Appendix 16A. The SARS epidemic: the control of infectious diseases and biological weapon threats

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I. Introduction

The rapid spread of severe acute respiratory syndrome (SARS) in early 2003 was perceived by a number of governments as a challenge to their national security because of its adverse impact on their economies, including their health care systems. The speed with which SARS spread also contributed to concern about the potential threat posed by biological weapons (BW) generally and the use of infectious disease as a method of warfare in particular. Such concerns had been heightened by the generally increased threat awareness and state of alert following the 11 September 2001 terrorist attacks in which hijacked aircraft were deliberately crashed into the New York World Trade Center and the Pentagon, and the subsequent distribution of letters filled with anthrax spores in the United States.[1]

The SARS epidemic is a useful case study for evaluating national and international capabilities to deal with disease outbreaks, both naturally occurring and deliberate. This appendix examines the course, the impact and the significance of the epidemic, including the lessons learned regarding the planning for and response to both naturally occurring and intentionally inflicted disease, and related implications for the 1972 Biological and Toxin Weapons Convention (BTWC).[2]

Section II of this appendix describes the emergence of SARS and the international fight against it, with particular reference to the role of the World Health Organization (WHO). Section III notes some unanswered questions about SARS, including the possibility of further outbreaks. Section IV discusses the broader problems and costs entailed by such epidemics and the general case for better preparedness against them. Section V identifies some lessons from the SARS episode which may be useful in this context, covering global cooperation, preparedness planning and public information policy. Section VI discusses the possible use of SARS and other infectious diseases as biological weapons and the relevance of the BTWC. Section VII contains the conclusions.

[1] As of Feb. 2004, no criminal charges had been brought for the anthrax attacks.

[2] The Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction is reproduced on the SIPRI Chemical and Biological Warfare Project Internet site at URL <http://projects.sipri.se/cbw/docs/bw-btwc-text.html>. Complete lists of parties and signatory and non-signatory states are available at the SIPRI CBW Project Internet site at URL <http://projects.sipri.se/cbw/docs/bw-btwc-mainpage.html>. See also annex A in this volume.

Table 16A.1. Cumulative number of probable cases of SARS, November 2002–July 2003[a]

Country	Cumulative number of cases	Number of deaths	Date of onset of the first probable case	Date of onset of the last probable case
Australia	6	0	26 Feb. 2003	1 Apr. 2003
Canada	251	43	23 Feb. 2003	12 June 2003
China	5 327	349	16 Nov. 2002	3 June 2003
Hong Kong	1 755	299	15 Feb. 2003	31 May 2003
Macao	1	0	5 May 2003	5 May 2003
Taiwan	346	37	25 Feb. 2003	15 June 2003
France	7	1	21 Mar. 2003	3 May 2003
Germany	9	0	9 Mar. 2003	6 May 2003
India	3	0	25 Apr. 2003	6 May 2003
Indonesia	2	0	6 Apr. 2003	17 Apr. 2003
Ireland	1	0	27 Feb. 2003	27 Feb. 2003
Italy	4	0	12 Mar. 2003	20 Apr. 2003
South Korea	3	0	25 Apr. 2003	10 May 2003
Kuwait	1	0	9 Apr. 2003	9 Apr. 2003
Malaysia	5	2	14 Mar. 2003	22 Apr. 2003
Mongolia	9	0	31 Mar. 2003	6 May 2003
New Zealand	1	0	20 Apr. 2003	20 Apr. 2003
Philippines	14	2	25 Feb. 2003	5 May 2003
Romania	1	0	19 Mar. 2003	19 Mar. 2003
Russia	1	0	5 May 2003	5 May 2003
Singapore	238	33	25 Feb. 2003	5 May 2003
South Africa	1	1	3 Apr. 2003	3 Apr. 2003
Spain	1	0	26 Mar. 2003	26 Mar. 2003
Sweden	5	0	28 Mar. 2003	23 Apr. 2003
Switzerland	1	0	9 Mar. 2003	9 Mar. 2003
Thailand	9	2	11 Mar. 2003	27 May 2003
UK	4	0	1 Mar. 2003	1 Apr. 2003
USA[b]	29	0	24 Feb. 2003	13 July 2003
Viet Nam	63	5	23 Feb. 2003	14 Apr. 2003
Total	**8 098**	**774**		

[a] Cumulative number of cases and deaths to 31 July 2003, the day that SARS was declared by the WHO as officially contained.

[b] Owing to differences in case definitions, the USA reported probable cases of SARS with onsets of illness after 5 July 2003.

Source: World Health Organization, 'Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003', URL <http://www.who.int/csr/sars/country/table 2003_09_23/en/>.

II. The emergence of a new disease

SARS is the first lethal, readily transmissible, new human disease to emerge in the 21st century. It is a febrile, severe lower respiratory illness that is characterized by high fever, cough and breathing difficulty and is caused by infection with a novel coronavirus.[3] Coronaviruses are named for their corona-like (halo) appearance in electron micrographs.[4] The SARS outbreak was a high-profile news item that instilled fear and panic among the general public and health care workers in Asia and elsewhere. The factors causing concern included the new and unfamiliar nature of the disease and the fact that the causative agent and its natural reservoir and mode(s) of transmission were not known—making it impossible at first to identify reliable containment methods, let alone a cure or vaccine. The rapid spread of the disease (along international travel routes) into other geographical regions of the world, coupled with its perceived high fatality rate (see table 16A.1), raised doubt that the international community could control and contain this and similar outbreaks in future.[5]

The first known SARS cases occurred in mid-November 2002 in Guangdong province in southern China. The disease spread to Hanoi, Viet Nam; Hong Kong, China; Singapore; and Toronto, Canada. These areas then became new focal points for the epidemic and contributed to the subsequent rapid rise in the number of cases.[6] It was in these areas that SARS became established in hospital settings. Hospital staff, unaware that a new disease had emerged and fighting to save the lives of patients, inadvertently exposed themselves to the infectious agent without barrier protection. In Taipei, up to 94 per cent of known SARS cases were transmitted in hospital settings.[7] It was reported that significant numbers of doctors and nurses either quit their jobs or refused to come to work for fear of becoming infected.[8] Some cases which occurred after the epidemic have been attributed to inadequate security precautions during laboratory work.[9] The initial outbreaks were also characterized by chains of secondary transmission outside the health care environment to people who were in contact with infected health care workers.[10] At the height of the spread of the epidemic, March 2003, the WHO regarded every country with an international airport, or bordering an area having recent cases of the disease, as presenting a potential risk.[11]

[3] Demmler, G. J. and Ligon B. L., 'Severe acute respiratory syndrome (SARS): a review of the history, epidemiology, prevention, and concerns for the future', *Seminars in Pediatric Infectious Diseases*, vol. 14, no. 3 (July 2003), pp. 240–44.

