Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Collateral damage: the unforeseen effects of emergency outbreak policies

Sue Lim, Tom Closson, Gillian Howard, and Michael Gardam

The 2003 outbreak of severe acute respiratory syndrome took the province of Ontario, Canada, by surprise. A lack of planning and the decentralised nature of the health-care system meant that disruptive control measures had to be put in place to control the outbreak. Several of the control strategies were difficult to implement and resulted in considerable confusion, fear, and costs. We discuss these difficulties and offer suggestions for improving outbreak planning.

Lancet Infect Dis 2004; **4:** 697–703

Little could one predict in November 2002 that early reports of an atypical pneumonia from Guangdong, China, would represent the start of the first international outbreak of the 21st century, known as severe acute respiratory syndrome (SARS). By March 2003, SARS had spread to several countries, including Canada. Toronto would later be recognised as the site of North America's largest outbreak of this disease.[1] It took 4 months of substantial control measures at the local, national, and international levels to contain the epidemic. In the end, SARS affected over 8000 patients in 29 countries, with 774 deaths worldwide. Toronto had 251 probable cases with 43 deaths.[2]

The province of Ontario was ill-prepared to deal with an infectious disease threat on such a scale.[3–5] In Canada, the provision of health care, including public health, is a provincial responsibility. However, the financial and operational responsibility for public health had increasingly been shifted to municipalities such that, at the time of the SARS outbreak, funding was shared equally between the two levels of government. This funding shift created a decentralised public-health system, with the province's 37 public-health units operating quite independently of each other.[3]

Ontario is the only Canadian province that does not have a regionalised health-care system so that each Ontario hospital functions semi-autonomously as a private not-for-profit organisation. Hospitals operate independently of public health, rehabilitation, and long-term-care facilities.

The role of pubic health had eroded in Ontario, and Canada in general, over the past two decades.[5] In a similar fashion, hospital infection-control programmes were also underfunded and poorly supported.[6] Under the Public Hospitals Act, Ontario hospitals are required to have an infection-control committee, but there is no specific requirement to educate staff on infection-control principles, the appropriate use of personal protective equipment, isolation techniques, and infection-control policies.[7]

When SARS first entered Toronto-area hospitals, management of the outbreak within the aforementioned health-care system required substantial intervention and centralisation. The government of Ontario declared a state of emergency on March 26, 2003, and gave the authority to manage the outbreak to an emergency management instrument, the Provincial Operations Centre (POC).[8] Plans and protocols in the form of government "directives" were developed and sent to all Ontario health-care facilities on a regular basis. A scientific advisory committee to the POC drafted directives relating to infectious-diseases control. These highly detailed protocols were meant to be implemented immediately upon receipt. Since SARS was a novel pathogen, and there was no preconceived blueprint to deal with an infectious-diseases outbreak of this magnitude, outbreak-management protocols were developed in "real time". This meant the protocols could not be widely disseminated for discussion before release, and potential problems were often not detected until attempts were made by facilities to put them into practice. Similarly, the directives also had to be issued before obtaining complete information. For example, early on in the SARS outbreak, neither the causative agent nor its mode of transmission were known, yet health-care workers had to be provided with detailed instructions on how to protect themselves and others.

The general strategies employed by the POC to manage the outbreak are shown in table 1. It has been suggested that many of the measures taken to interrupt the chain of infection were excessive.[9] However, it must be emphasised that the POC was faced with a yet-to-be-identified infectious threat, and decision making had to be made within the context of incomplete knowledge. Of note, control measures used were similar to those of other countries, and to those recommended by national and international bodies.[10–14]

Whereas, as a whole, these emergency decisions were successful in controlling the outbreak, they also created repercussions that may not have been apparent or considered when these outbreak-focused policies were

SL and MG are at the Infection Prevention and Control Unit, and TC and GH are senior administrators, University Health Network, Toronto, Ontario, Canada.

Correspondence: Dr Michael Gardam, Infection Prevention and Control, University Health Network, 200 Elizabeth St, ES3-428, Toronto, ON, M5G 2C4, Canada. Tel +1 416 340 3758; fax +1 416 340 5047; email michael.gardam@uhn.on.ca

