SARS: market, toilet, hospital, and laboratory

One year after the worldwide outbreak of the severe acute respiratory syndrome (SARS), inadequacies in our knowledge of this new disease, as well as in our compliance to measures for controlling the spread of the disease, still give us much cause to continue learning about issues of public health, infection control, and laboratory safety.

Neglect is widespread

The origin of the SARS-coronavirus (SARS-CoV) has not been pinpointed with certainty. Yet, there is circumstantial evidence that SARS is likely a zoonosis, and that the virus originated in wild mammals and crossed the species barrier to humans. The link between wild animals and humans might involve game animals that were kept and traded in wet markets in southern China. Surveillance of game animals in these markets showed that the civet cat (*Paguma larvata*) could be an important link.[1] Seroprevalence of antibodies to SARS-CoV is higher among traders of these game animals in Guangdong province than among control populations, including non–wild animal traders in the same markets and hospitalised patients suffering from non-respiratory diseases.[1] Further evidence suggesting a link between SARS and game animals came from four community-acquired cases of SARS in Guangdong province in January 2004, some of which had a definite history of contact with these animals.[2] Once the virus has infected a human, further mutations may confer it the ability to be transmitted from person-to-person with a high degree of efficiency.[3]

Severe acute respiratory syndrome is merely one of the examples of a zoonotic infection with epidemic or pandemic potential to have crossed the species barrier. Human immunodeficiency virus infection and avian influenza are two of the well-known examples in recent times. Predicting which, when, and where such zoonotic transmissions will occur is impossible, but certain principles might be helpful in reducing the risk of such an event. Firstly, and most importantly, is to minimise and avoid unnecessary contact between humans and wild animals. This precaution is virtually the only way to reduce the risk of transmission for previously unknown pathogens such as SARS-CoV. The preservation of the natural environment and habitats of wild animals is the ultimate target, and is not only crucial for conservation, but also for the prevention of incursion of humans into the natural ecosystem of infectious agents and the prevention of incursion of animals or vectors carrying pathogens into our immediate environment. Outbreaks of leptospirosis, borreliosis, rickettsiosis, and hantavirus infections are some examples of such interactions between human beings and the natural environment. The prevention of infectious diseases should be considered when one is planning new environmental projects. Yet, this aspect is most often neglected.[4]

Secondly, although the consumption of wild and sometimes endangered species of animals has no documented nutritional benefits to human health, it has been a cultural practice for thousands of years. In addition to detrimental effects on biodiversity, this practice provides a potential portal for the acquisition of exotic zoonoses. Such habits obviously cannot change overnight, but attempts were at least made to ban the consumption of game animals in southern China at the height of the SARS epidemic last year. Unfortunately, such a control measure was not insisted on, perhaps for political, economic, or cultural reasons. The ban was then lifted after only a few months. As a consequence, several cases of community-acquired SARS were reported in January 2004 in Guangdong province, in which individuals apparently contracted the infection after having contact with these animals—for example, in restaurants. Undesirable practice in culinary habits is a definite risk factor for some zoonoses, and deserves more attention than it is currently receiving.

Thirdly, the wet market has emerged as an important incubator of zoonotic infections that can be transmitted to humans via animals used as food. Prime examples are highly pathogenic avian influenza viruses—most notably, influenza A H5N1 viruses.[5] The importance of the wet market in allowing pathogenic viruses to circulate, multiply, and undergo genetic reassortment and mutation has been confirmed in Hong Kong since 1997. The implementation of a number of measures such as the introduction of rest days in markets have had a significant impact on the dynamics of the viruses in terms of reduction of the viral load in live poultry kept in the wet markets. This in turn may reduce the risk of transmission to humans. Whether the same dynamics apply to SARS-CoV is unknown, but the potential of the wet market in SARS-CoV transmission should never be ignored. Appropriate management of wet markets in which live animals are traded must be strictly observed—not only to prevent SARS and avian influenza, but also other, so far unknown infections.

Another setting that could act as an epicentre for the transmission of infectious agents is the hospital: when a patient with SARS or avian influenza is sick enough to be hospitalised, these infections can be spread readily to health professionals and other patients. Several nosocomial pathogens, most notably methicillin-resistant *Staphylococcus aureus* (MRSA) in Hong Kong, have already become endemic in our hospitals. Eradication of such endemic pathogens from the hospital is extremely difficult, if not impossible. Unlike MRSA, SARS-CoV is unlikely to become endemic in the hospital setting, but the nosocomial outbreak of SARS in many hospitals in 2003 was a painful reminder that rapid and extensive transmission could occur if there was just a small breach in hospital infection control measures. One year after the SARS outbreak, we are proud to declare that attitudes, policies, and practices regarding infection control have been improved in our hospitals. Hospitals in mainland China have also made similar claims. In the latest outbreak of SARS in Beijing in May 2004, however, there was epidemiological evidence that nosocomial transmission of SARS had occurred.[6] Had hospital infection control practices been strictly adhered to, such cases should not have arisen. Therefore, even at times when a communicable disease is no longer endemic in the community, hospital infection control must not be forgotten or relaxed.