[4] Qin, E. *et al.*, 'A complete sequence and comparative analysis of a SARS-associated virus', *Chinese Science Bulletin*, vol. 48, no. 10 (May 2003), pp. 941–48, available at URL <http://www.scichina.com/ky0941.pdf>; and Spaan, W., Cavanagh, D. and Horzinek, M. C., 'Coronaviruses: structure and genome expression', *Journal of General Virology*, vol. 69 (Dec. 1998), pp. 2939–52.

[5] WHO, *Severe Acute Respiratory Syndrome (SARS): Status of the Outbreak and Lessons for the Immediate Future* (WHO: Geneva, 20 May 2003), available at URL <http://www.who.int/csr/media/SARS_wha.pdf>.

[6] WHO, *Consensus Document on the Epidemiology of Severe Acute Respiratory Syndrome (SARS)* (WHO: Geneva, 2003), WHO document no. WHO/CDS/CSR/GAR/2003.11, available at URL <http://www.who.int/csr/SARS/en/WHOconsensus.pdf>.

[7] McNeil, D., 'SARS fears spark walkout by health workers in Taiwan', *The Age* (Taipei), 22 May 2003, URL <http://www.theage.com.au/cgi-bin/common/popupPrintArticle.pl?path=/articles/2003/05/21/1053196639992.html>; and Canadian Broadcasting Corporation, 'Some Toronto nurses quit over SARS', 26 Apr. 2003, URL <http://www.cbc.ca/storyview/CBC/2003/04/26/sarsnurses_030426>.

[8] McNeil (note 7); and Canadian Broadcasting Corporation (note 7).

[9] Singapore Ministry of Health, 'Biosafety and SARS incident in Singapore September 2003: report of the review panel on new SARS case[s] and biosafety', URL <http://www.moh.gov.sg/SARS/pdf/Report_SARS_Biosafety.pdf>.

[10] Varia, M. *et al.*, 'Investigation of a nosocomial outbreak of severe acute respiratory syndrome: (SARS) in Toronto, Canada', *Canadian Medical Association Journal*, vol. 169, no. 4 (19 Aug. 2003), pp. 285–92, available at URL <http://www.cmaj.ca/pdfs/sars_july29.pdf>.

[11] WHO, 'Update 11—WHO recommends new measures to prevent travel-related spread of SARS', 27 Mar. 2003, URL <http://www.who.int/csr/SARS/archive/2003_03_27/en>.

Fighting SARS: the role of the WHO and other organizations

The WHO International Health Regulations provide the legal framework for global surveillance and reporting of infectious diseases and a mechanism by which measures to prevent the international spread of disease can be enforced. Possible further revisions of these regulations are being discussed at the WHO. WHO member states are currently obliged to notify the organization within 24 hours if a single suspected case of cholera, plague or yellow fever occurs in humans in their territories and to inform the WHO when an area is judged to be free from these diseases.[12]

The SARS outbreak provided clear evidence of the need for such regulations and highlighted examples of the areas where revision and updating of the current regulations are urgently needed. The novel nature of the SARS virus complicated efforts to contain the disease. Researchers had to identify and characterize the causative agent in order to be able to develop a diagnostic test, treatment protocols and a scientifically sound basis for recommending control measures

Stopping the spread of SARS by isolating infected individuals and those who had been in contact with them initially offered the only hope of containing and eliminating the virus.[13] Controlling people's movements and providing facilities and health care are difficult in any country, and this is especially true for economically disadvantaged countries. Isolating the victims of SARS and their contacts nevertheless provided the most effective means of control. The WHO information circulars and travel advisories also greatly assisted in the containment of the disease. This was especially true in the period immediately following the initial outbreaks, when there was a need for basic information about the virus.[14]

Verifying the cause of a disease is a necessary first step towards creating a vaccine and establishing and refining diagnostic methods and techniques. In experiments conducted at Erasmus University in Rotterdam, the Netherlands, scientists infected monkeys with the coronavirus that is suspected of causing SARS, and which was first isolated by Hong Kong University on 27 March 2003.[15] On 16 April, within a month of its establishment, the laboratory network announced conclusive identification of the SARS causative agent: a new coronavirus, unlike any other known human or animal virus in its family. The test animals developed the same symptoms of the disease as those developed by humans, and this confirmed the identity of the virus that causes SARS.[16] In May 2003, scientists released the first results of studies on the survival time of the SARS virus in different environmental settings and in various bodily specimens, including faeces, respiratory secretions and urine.[17] The results provided

[12] World Health Organization, 'Current International Health Regulations', URL <http://www.who.int/csr/ihr/current/en/>.

[13] Barbera, J. *et al.*, 'Large-scale quarantine following biological terrorism in the United States: scientific examination, logistic and legal limits, and possible consequences', *Journal of the American Medical Association* (JAMA), vol. 286, no. 21 (5 Dec. 2001), pp. 2711–17, available at URL <http://jama.ama-assn.org/cgi/reprint/286/21/2711.pdf>.

[14] WHO (note 5).

[15] WHO, 'Update 95—SARS: chronology of a serial killer', 4 July 2003, URL <http://www.who.int/csr/don/2003_07_04/en/>; and Rota, P. A. *et al.*, 'Characterization of a novel coronavirus associated with severe acute respiratory syndrome', *Science*, vol. 300, issue 5624 (30 May 2003), pp. 1394–99, available at URL <http://www.sciencemag.org/cgi/content/full/300/5624/1394>.

[16] Fouchier, R. A. *et al.*, 'Aetiology: Koch's postulates fulfilled for SARS virus', *Nature*, vol. 423, no. 6937 (15 May 2003), p. 240.

[17] WHO, 'First data on stability and resistance of SARS coronavirus compiled by members of WHO laboratory network', available at URL <http://www.who.int/csr/SARS/survival_2003_05_04/en/index.html>.

scientific guidance for devising recommendations on public health measures and shed light on why so many staff in sophisticated, well-equipped hospitals continued to become infected.