Table 1. General strategies used to contain the SARS outbreak

Intervention	Description
Universal barrier precautions and personal protective equipment	Submicron filtering mask (N95 required later in the outbreak), gown, gloves, and eye protection (required later in outbreak) for all patient contact.
	Submicron filtering masks in all areas of the hospital (early on in outbreak).
	Requirement for N95 mask use and staff quantitative fit testing later in the outbreak
Limited entry and movement	Entry to hospital limited to "essential personnel" only.
	All elective inpatients and outpatients cancelled.
	Visitors only allowed for critically ill.
	Students and volunteers not allowed.
	Provincial authorisation required for inter-hospital patient transfers. Transfers typically not approved unless urgent or emergent care required and level of care not available at transferring hospital.
	Staff not allowed to work at different hospitals; casual or part-time staff had to chose one hospital to work at.
Surveillance	Fever, history of contact with possible or probable cases, and symptom surveillance on entry into the facility.
	Patient fever, history of case contact, and symptom surveillance on admission
Patient (case) isolation	Negative pressure rooms for all possible and probable SARS cases.
	Creation of specialised facilities for SARS patients (clinics and hospitals).
	Work quarantine ordered for health-care staff at some facilities affected by widespread SARS transmission.
Public education	Daily updates provided by the POC aided by public health and academics
Contact tracing/quarantine	Home quarantine ordered for 23 103 contacts of SARS cases. Monitoring done by public health.

initially developed. The intent of the following discussion is to describe the implications of certain rapid policy decisions to provide a balanced perspective to decision makers faced with similar situations in the future. It is not meant to criticise these decisions, since all decisions have repercussions and emergencies require a rapid response. Possible solutions and considerations for the management of future outbreaks are outlined in table 2.

Lack of supplies

The decision to require gowns, gloves, masks, and eye protection for all patient contact seemed a reasonable approach early on in the outbreak. SARS symptoms were non-specific, case definitions were hampered by limited understanding of epidemiological links and the lack of a confirmatory test, and the mode of transmission had not yet been determined. The financial impact of providing this isolation equipment was considerable. During the first 8 weeks of the outbreak, the University Health Network spent over Canadian $3 million on isolation equipment alone.[15]

However, health-care facilities did not have immediate access to the required supplies. In particular, submicron-filtering masks (eg, N95 masks) were in variable supply, because before SARS such masks were used only for patients with airborne infections and hence most facilities would have only kept a limited supply. With 211 hospitals in Ontario alone requiring these supplies, Canadian suppliers rapidly ran out of stock. There was no pre-existing supply stockpile, and our mask supplies were obtained from foreign manufacturers. Because SARS was a worldwide threat, there was great difficulty in acquiring masks from other countries, since foreign governments understandably wanted to keep such supplies for their own citizens.

The inability to obtain the masks specified in the government directives led to considerable staff alarm and raised the question whether staff should be allowed to see patients if they could not be provided the appropriate mask. To follow this path meant that for the majority of the outbreak, most staff would not have been allowed to provide patient care. In our hospital, staff were repeatedly educated regarding the limited role of N95 masks in a predominantly droplet-transmitted disease.

Had there been a pre-existing stockpile of isolation equipment and a secure supply chain from a Canadian supplier, this tense situation could have been partially averted. Following the SARS outbreak, our hospital and others, as well as the Ontario and federal governments, have begun this process. At the University Health Network, we now have 2 weeks worth of isolation equipment on site, in addition to our regular supply. Whereas this supply would not last for a prolonged outbreak, it would provide some leeway while awaiting supplies.

Use of personal protective equipment

Several weeks into the outbreak, the US Centers for Disease Control and Prevention (CDC) were asked to investigate patient-to-staff transmissions that occurred during a difficult and prolonged intubation of a SARS patient in a Toronto hospital intensive care unit.[16] The investigators noted that none of the staff had been fit tested and hypothesised that aerosolised, airborne virus may have breached the edges of improperly-fitting masks. Transmission as a result of self-contamination could not be ruled out.

Concerns that improperly fitted masks may have contributed to a nosocomial cluster led the POC to issue a province-wide requirement for N95 mask-it testing.[17] Fit testing had never been required in the Canadian health-care setting, and thus facilities lacked properly trained personnel to do this task. Other issues included men wearing beards for cultural or religious reasons who would not shave to pass fit testing; health-care workers who developed allergic reactions to masks; and the mistaken belief from some staff that, once alternate protective devices such as positive airway pressure

respirator (PAPR) hoods were offered for those with beards and allergic reactions, that N95 masks were inferior.

The requirement for fit testing implied that SARS transmission was often airborne, which increased the concerns of frontline nursing staff who called for enhanced enforcement of fit testing and respirators with high filtration efficiency.[18,19] By focusing on airborne transmission rather than the far more common contact and droplet routes of SARS transmission, there was a concern that staff might ignore important control measures such as hand washing and avoiding self-contamination, and actually increase their risk of acquiring infection.

Any strategy that required use of personal protective equipment also required that staff were well versed in its use. In fact, inappropriate and/or non-compliant use of isolation equipment was often cited as a reason for nosocomial transmission of SARS in Ontario[20–22] and elsewhere.[21,23,24] In our experience, non-compliance worsened once the use of N95 masks was enforced because these masks were uncomfortable to wear for prolonged periods.

