe or some other avian strain yet to be conceived. Because of its zoological origin, humans lack antibodies to the animal-derived antigens present on the viral surface, thereby making the virus, which has now become endemic in certain countries, a leading threat to become a worldwide pandemic.

Whether the new pandemic strain emerges this year or in 10 years, the optometrist in practice will have to remain particularly vigilant, as occurred during the SARS outbreak, to prevent patient-to-practitioner or patient-to-patient transmission. The evidence from 2003 showed that SARS was transmitted by airborne means as well as through direct contact with the secretions of an infected individual. No one can be sure of the form that the next influenza virus will take but if it too has airborne spread, it will have a similar very high risk of transmission.

**THREAT OF BIOTERROR**

In medical discourses of pandemic threats, the concern for bioterror is seldom discussed. In the days and weeks after September 11, the public got a glimpse of what may become a face of pandemic disease delivery in the 21st Century, that is, bioweaponry, as weapons-grade anthrax circulated through the US postal system.

The rapid evolution of basic microbiotechnology and hence, affordability of bioweapons, makes them accessible to virtually any group intent on inflicting mass casualties. An oft quoted 1969 study by the United Nations estimated the cost per square kilometre of a large-scale military attack on civilians to be US$2,000 for conventional weapons, US$800 for nuclear weapons, US$600 for nerve gas weapons and US$1 with biological weapons (cited by Pringle). Though inflation has occurred since 1969, there has been a precipitous fall in the price of the necessary biotechnologies. Many of the appropriate biological procedures can be performed using basic high-school scientific equipment, the techniques can be retrieved in ‘cook-book’ format from the internet and materials can be acquired inexpensively from medical supply companies.

The reasons for bioterror being considered a significant public health concern are clear. Worrisomely, the Atlanta-based Centers for Disease Control and Prevention (CDC) have identified a number of agents as being potential bioweapons. Among them are six entities known as Category A agents (anthrax, botulinum toxin, plague, smallpox, tularemia and viral haemorrhagic fevers, such as Ebola), scourges viewed as having the highest potential as bioweapons because of their high transmissibility and mortality rates.

The presumption is that an optometric office would not be the target of a bioterror attack but such an attack could easily occur within our own city, province or country. Even if an attack occurred outside our country, we might not be immune, as many diseases have long incubation periods, in the case of smallpox up to 19 days. If one considers the ubiquitous presence of intercontinental flight, a disease outbreak in even a remote part of the world followed by aeroplane travel by an asymptomatic person could conceivably land that person in our office. Given the numerous possible weapons of bioterror and their various modes of transmission, the practising optometrist should have a basic protocol for the control of infection, in case an attack occurs and a disease is spread.

**INFECTION CONTROL DURING AN OUTBREAK OF A HIGHLY INFECTIOUS DISEASE**

Optometrists may consider addressing some areas common to most private clinics in an era when a highly infectious disease is being transmitted from person to person. These areas are listed below and the sum of the ideas presented is intended to decrease the risk of acquiring an infection transmitted by respiratory droplets or direct contact. They do not constitute a set of directives per se, nor are they intended as a fully comprehensive algorithm of precautionary measures, as we cannot know in advance the exact nature of a future pandemic. The intent is to highlight areas the practising optometrist might consider with regards to personal and practice safety, in an era when a highly transmissible epidemic disease is present.
Patient screening

The risk optometrists face in acquiring an infectious disease resides in the present- ing patient population. A practising optometrist is safest if infectious persons can be excluded from the clinic. The first step is through proper screening of potential patients, typically by telephone, at a time when patients are called to confirm their appointments.

The exact screening questions will vary according to the nature of the disease. A basic framework is given below for a transmissible disease that presents with flu-like symptoms and is modelled after the CDC’s guidelines for the screening of SARS.16

Screen all patients with fever or lower respiratory symptoms, with or without pneumonia, to determine if, within 10 days (that is, the incubation period of the disease) of the onset of symptoms, they had:

- close contact (defined as living with or being the care-giver of) with a person suspected of having the epidemic disease
- a history of foreign travel (or close contact with a person with a history of travel) to a location with documented or suspected cases of the epidemic disease
- exposure to a domestic or occupational location with documented or suspected cases of the epidemic disease (including a laboratory that contains live strains of the epidemic disease) or close contact with an ill person with such an exposure history.