SARS is transmitted mainly by respiratory droplets during close face-to-face contact. Most cases of transmission can be traced to person-to-person contact. However, the sudden appearance of a large cluster of cases at a single housing estate in Hong Kong led to the realization that the virus could be transmitted in other ways.[18] In this case, transmission occurred when the virus became airborne as a result of being spread through a faulty drainage system. This proved that the infectious agent could survive for some time in the physical environment without a human or animal host. More studies are under way to understand the complex nature of the transmission of this virus.[19]

Scientists at Canada's British Columbia Cancer Agency's Genome Sciences Centre completed sequencing of the genome of the SARS virus in record time of one week on 12 April 2003.[20] This was a further aid to diagnosis, which had previously been done through a process of elimination. Speedy diagnosis was useful because it enabled patients suffering from SARS to be isolated more quickly. The genome map will assist in other ways, such as providing the basis for identifying possible mutations. A common feature of coronaviruses is that they tend to mutate more readily than other viruses.

Daily teleconferences of epidemiologists, including WHO team members, at the major outbreak sites led to refined case definitions, facilitated daily reporting, confirmed modes of transmission, tracked exported cases and greatly increased the understanding of the control measures that worked best in various country settings.[21] The WHO also sent teams of epidemiologists and other specialists to investigate environmental sources of infection and to confer with authorities about the conditions under which the initial cases of SARS might have emerged. The first international consultative meeting on the global epidemiology of SARS produced a consensus document on the status of current knowledge to guide firm policy recommendations for containment and control.[22] Participants in the network described the clinical course of SARS, compared experiences with different treatments, developed guidelines for isolation and infection control, and explored possible reasons for the spontaneous recovery of many patients and the rapid deterioration of others as well as for the very small number of paediatric cases.

[18] Manocha, S., Walley, K. R. and Russell, J. A., 'Severe acute respiratory distress syndrome (SARS): a critical care perspective', *Critical Care Medicine*, vol. 31, no. 11 (Nov. 2003), pp. 2684–92.

[19] US Department of Health and Human Services, *CDC Preparedness Planning for Severe Acute Respiratory Syndrome (SARS)*, Statement by James M. Hughes, Director of the National Center for Infectious Diseases (US Centers for Disease Control and Prevention), before the Permanent Subcommittee on Investigations of the US Senate's Committee on Governmental Affairs, 30 July 2003, URL <http://www.senate.gov/~govt-aff/_files/073003hughes.pdf>.

[20] Marra, M. A. *et al.*, 'The genome sequence of the SARS-associated coronavirus', *Science*, vol. 300, no. 5624 (30 May 2003) pp. 1399–404, available at URL <http://www.sciencemag.org/cgi/content/abstract/1085953v1>; and British Columbia Cancer Agency, 'Killer flu breakthrough: Genome Sciences Centre sequences SARS associated corona virus', Press Release, 14 Apr. 2003, URL <http://www.sciencedaily.com/releases/2003/04/030414090112.htm>.

[21] WHO (note 5).

[22] WHO (note 6).

III. Unanswered questions about SARS

Despite the progress and achievements described above, many questions about SARS remain.[23] The disease seemed to appear out of nowhere: a virulent virus that bears a striking resemblance to other pathogens in its class. Long after the WHO's declaration, on 5 July 2003, that the SARS epidemic was under control in the epidemic focal areas, there are still too many unknown details about SARS to confidently predict what will happen in future.[24] The principal unanswered questions are:

1. Where did the virus come from and will it return? Did it evolve independently and is it certain that it was not laboratory-derived? Experimentally, researchers have been able to cause the coronavirus to mutate and cross over to other species. In general, coronaviruses are very species-specific. However, the genome of the SARS virus differs significantly from those of the three known subfamilies of coronaviruses. Thus there is less basis to justify the argument that it has 'jumped species'. Is it likely then that it evolved separately?[25]
2. What, if any, would be the ideal choice of animal to be used for research into SARS? Coronaviruses are species-specific; identifying an animal model for SARS could therefore be difficult.[26] The two previously known human coronaviruses, which cause common colds, do not have appropriate animal models. The history of developing a vaccine for coronavirus disease in cats suggests that researchers need to proceed with caution. (In this case, the vaccine actually helped the virus to enter the host cells.) The risk of infection or re-exposure to the virus in future must not be inadvertently increased. Is the monkey model ideal in this case or not?
3. There is evidence that the virus has mutated since the onset of the outbreak; are the infections from mutated viruses more lethal?[27] If so, what additional steps are required to meet the threat?
4. Why are some SARS-infected individuals able to infect tens or hundreds of other people while others show much less propensity to transmit the virus?
5. Why is there such a small number of paediatric cases?

The pattern of any future SARS epidemic is impossible to predict. While some dangerous new infections experienced in the past no longer exist, others, such as the human immunodeficiency virus (HIV), have become endemic global disasters. Some experts suggested that, after the current SARS outbreak dies down, the virus could reappear with little or no warning, or it might follow a seasonal pattern, like influenza.

[23] US Department of Health and Human Services (note 19).

[24] Demmler and Ligon (note 3); and 'Special online collection: the SARS epidemic', *Science Magazine*, URL <http://www.sciencemag.org/feature/data/sars/index.shtml#genome>.

[25] Manocha, Walley and Russell (note 18).

[26] La Montagne *et al*., 'Severe acute respiratory syndrome: developing a research response', *Journal of Infectious Diseases*, vol. 189, no. 4 (15 Feb. 2004), pp. 634–41.

[27] Hu, L. D. *et al*., 'Mutation analysis of 20 SARS virus genome sequences: evidence for negative selection in replicase ORF1b and spike gene', *Acta Pharmacological Sinica*, vol. 24, no. 8 (Aug. 2003), pp. 741–45, available at URL <http://www.chinaphar.com/1671-4083/24/741.htm>.