There have been four clusters of cases (each ranging from one to nine patients) since the end of the SARS pandemic in June 2003. With the exception of the four community-acquired cases in January 2004 in Guangdong, all of the three other clusters had originated (or were likely to have originated) from laboratories. These cases were in countries and areas with a fairly high level of sophistication in terms of biomedical research; in some instances, state level laboratories were involved. In the very early stages of the outbreak in 2003, the WHO had already issued guidelines on laboratory biosafety issues. Compliance to official guidelines, however, has always been difficult to ensure. The index case of the recent outbreak in Beijing in April 2004 is a timely reminder to all SARS researchers that a small breach in laboratory biosafety is all that is required to start another outbreak of SARS in the community. Laboratory staff must remain vigilant at all times.

Foresight or overkill?

The route of transmission of SARS and the level of personal protection required in the hospital have been the topic of debate for some time. In its consensus on the epidemiology of SARS, the WHO concluded that "the primary mode of transmission appears to be direct mucous membrane (eyes, nose, and mouth) contact with infectious respiratory droplets and/or through exposure to fomites."[7] Epidemiological studies performed during nosocomial outbreaks of SARS have also suggested that droplet transmission is the most important mode of transmission, and that the adoption of simple infection control measures such as the wearing of surgical masks and proper handwashing are sufficient to prevent infection. Airborne transmission has repeatedly been negated.

Yet, there had been an outcry for the lack of personal protective equipment for health care workers in Hong Kong, at least in the early part of an outbreak. For their own protection, health care workers have often resorted to the use of N95 (or even N100) respirators, respirators with high-efficiency particulate air (HEPA) filters, and even powered air-purifying particulate respirators. Indeed, hospital infection control guidelines from the United States Centers for Disease Control and Prevention and the WHO also recommended the use of respirators for respiratory protection. Another area intensely debated was the ventilation system of hospitals. Considerable resources were invested into renovating existing ventilation systems, installing HEPA filters, and constructing negative-pressure isolation rooms. Although these engineering improvements are without doubt essential in a properly equipped hospital with isolation facilities, one cannot help but to ask whether they are essential specifically for SARS prevention. If SARS were indeed an infection transmitted by relatively large respiratory droplets rather than droplet nuclei (ie airborne transmission), then why should we ask for respiratory and negative pressure rooms, which are conventionally used only for airborne infections such as tuberculosis and measles? Does more personal protective equipment necessarily mean more protection? Are these measures an overkill?

If we believe SARS is purely a respiratory infection that is transmitted by large respiratory droplets, then all these protective measures against airborne transmission are definitely an overkill. However, a recent study jointly performed by researchers from two universities in Hong Kong showed that airborne transmission of SARS can indeed occur, at least in the setting of a community housing complex.[8] This mode of spread is hardly surprising, because SARS-CoV is shed in the secretions of symptomatic patients at fairly high quantities and the virus is much more resistant to adverse environmental conditions (such as desiccation) than were previously known human coronaviruses.[9,10] Both these properties enable the virus to survive in droplet nuclei in sufficient quantities and for sufficient time to be spread in the air. The control of SARS within hospitals, therefore, may at times need measures more than just the prevention of droplet formation, especially when there is significant aerosolisation from infected patients, such as during bronchoscopy, intubation, and suctioning of the airways.

KY Yuen, MD, FRCPath (e-mail: hkumicro@hkucc.hku.hk)
Department of Microbiology, The University of Hong Kong
Queen Mary Hospital, 102 Pokfulam Road, Hong Kong

References

1 Guan Y, Zheng BJ, He YQ, et al. Isolation and characterization of viruses related to the SARS coronavirus from animals in southern China. Science 2003;302:276-8.
2 Update 4 (27 January 2004): Review of probable and laboratory-confirmed SARS cases in southern China. WHO website: http://www.who.int/csr/don/2004_01_27/en/. Accessed 13 May 2004.
3 Guan Y, Peiris JS, Zheng B, et al. Molecular epidemiology of the novel coronavirus that causes severe acute respiratory syndrome. Lancet 2004;363:99-104.
4 von Schirnding Y. Health and sustainable development: can we rise to the challenge? Lancet 2002;360:632-7.
5 Webster RG. Wet markets: a continuing source of severe acute respiratory syndrome and influenza? Lancet 2004;363:234-6.
6 Update 5 (30 April 2004): China confirms SARS infection in another previously reported case; summary of cases to date-updates. WHO website: http://www.who.int/csr/don/2004_04_30/en/. Accessed 13 May 2004.
7 Consensus document on the epidemiology of severe acute respiratory syndrome (SARS). Geneva: World Health Organization; 2003.
8 Yu IT, Li Y, Wong TW, et al. Evidence of airborne transmission of the severe acute respiratory syndrome virus. N Engl J Med 2004;350:1731-9.
9 Rabenau HF, Cinatl J, Morgenstern B, Bauer G, Preiser W, Doerr HW. Stability and inactivation of SARS coronavirus. Med Microbiol Immunol (Berl). In press.
10 Duan SM, Zhao XS, Wen RF, et al. Stability of SARS coronavirus in human specimens and environment and its sensitivity to heating and UV irradiation. Biomed Environ Sci 2003;16:246-55.