Specific screening questions will vary according to the disease. For instance, questions relating to a smallpox outbreak may pertain to the presence of fever and questions relating to a smallpox outbreak according to the disease. For instance, "a history of foreign travel (or close contact with a person with a history of travel) to a location with documented or suspected cases of the epidemic disease or close contact with an ill person with such an exposure history.

If a patient’s infectious status is uncertain, the optometric appointment should be deferred indefinitely until the status is ascertained. Patients should be instructed on the telephone to avoid bringing others to the office, except where necessary, as in the case of small children or visually impaired individuals.5

Personal protective equipment

As with the screening objectives, personal protective equipment (PPE) will vary with the nature of each pandemic. The protective measures described below will assist a wearer to reduce the likelihood of infection via either direct contact or respiratory droplets.18

Eye protection

Face shields or visors should be used if sprays, such as those occurring with non-contact tonometry, are expected.2 If splashes or direct coughing occurs, goggles should be worn.19 Eyeglasses or contact lenses are not considered eye protection.16

Gowns and gloves

To protect against splashes or droplets, water-repellent or water-resistant gowns and gloves (these need not be sterile) may be worn.18 In the event that gowns are required, the apparel should fully cover the front torso and arms and should be tied at the back. Gloves should specifically cover the cuffs of the gown.16

Masks

Recommended respirators are National Institute for Occupational Safety and Health (NIOSH) certified N95 masks. Surgical masks are not considered a substitute for an N95 or higher-rated mask and should be used only if there is no alternative.19

Care must be taken with the removal of PPE. One may consider designating an area with adequate space within the office specifically for the task of PPE removal, so as not to contaminate the environment.18 The appropriate sequence of PPE removal is not yet established as many national bodies offer contrasting recommendations.9 If one is wearing all the apparel mentioned above, the recommendations are generally consistent in that the shields for the mucous membranes of the face, mainly the mask and eye protection, should be removed last, after the gloves have been removed and the hands sanitised.

As for handling and storage of fabric-based personal protective equipment such as gowns, it must be noted that textiles have not been implicated in the transmission of viruses such as SARS-CoV.16 Nonetheless, fabrics and textiles should be handled carefully and not shaken in any manner that might cause infectious particles to become airborne. Ideally, these items should be stored in negative pressure environments away from patient examination rooms. If soiled textiles are to be cleaned, they should be handled using gloves and transported using laundry drys. Washing and drying of textiles may be performed according to routine standards and procedures.16

If equipment, such as plastic goggles that cannot be soaked, does not come into direct contact with patients it should be washed daily with tap water. Masks and disposable gloves are to be discarded after every use.

Equipment disinfection

Disinfection of equipment is mandatory, as microbes such as virus particles can remain stable on most surfaces for several days. Though the survival of pathogens varies, common disinfectants such as hypochlorite (bleach), alcohol and sodium peroxide have proved effective for the vast array of disinfection needs.18 In the case of the SARS-CoV virus, the recommendation is that ophthalmic instruments in direct contact with patients’ mucosal membranes be given an intermediate level of disinfection. For instance, the Goldmann applanation prism tip should be rinsed with tap water to remove any organic manner, soaked for 20 minutes at room temperature in six per cent sodium
have greater efficacy.22 A bottle of alcohol-
of infection, the alcohol-based sanitisers is accepted in many guidelines for control
ational hand-washing with soap and water
34
auto-refraction, automated visual fields et
cetera) or auxiliary testing (for example,
cover vision, contact lenses and low
borders must remain vigilant in the control of
In addition to the optometrist, staff mem-
Hand sanitisation
Hand sanitisation is a critical element in the control of infection, particularly when disposable gloves are not worn. Hands are to be disinfected between patients. Practi-
tioners should avoid touching their masks, eye protection and head and neck regions until they have completed a thorough hand cleansing procedure.2 Though traditional hand-washing with soap and water is accepted in many guidelines for control of infection, the alcohol-based sanitisers have greater efficacy.23 A bottle of alcohol-
ated by the spread of droplets and the
other apparatus with high patient contact, should be done on a daily basis. PPE should be worn during cleansing regimens.2

Other recommendations
Because of the very short working distance used in direct ophthalmoscopy and the risk imposed by airborne disease transmis-
sion, Hong Kong ophthalmologists ceased using direct ophthalmoscopy shortly after the SARS outbreak. In cases where the spread of pandemic disease is characterised by the spread of droplets and the infectious status of a patient is in doubt, fundus photography may serve as an alter-
ative to traditional fundus examination.2