IV. Counting the cost: the global challenge of SARS and other emerging diseases

The SARS epidemic is a reminder to the world of the challenges that emerging infectious diseases pose to health care systems, economies and overall security. While infectious diseases have traditionally been regarded as a medical issue, the actual threats posed by them in a rapidly changing global environment are no longer confined to the area of health risks. The disruption of business activities, travel and tourism (and hence economic growth and development) following the outbreak of SARS are among the serious potential repercussions that necessitate defining it and similar epidemics in broader, more strategic terms.[28]

Today the scale, speed and extent of the movement of people and goods are unprecedented. These movements, in turn, have shaped the appearance, spread and distribution of infectious diseases not only in humans, but also in animals.[29] The SARS case is instructive in this regard. There is speculation that the infectious pathogen may have come from an animal, such as a civet cat held in a food market, and that it then managed to cross into another species. In a densely populated area, where human and animal contact is very close, the transmission and spread of infection are much more rapid, while the effective containment of the disease becomes correspondingly more difficult. With the movement of people in and out of China and the ease of international air travel, it was not surprising that SARS spread to more than 31 countries in every region of the world in fewer than six months.[30] In a globalized world, no community can be entirely immune from emerging infectious diseases.[31]

SARS appeared to have been contained, at least temporarily, by the end of 2003. Thus far, it has not become a global epidemic in the way that HIV/acquired immune deficiency syndrome (AIDS) has,[32] but the economic losses associated with it may nevertheless be felt for a long time in many countries. The total monetary losses associated with SARS within the Asian economies are estimated to be approximately $10 billion,[33] while the Canadian losses are estimated at C$1 billion (*c.* $760 million).[34] The major effect on economies was due to the loss of revenues from tourism and, to a lesser extent, because of the extra spending in health care-giving institutions.

Similar cases of major economic damage—and of the way the costs can be aggravated by initial lack of transparency—are well documented in the cases of other infectious diseases, human and animal, originating both in developed and developing countries.[35] The HIV/AIDS pandemic continues and there is no clearly successful concerted international action to deal with it. A wide gap still exists between the

[28] Caballero-Anthony, M., Center for Strategic & International Studies (CSIS), 'Make SARS a security priority', *PacNet Newsletter*, 17 Apr. 2003, URL <http://www.csis.org/pacfor/pac0317.htm>.

[29] Butler, J. C. and Peters, C. J., 'Lessons learned from the hantaviruses and other hemorrhagic fever viruses', *American Journal of Medical Science*, vol. 311, no. 1 (Jan. 1996), pp. 55–59.

[30] WHO (note 6).

[31] WHO (note 11).

[32] WHO, 'Update 5—new case of laboratory-confirmed SARS in Guangdong, China', 31 Jan. 2004, URL <http://www.who.int/csr/don/2004_01_31/en/>.

[33] Fan, E. X., *SARS: Economic Impacts and Implications*, ERD Policy Brief no. 15 (Asian Development Bank: Manila, May 2003), available at URL <http://www.adb.org/Documents/EDRC/Policy_Briefs/PB015.pdf>.

[34] Ferley, P., 'Special report: the impact of SARS on the Canadian economy', Bank of Montreal Economic Research and Analysis, 29 Apr. 2003, URL <http://www.bmo.com/economic/special/sars.html>.

[35] WHO (note 6).

threat posed by HIV/AIDS and coordinated, effective international action. Within a few years of its identification in the 1980s, HIV/AIDS had spread to every continent and every country. So far, 25 million people have died of AIDS, and about 3 million people a year continue to die from the disease. This massive loss of human potential also involves the most economically productive segment of the population, altering the economic and social structures of the most affected countries.[36]

Serious economic damage and indirect impact on human security can also result from natural or deliberately engineered outbreaks of animal disease. A case in point was the foot-and-mouth disease (FMD) epidemic in the United Kingdom in 2001. Between the date on which FMD was confirmed to be present at an abattoir in Essex, on 20 February 2001, and its official eradication in September 2001, more than 6 million animals had been slaughtered. When FMD broke out, at least 57 premises had been infected before the initial analysis of the extent of the problem was made. All State Veterinary Service resources were fully utilized almost immediately. During the course of the outbreak, over 2500 temporary veterinary inspectors were appointed and an additional 700 foreign government veterinarians were temporarily seconded to assist in control and containment of the disease.[37]

More realistic scenario planning would have enabled the State Veterinary Service to better cope with the severity of the outbreak that it eventually faced, including how to expand measures to meet the challenge posed by the disease.[38] The outbreak had a devastating affect on the rural economy and the tourist industry of the UK. It is acknowledged that it was of an unprecedented nature and magnitude. The Treasury estimated that the net economic effect of the outbreak was about £2 billion (*c.* $3.7 billion).

These examples demonstrate that an improved ability by the world community to detect, control and rapidly end new disease outbreaks—of whatever origin—would bring economic as well as humanitarian rewards and would improve the conditions for welfare and development as well as for security in the broadest sense. The lessons of the achievements, and mistakes, made in connection with the SARS outbreak are discussed in the following section.

V. Lessons learned from the SARS outbreak

International communication and collaboration

In modern conditions, both the diagnosis and containment of a disease such as SARS can, in practice, only be controlled through wide-ranging (and preferably institutionalized) international cooperation. The free flow of relevant information, vigilance in

[36] Joint United Nations Programme on HIV/AIDS (UNAIDS) and the WHO, *AIDS Epidemic Update* (UNAIDS: Geneva, Dec. 2003), available at URL <http://www.unaids.org/wad/2003/press/Epiupdate2003_en/EpiUpdate2003_partI_en.pdf>.

[37] *The Veterinary Record*, vol. 150, no. 23 (8 July 2002).

[38] Committee of Inquiry on Foot-and-Mouth Disease, *The Report of the Committee of Inquiry on Foot-and-Mouth Disease 1967–68: Applicability of Recommendations During the 2001 Outbreak*, URL <http://www.defra.gov.uk/corporate/inquiries/lessons/fmdapplic.pdf>. The previous FMD epidemic in the UK began on 25 Oct. 1967. It peaked in Nov. 1967, with more than 400 new cases in a week, and then decreased till the first week of June 1968. At that date, there had been 2364 infected farms and 433 987 animals had been destroyed: 211 825 cattle, 113 766 pigs, 108 345 sheep and 51 goats. In comparison with the same period (32 weeks of epidemic) in 1967, the FMD crisis in 2001 shows a worse result: 9477 farms were infected and *c.* 4 200 000 animals were destroyed. MHR Group, 'Foot and mouth disease in UK: 1967–2001', URL <http://www.mhr-viandes.com/en/docu/docu/d9000119.htm>.

restricting travel, and isolating SARS patients and their contacts helped to contain the disease and prevented the spread to more countries. However, the spread of the SARS virus was difficult to stop, as was observed in Canada. This raised the possibility that the disease could become endemic if it spread to developing countries because of their inferior health care systems.[39]

When the first suspected SARS cases began to spread to additional countries from China in March 2003, many hospital staff cited WHO advisories[40] as a major reason for their awareness of the disease. This, in turn, was perhaps the main reason why cases were quickly detected and isolated. As a result, the further transmission of the virus was either avoided entirely or was kept low enough so that the number of additional cases was small. A second explanation offered for the comparatively mild and well-contained SARS outbreak in countries such as the USA was the heightened level of national planning and preparedness following the deliberate distribution of mail contaminated with anthrax spores in the US postal system in October 2001.[41]

The experience gained from the SARS epidemic has demonstrated that, with strong global leadership, scientific experts from around the world can work in an effective collaborative manner to identify and contain novel pathogens.[42] Such cooperation would be invaluable in the event of a deliberate release of a biological agent (see section VI below) or if a novel or poorly understood pathogen were to emerge in future. The WHO led an aggressive containment campaign that prevented SARS from becoming a widely established threat. The immediate scientific priorities included the development of a robust and reliable diagnostic test, improved understanding of the modes of transmission and identification of effective treatment regimes. The influenza network was used as a model for the SARS laboratory network, suggesting that such an approach contributes great speed as well as efficiency.[43]

Preparedness planning

The international response to SARS was largely guided by lessons learned during preparedness planning for a possible future influenza pandemic or for a possible bioterrorist attack. Both of these types of potential public health emergencies have, in turn, benefited from the lessons learned from the international response to SARS.[44]

The response to SARS has also highlighted a number of challenges for future preparedness planning. The SARS epidemic has shown that the effectiveness of global

[39] Brundtland, G. H., 'New global challenges: health and security from HIV to SARS', Speech given at the Geneva Centre for Security Policy, 18 July 2003, available at URL <http://www.who.int/dg/-brundtland/speeches/2003/genevasecuritypolicy/en/>.

[40] WHO (note 11).

[41] US General Accounting Office (GAO), *SARS Outbreak: Improvements to Public Health Capacity are Needed for Responding to Bioterrorism and Emerging Infectious Diseases*, Testimony Before the Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives, GAO-03-769T (US GAO: Washington, DC, 7 May 2003), available at URL <www.gao.gov/cgi-bin/getrpt?GAO-03-769T>.

[42] US Department of Health and Human Services (note 19).

[43] It is worth noting that scientific research involving SARS or other equally dangerous pathogens should be conducted with utmost care to avoid catastrophic accidents. Some SARS cases have also been the result of poor laboratory operating procedure. Singapore Ministry of Health (note 9); and Groneberg, D. A. *et al.*, 'Severe acute respiratory syndrome: global initiatives for disease diagnosis', *Quarterly Journal of Medicine*, vol. 96, no. 11 (Nov. 2003), pp. 845–52.

[44] US General Accounting Office (note 41).

alerts is greatly improved by electronic communications[45] and that improved global vigilance and awareness exist at all levels (from health professionals and national authorities to politicians and international travellers). A high state of alert existed (because of terrorism-related concerns) at the time of the SARS epidemic. This helps explain the speed with which developing countries were able to prepare their health services with response plans and launch SARS awareness campaigns, often with WHO support, to guard against imported cases.[46] Following the SARS epidemic, numerous reports recommended that the best strategy for fighting future epidemics would be to strengthen existing institutions by increasing their capacity to address such events and by the development of clearly defined roles (disease surveillance and monitoring, patient isolation and bio-containment, and travel and immigration controls)[47] during times of emergency. The importance of having a single coordinator (institution or individual) in charge of the whole operation was also stressed.[48]

Public information as a tool against emerging diseases

The SARS epidemic underlined the importance of open, immediate and accurate reporting on health issues as well as the responsibility of governments to allow such reporting. There were positive as well as negative examples during the epidemic in this regard. The experience of SARS in Viet Nam illustrated that immediate political commitment at the highest level can be decisive and that a developing country can effectively deal with a severe outbreak of a disease when reporting is prompt and open and the requested assistance is quickly and fully provided. The rapid detection of SARS cases in Viet Nam was followed by immediate isolation of those infected, the control of possible sources of infection and comprehensive tracking of the contacts of the infected individuals.[49]

In the context of information policy, there are striking parallels between the outbreak of SARS and the spread of radioactive fallout from the Chernobyl nuclear power plant accident in 1986. In both cases, the full implications for public health were first widely publicized outside the countries in which the initial events took place. In each case, the authorities in these countries (the Soviet Union in the case of Chernobyl, and China in the case of SARS) were accused of a cover-up because of their initial refusal to admit to the size and nature of the problems involved.[50]

The temptation to exert excessive control over information is not, however, confined to Communist countries. Given the fact that all countries have legitimate reasons to restrict certain information on security grounds, a key consideration in future regarding scientific research in the field of infectious and other diseases is whether and how information restrictions should be applied. Failure to communicate

[45] ProMED-mail—the Program for Monitoring Emerging Diseases and outbreaks of infectious diseases and toxins that affect human, animal and crop plant health—is an Internet-based reporting system dedicated to rapid and global dissemination of information about outbreaks of infectious diseases that affect human health. ProMED-mail uses electronic communication to provide up-to-date and reliable news on disease outbreaks around the world, 7 days a week. International Society for Infectious Diseases, 'ProMED-mail', URL <http://www.promedmail.org>.

[46] WHO (note 11).

[47] WHO (note 11); and WHO (note 6).

[48] WHO (note 6).

[49] WHO (note 6).

[50] Laurance, J., '"It could be China's Chernobyl": Beijing comes under increasing scrutiny as the virus crisis deepens', *The Guardian*, 22 Apr. 2003, available at URL <http://www.guardian.co.uk/editor/story/0,12900,940695,00.html>.

research results, for example, can hinder the effective dissemination of timely information that is designed to contain and control disease outbreaks. In general, no single country is currently capable of handling on its own a medical crisis involving an infectious disease outbreak.

It is widely acknowledged that openness has contributed directly to the relative success of Uganda in tackling AIDS.[51] On the one hand, widespread coverage in the media has raised public awareness about the nature of the disease and how to avoid becoming infected. On the other hand, the willingness of those working in the health professions to share their knowledge and experience with journalists has encouraged informed reporting, which, in turn, has strengthened the ability of individuals to take effective precautionary measures.[52] This is in contrast to the approach taken by some governments on the same subject where information to the public on the transmission of HIV/AIDS is confused or unclear.[53] Unfortunately, it follows that information on the control and prevention of the disease also becomes unclear in the process.