During a disease outbreak, competent use of measures to control infection will reduce but not prevent or eliminate a per-
son’s exposure to pathogens. At the SARS epicentre of the Hong Kong outbreak during 2003, the HCWs who properly adhered to the control measures, specifi-
cally mask, gloves, gowns and hand wash-
ing, were overwhelmingly less likely to be infected. Conversely, the overwhelming majority of HCWs who were infected had omitted one or more of the preventa-
tive steps, signalling the efficacy of the measures.2

CONCLUSION
A worldwide epidemic of an infectious dis-
case, whether it is an H5N1-like flu, a re-
emergence of SARS, a bio-terror attack or
an as yet unidentified cause, has been described as a virtual certainty in the future. Learning from our experience in 2003, a critical factor in the rapid resolu-
tion of the SARS outbreak was adequate dissemination of screening and triage information to health-care workers.24 As a front-line health-care provider, it remains the optometrists’ responsibility to contrib-
ute to the resolution of any future pan-
demic by being informed of the nature of the current threats and by understanding the areas that must be addressed to protect themselves, their employees and their patients from the risk of infection in their practice.

ACKNOWLEDGEMENT
I would like to thank Dr Anil Misir MD, Pathology Resident, Michael G DeGroote School of Medicine, McMaster University, Hamilton, Ontario, Canada, for contri-
buting ideas towards the creation of this paper.

REFERENCES
1. Miller JT, Rahimi SY, Lee M. History of infection control and its contributions to the development and success of brain tumor operations. Neurosurg Focus [elec-
tronic resource]. 2005 Apr 15; 18: e4.
2. Chan WM, Liu DT, Chan PK, Chong KK, Yuen KS, Chiu TY, Tam BS, Ng JS, Lam DS. Precautions in ophthalmic practice in a hospital with a major acute SARS outbreak: an experience from Hong Kong. Eye 2005 Apr 29; [Epub ahead of print].
3. World Health Organization. Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003 [monograph on the Internet]. April 21, 2004 [cited 2006 Mar 11]. Available from: http://www.who.int/csr/sars/country/
table2004_04_21/en/index.html.
4. Mazzulli T, Kain K, Butany J. Severe acute respiratory syndrome: overview with an emphasis on the Toronto experience. *Arch Pathol Lab Med* 2004; 128: 1346–1350.

5. Loon SC, Teoh SC, Oon LL, Se-Thoe SY, Ling AE, Leo YS, Leong HN. The severe acute respiratory syndrome coronavirus in tears. *Br J Ophthalmol* 2004; 88: 861–863.

6. Eaton L. Doctors warn of potentially catastrophic flu pandemic in UK. *BMJ* 2005; 331 (7524): 1041.

7. Oxford JS. Influenza A pandemics of the 20th century with special reference to 1918: virology, pathology and epidemiology. *Rev Med Virol* 2000; 10: 119–133.

8. Kaiser J. Influenza: girding for disaster. Facing down pandemic flu, the world’s defences are weak. *Science* 2004; 306 (5695): 394–397.

9. Lee PJ, Krilov LR. When animal viruses attack: SARS and avian influenza. *Pediatr Ann* 2005; 34: 42–52.

10. Tegnell A, Wahren B, Elgh F. Smallpox—eradicated, but a growing terror threat. *Clin Microbiol Infect* 2002; 8: 504–509.

11. Gottsch JD. Surveillance and control of epidemic keratoconjunctivitis. *Trans Am Ophthalmol Soc* 1996; 94: 539–587.

12. Roy J, Lucille A. First do no harm: get your flu shot! *Iowa Med* 2004; 94: 7.

13. Centers for Disease Control and Prevention. Emergency Preparedness and Response, Bioterrorism Agents/Disease. November 19, 2004 [cited 2006 Mar 11]. Available from: http://www.bt.cdc.gov/agent/agentlist.asp.

14. Centers for Disease Control. Severe Acute Respiratory Syndrome, Supplement I: Infection Control in Healthcare, Home and Community Settings, III. Infection Control in Healthcare Facilities. January 8, 2004 [cited 2006 Mar 11]. Available from: http://www.cdc.gov/ncidod/sars/guidance/I/pdf/healthcare.pdf.

15. Freed HA, Milzman D, Freed M. Knowledge about the initial presentation of smallpox among emergency physicians in Washington, DC. *Acad Emerg Med* 2005; 12: 771–774.

16. Chow CB. Post-SARS infection control in the hospital and clinic. *Pediatr Respir Rev* 2004; 5: 280–295.

17. Derrick JL, Gomersall CD. Protecting healthcare staff from severe acute respira-