The lesson learned from the AIDS outbreak in Africa is that the mass media can be an important instrument of health policy. Countries whose governments provide the media with contradictory or incorrect information, as has been the case with AIDS in Africa, or which conceal information, as occurred at the beginning of the SARS epidemic, risk losing the battle against such diseases. Nonetheless, it remains common practice for many governments to consider that access to information by journalists, even in these areas, should be strictly controlled or managed.[54] Openness to the media and the public is not simply a question of issuing timely and informative press releases.[55] It is also a 'state of mind': namely, a willingness to accept that the risks of embarrassment are less than the potential risks of non-disclosure. In cases involving science and medicine, in particular, only a compelling reason should persuade governments to withhold information. Avoiding embarrassment, or attempting to allay 'unnecessary' public fears, is not such a reason.

Neither an effective national information policy nor good public health journalism would have prevented the SARS epidemic any more than they could have prevented the spread of HIV/AIDS. However, both cases have demonstrated that reliable information is an essential component in combating the spread of disease.[56] Such information helps to place responsibility for action where it is likely to be most effective: namely, on individuals rather than on governments.[57] Such measures will only be effective if they are based on sound knowledge. The information technology revolution has helped to ensure this by, in principle, making up-to-date scientific information directly available at virtually no cost and in real time.[58] Journalists and

[51] Lewicky, N. *et al.*, 'The Uganda HIV/AIDS youth communication campaign: preliminary evaluation results', Paper presented at the 124th Annual Meeting of the American Public Health Association, New York, Nov. 1996, pp. 17–21.

[52] Keller, S., 'Media contribute to better health', *Network*, vol. 17, no. 3 (spring 1997), available at URL <http://www.fhi.org/en/RH/Pubs/Network/v17_3/nt1739.htm>.

[53] Cherry, M., 'Mbeki disputes AIDS statistics', *Nature Medicine*, vol. 7, no. 11 (Nov. 2001), p. 1170.

[54] Reporters Without Borders, 'Reporters Without Borders publishes the first worldwide press freedom index (October 2002)', Oct. 2002, URL <http://www.rsf.org/article.php3?id_article=4116>.

[55] Ball-Rokeach, S. and Loges, W., 'Ally or adversary?: using media for systems for public health', *Prehospital Disaster Medicine*, vol. 15, no. 4 (Oct.–Dec. 2000), pp. 188–95.

[56] Keller (note 52).

[57] Barbera *et al*. (note 13).

[58] Widdowson, M.-A. *et al.*, 'Automated, laboratory-based system using the Internet for disease outbreak detection', *Emerging Infectious Diseases*, vol. 9, no. 9 (Sep. 2003), pp. 1046–52, available at URL <http://www.cdc.gov/ncidod/EID/vol9no9/02-0450.htm>. See also the ProMED Internet site at URL <http://www.promedmail.org>.

other health commentators cannot, however, be expected to interpret this information accurately on their own. They require access to scientists and medical specialists to assist them. They also need governments to encourage such specialists to be more open in their relations with the media. If the SARS epidemic has succeeded in impressing on the world the potential of the media as a tool for combating epidemics, this will have been a small blessing in an otherwise bleak situation.

VI. Lessons for countering the use of disease as a weapon: the role of the BTWC

Researchers, governmental organizations,[59] non-governmental organizations (NGOs) and other observers[60] have linked the SARS epidemic to biodefence issues, taking it as an opportunity to evaluate how well prepared the world is for a biological attack. Genuine concern was expressed whether SARS was a natural occurrence and whether it could be used as a 'weapon of terror'. Questions were raised whether the majority of countries could cope with possible future widespread epidemics.

The question of how precisely a biological weapon and its use could be identified so as to ensure international consensus is complex.[61] In principle, any disease whose causal component can be isolated, stored and disseminated could be used as a bioweapon, but the current diseases of concern differ in their suitability for this purpose. With the notable exception of AIDS, most new diseases that have emerged in the past two decades or so have become established in particular geographical areas and exhibit features that have limited their ability to pose a major, general global health threat. Many causative agents (e.g., avian influenza virus, Nipah virus, Hendra virus and hantavirus) have thus far failed to establish efficient human-to-human transmission. Diseases that have spread to new geographical areas, such as West Nile fever and Rift Valley fever, require a suitable vector that can readily cross natural boundaries, such as rivers, as part of the transmission cycle. Other diseases (e.g., *Neisseria meningitidis* Serogroup W135,[62] and the Ebola, Marburg and Crimean–Congo haemorrhagic fevers) have strong geographical foci for reasons that are currently poorly understood.[63] Although outbreaks of Ebola haemorrhagic fever have been associated with a case-to-fatality ratio ranging from 53 per cent (Uganda) to 88 per cent (the Democratic Republic of the Congo), a number of factors have limited the impact of such diseases. For example, person-to-person transmission requires close physical exposure to infected blood or other bodily fluids. Moreover, patients suffering from Ebola during the period of high infectivity are visibly very ill and too

[59] US General Accounting Office (note 41).

[60] WHO (note 5).

[61] See chapter 13 in this volume; and Dando, M., Pearson, G. and Kriz, B. (eds), *Scientific and Technical Means of Distinguishing Between Natural and Other Outbreaks of Disease* (Kluwer Academic Publishers: Dordrecht, Netherlands, 2001), pp. 93–104.

[62] Cases have been associated with pilgrims returning from the Haj. See Issack, M. I. and Ragavoodoo, C., 'Hajj-related *Neisseria meningitidis* Serogroup W135 in Mauritius', *Emerging Infectious Diseases*, vol. 8, no. 3 (Mar. 2002), available at URL <http://www.cdc.gov/ncidod/EID/vol8no3/01-0372.htm>; and Wilder-Smith, A. *et al.*, 'Persistence of W135 *Neisseria meningitidis* carriage in returning Hajj pilgrims: risk for early and late transmission to household contacts', *Emerging Infectious Diseases*, vol. 9, no. 1 (Jan. 2003), available at URL <http://www.cdc.gov/ncidod/EID/vol9no1/02-0131.htm>.

[63] Butler and Peters (note 29).

unwell to travel.[64] (It should also be noted that the ability of a disease to survive is lessened if it kills its host too quickly. Otherwise, there is a risk that the disease agent will not have sufficient time to spread to a new host, in which case the disease could, in principle, cease to exist.) Notwithstanding all these points, the utility of a number of the above-mentioned pathogens for use as biological weapons has been considered, including their possible use as part of crude, deliberate disease attacks by criminals or terrorist groups.[65]

SARS, for example, had a case fatality of 6 per cent in persons aged 25–44 years, 15 per cent in persons aged 45–64 years, and greater than 50 per cent in persons aged 65 years or older[66] and has been transmitted by individuals still healthy enough to travel or otherwise come into contact with others in society.[67] These characteristics make the SARS virus a more lethal agent and potentially more attractive to criminals or terrorists than many other infectious agents considered for biological warfare purposes. It was therefore not surprising that some commentators speculated that the disease could have originated from a biological warfare facility.[68]

The relevance of the BTWC

The hostile use of disease against humans, animals or plants is prohibited by the BTWC.[69] The regime for controlling biological weapons is currently undergoing an evolution necessitated by the weakness in the capacity of the BTWC to ensure compliance and by demands for acceptable regimes for verification.[70]

A number of researchers and governments have favoured linking the BTWC to specific measures for fighting infectious diseases and to the transfer of relevant technology and expertise to achieve this end. For example, a measure, which later became known as the Vaccines for Peace Programme, was proposed to counteract the threat of both deliberate and natural disease.[71] A second proposal was made to establish a global disease surveillance programme.[72] If institutionalized, these measures would have the capacity to lessen the threat posed by deliberate disease. Some international

[64] Arthur, R. R., 'Ebola in Africa—discoveries in the past decade', *Eurosurveillance Monthly*, vol. 7, no. 3 (Mar. 2002), pp. 33–36, available at URL <http://www.eurosurveillance.org/em/v07n03/0703-222.asp>.

[65] Kortepeter, M. G. and Parker, G. W., 'Potential biological weapons threats', *Emerging Infectious Diseases*, vol. 5, no. 4 (July/Aug. 1999), pp. 523–27, available at URL <http://www.cdc.gov/ncidod/EID/vol5no4/pdf/kortepeter.pdf>.

[66] Manocha, Walley and Russell (note 18); Dando, M., *The New Biological Weapons: Threat, Proliferation, and Control* (Lynne Rienner Publishers: London, 2001); and Geissler, E. (ed.), SIPRI, *Biological and Toxin Weapons Today* (Oxford University Press: Oxford, 1986).

[67] WHO (note 5).

[68] 'Rumours abound of link to bio-weapons', *Straits Times* (Singapore, Internet edn), undated, URL <http://straitstimes.asia1.com.sg/mnt/html/webspecial/sars/0205_24.html>.

[69] For an analysis of the history of the term 'use' under the BTWC see Zanders, J. P. and Eckstein, S., 'The prohibition of "use" under the BTWC: backgrounder on relevant developments during the negotiations, 1969–1972', Dec. 1996, URL <http://projects.sipri.se/cbw/research/btwc-use.pdf>.

[70] UN Department of Disarmament Affairs, Fifth Review Conference of the States Parties to the Convention on the Prohibition of the Development Production and Stockpiling of Bacteriological (Biological) and Toxins and Their Destruction, BTWC Review Conference document BWC/CONF.V/17, 2002, available at URL <http://www.opbw.org/rev_cons/5rc/docs/final_dec/BWC-CONF.V-17-(final_doc).pdf>.

[71] Geissler, E. and Woodall, J. P. (eds), *Control of Dual-Threat Agents: The Vaccines for Peace Programme*, SIPRI Chemical & Biological Warfare Studies no. 15 (Oxford University Press: Oxford, 1994).

[72] Wheelis, M., 'The role of epidemiology in strengthening the Biological Weapons Convention', eds E. Geissler and R. H. Haynes, *The Prevention of a Biological and Toxins Arms Race and the Responsibility of Scientists* (Akademie Verlag: Berlin, 1991), pp. 277–85.

institutions, such as the Office International des Epizooties (OIE), the United Nations (UN) Food and Agriculture Organization (FAO) and the WHO, are perceived as appropriate bodies for implementing such programmes. These measures would bring security benefits by reducing the impact of disease, so that deliberate use of disease would arguably have limited success.[73] More importantly, the selection of offensive biological materials for hostile purposes would be limited by the availability of vaccines and countermeasures.

While the BTWC is, in general, designed to prevent the transfer of BW materials and technology, its Article X encourages 'the fullest possible exchange of equipment, materials and scientific and technological information for the use of bacteriological (biological) agents and toxins for peaceful purposes'.[74] The spirit of this article underlines the need for state parties to cooperate in defeating disease by developing cures, vaccines and surveillance tools. Not only is this of benefit to developing states, but it is also the best guarantee of diminishing the threat posed by deliberate disease.

In 2004 the parties to the BTWC will hold expert and political meetings to consider 'enhancing international capabilities for responding to, investigating and mitigating the effects of cases of alleged use of biological or toxin weapons or suspicious outbreaks of disease; and strengthening and broadening national and international institutional efforts and existing mechanisms for the surveillance, detection, diagnosis and combating of infectious diseases affecting humans, animals and plants'.[75]

A global concern for the containment of infectious diseases through the provision of vaccine and surveillance tools should be just as important as a possible future protocol to the BTWC.[76] Thus a country which reported a rare disease occurrence would be reporting not just out of fear of retribution for the failure to make such a report, but also because it would be expecting to gain support to contain the outbreak.

The recent outbreaks of SARS and the continuing AIDS epidemic have demonstrated critical weaknesses in global public health infrastructure in the face of a threat from a novel pathogen.[77] The international community must continue to learn from the experience of natural outbreaks in order to improve early detection and effective response to emerging disease on a global basis. Minimizing the impact of disease, of natural or deliberate origin, will save countless lives as well as serve to deter bioterrorist acts.[78]

VII. Conclusions

Infectious diseases can be the source of serious security issues—whether these diseases are deliberately inflicted by biological warfare or occur naturally. In 2000 the UN Security Council declared AIDS an international security threat, and similar pol-

[73] Pearson, G. S., 'Deliberate disease: why biological warfare is a real concern', ISIS Briefing Paper no. 6, July 1996, URL <http://www.isis-europe.org/ftp/download/bp-6.pdf>.

[74] BTWC (note 2).

[75] See Hart, J., Kuhlau, F. and Simon, J., 'Chemical and biological weapon developments and arms control', *SIPRI Yearbook 2003: Armaments, Disarmament and International Security* (Oxford University Press: Oxford, 2003), pp. 646–50.

[76] Goosen, P., 'Statement by Peter Goosen, Chief Director: Peace and Security, Department of Foreign Affairs, Pretoria', Statement by the South African delegation to the Fifth Review Conference of the Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction, 19 Nov. 2001, Geneva, Switzerland, available at URL <http://www.opbw.org/rev_cons/5rc/docs/statements/5RC-OS-SAFRICA.pdf>.

[77] Prescott, E. M., 'SARS: a warning', *Survival*, vol. 45, no. 3 (2003), pp. 207–26.

[78] Dando, Pearson and Kriz (note 61), pp. 111–42.

itical endorsements were made at the meetings of the Group of Eight industrialized countries (G8) in Okinawa, Japan, and Genoa, Italy.[79] Despite these initiatives, however, AIDS, tuberculosis, malaria and now SARS are still perceived by many, if not most, countries as health or social problems, not as human security threats. When the USA first urged that HIV/AIDS be discussed in the Security Council,[80] many nations objected for procedural reasons, stating that the Security Council was not an appropriate forum for what was perceived as a health, social and economic issue.[81]

Unless the link between infectious diseases and human security is recognized, most countries will continue to 'medicalize' infectious diseases such as SARS rather than 'securitize'[82] them until the outbreak of the disease(s) reaches alarming proportions. The experience of sub-Saharan Africa with AIDS shows, however, that the socio-economic and political effects are more devastating than the effects of war.[83] Disease outbreaks should therefore be addressed with the same urgency and political will as are other serious security threats.[84] Going beyond the medical approach in securitizing infectious diseases must become a routine practice rather than an exception.

Once the security significance of diseases of this kind has been grasped, the next step must be to develop a strategy for prevention, containment and cure at both the national and international level. An effective approach would begin with the recognition that the threats of naturally occurring, highly infectious diseases and of the deliberate use of disease as a bio-weapon are closely related. Fortunately, the best way to deal with one threat is the same way to deal with the other—preparedness and planning. While many multinational efforts have focused on the response to biological warfare, the most effective response may result from improved capability to respond to naturally occurring outbreaks. It is for this reason that any new activities planned under the auspices of the BTWC should reflect the realities of infectious diseases as a more general threat to human security.

Understanding the immediate, specific risks and vulnerabilities posed by infectious diseases is just the tip of the iceberg.[85] There are underlying challenges that need to be addressed in order to cope with the threats of infectious diseases. These are the lack of basic health care and the poor health infrastructure prevalent in many developing countries. Poverty and infectious diseases reinforce each other. The risks of poverty-related diseases are compounded by malnutrition and environmental threats, especially the lack of clean water and sanitation. Together with crowded conditions and poor hygiene, these become perfect breeding grounds for infectious diseases.

Coping with infectious diseases requires a multifaceted approach that includes the establishment of an effective mechanism for global disease surveillance and control. A new, emerging infectious disease whose epidemiology and treatment are poorly understood demands the development of a basic database of biological information, and effective national and international coordination. This would necessitate a sub-

[79] UN Security Council Resolution 1308, 17 July 2000; and Ministry of Foreign Affairs of Japan, 'From Okinawa to Genoa: G8 action based on the decisions of Okinawa', July 2001, URL<http://www.mofa.go.jp/policy/economy/summit/2000/genoa.html#2>.

[80] 'Clinton administration declares AIDS a security threat', 30 Apr. 2000, CNN.com, URL <http://edition.cnn.com/2000/HEALTH/AIDS/04/30/aids.threat.03/#1>.

[81] Caballero-Anthony (note 28).

[82] Waever, O., 'Securitization and desecuritization', ed. R. D. Lipschutz, *On Security* (Columbia University Press: New York, 1995), p. 54.

[83] UN Food and Agriculture Organization, 'HIV/AIDS: a rural issue', URL <http://www.fao.org/FOCUS/E/aids/aids1-e.htm>.

[84] Prescott (note 77).

[85] Prescott (note 77).

stantial investment in financial and human resources, which are limited in developing countries. Such countries must rely on technologies that originated in the developed world. In addition, new regulations affecting intellectual property rights may in future make the transfer of technology between nations more difficult.[86]

There is a clear case for making technology transfer easier in order to modernize the health care systems of poor countries. Without such a change, it will be difficult to induce certain governments to act promptly and decisively. In the case of an infectious disease of security concern, less developed countries will need assistance from the international community to contain and control the disease outbreak. With such assured support, governments can be made accountable to both the local and international community.

The globalization of health risks also means that leadership must be exercised by the United Nations, with international support. Reducing health threats to security will require comprehensive cooperation among diverse actors and nations. Strengthening international public health care systems to adequately respond to and contain disease outbreaks is the best way to prepare for threats, regardless of their origin.

At the national level, more is required than official pronouncements characterizing a given disease as a national security issue. An integrated approach with the participation of various ministries, government agencies and the medical sector was an important step for several countries in coping with SARS. Singapore was the first country to legislate for use of multiple government agencies in the control and containment of SARS, and other countries, such as Indonesia, Malaysia and Thailand, followed suit.[87] Political and other national sensitivities should, at least in some cases, be re-evaluated. In particular, political embarrassment need not result from the perception that a government is unable to cope with a medical problem, nor should this be interpreted as a poor reflection of the state's scientific, technical and other capabilities. The timely release of relevant technical information should not be viewed as an admission of a state's shortcomings.

As regards the specific threat of deliberate disease use: the annual meetings of states parties to the BTWC may culminate in a stronger regime with substantive means to ensure compliance and, more importantly, one that is able to implement the 'spirit' of Article X. In 2004 the states parties to the BTWC will hold expert and political meetings on this issue.

Advanced technologies and international cooperation played significant roles in the efforts to contain the SARS epidemic and would have similar roles in an intentional attack with an infectious agent. The cooperation demonstrated by the countries which were affected by the SARS virus and the central role played by the WHO also underline the importance of international collaborative efforts in the context of response to the possible use of biological weapons.

[86] Wright, S. (ed.), *Biological Warfare and Disarmament: New Problems/New Perspectives* (Rowman & Littlefield Publishers, Inc.: Oxford, 2002), pp. 391–410.

[87] Khalik, S., 'Tough new laws get firm backing', *Straits Times* (Singapore, Internet edn), 26 Apr. 2003, URL <http://straitstimes.asia1.com.sg/mnt/html/webspecial/gallery/mktsars/story.html>.