Before SARS, personal protective equipment had typically been used for patients isolated for multidrug-resistant organisms, and occasionally for airborne or droplet-transmitted diseases. Our infection-control staff had observed, before SARS, that frontline staff had become complacent with isolation protocols, believing that these precautions were meant to prevent patient-to-patient transmission rather than to protect the health-care worker. Despite substantial educational efforts during the outbreak, misuse of equipment remained fairly common on wards other than the SARS unit.

As a result of misuse, there was a concern that universal barrier precautions could paradoxically increase the risk of disease transmission. Although there is no doubt that universal barrier precautions are a key strategy in the prevention of nosocomial infections, the issue at hand is one of human behaviour during a frightening outbreak. Having donned gowns and gloves, frightened staff would be reluctant to remove them between patients, and hand washing between patients might decrease. There is no evidence that SARS was transmitted by this behaviour, but there is indirect evidence derived from measurements of nosocomial methicillin-resistant *Staphylococcus aureus* (MRSA) transmission that this could occur. During the period of universal barrier precautions, the rate of hospital-acquired MRSA was unchanged or increased compared with the pre-SARS and post-SARS periods in four Toronto hospitals that all treated SARS inpatients (unpublished observation). Conventional wisdom would have predicted a decrease in hospital-acquired MRSA during this period.

The solution to inappropriate use of barrier precautions is staff education. Following the SARS outbreak, the Ontario Ministry of Health and Long-Term Care (MOHLTC) required the hospitals to develop education programmes in infection-control fundamentals. Most hospitals are planning yearly refresher courses. Ontario hospitals continue to require fit testing of all employees.

Limited entry

The rationale for this strategy was simply to prevent community spread of SARS by limiting all but essential staff, critically ill patients, and their visitors from entering health-care facilities (figure 1). Similarly, inter-facility transmission was controlled through prohibiting movement between institutions.

Access to health care

Obviously, the most serious implication of the limited-entry strategy was to deny or delay patient access to medical care for several months. Although the long-term impact of this

Table 2. Major outbreak issues and possible solutions

Issues	Lessons learned/possible solutions
Lack of supplies	Develop pre-existing stockpiles of personal protective equipment. Secure supply chain
Use of personal protective equipment	
Inappropriate use	Mandated infection control education about routine precautions and modes of disease transmission; mandatory refresher courses. Testing of staff to assess knowledge retention.
Fit testing of N95 masks	Train staff for fit testing—fit testing is a mandatory condition of employment.
Contraindicated use–ie, allergy to materials	Obtain alternative supplies for those who cannot use standard personal protective equipment
Limited entry	
Patient access to health care	Regional prioritisation of health-care programmes to allow for undisturbed continuity of patient care.
Hospitalised patients and staff	Human resources policies that outline employee obligations during emergencies, including obligations of physicians.
Students & researchers	University level policies related to student attendance and expectations during external disasters. Separate clinical and research staff and physical space within hospital
Remuneration	
Revenue	Contingency planning to compensate hospital at regional, provincial, national level as appropriate for extent of outbreak.
Physicians	Pre-negotiated agreements about remuneration in specified circumstances
Surveillance	Education of target population about symptoms and the importance of compliance. Anonymous/non-punitive reporting of ill co-workers.
Communications/public education	Within hospital: designate single spokesperson; pre-existing outbreak communication protocol. External working groups: creation of communications committee to specifically address messaging during outbreaks. Avoid multiple spokespersons.
Contact tracing and quarantine: compliance	Financial incentives/compensation for compliance and completion of quarantine

Figure 1. Due to limited space within the facility, temporary tents used for staff screening were set up at the entrance of the Toronto Western hospital.

decision on population health is still undetermined, it is conceivable that this delay could have had a large impact on individual outcomes. For example, in the greater Toronto area for the month of April, 2003, the mean number of patients awaiting cardiac surgery increased 15%, the number of cases completed decreased 40%, and cancelled cases increased 254%.[25]

A possible future solution to this problem would be to prioritise which health programmes need to continue, and which can be delayed. This planning needs to be done at a regional level rather than relying on each hospital to make its own choices. It is instructive to note that following the outbreak, the MOHLTC has embarked upon the formation of local health integration networks, which will, in part, aid in future planning for similar emergencies. These networks will oversee the implementation of acute and chronic care, as well as public-health services for the region.

Hospitalised patients and staff

All Ontario health-care facilities, but especially long-term care institutions, paediatric hospitals, and rehabilitation facilities, rely heavily on visitors and volunteers to provide hands-on care, such as assistance with feeding, as well as companionship and emotional support. In most circumstances, these roles had to be filled by "non-essential" hospital employees who had been redeployed. Attempts at redeployment to temporary outbreak-specific roles such as this or for surveillance seemed a logical use of resources but occasionally proved difficult to accomplish. Redeployment was sometimes viewed as putting untrained staff "in harm's way". Non-clinical staff often felt uncomfortable making decisions outside their usual work environment. With respect to unionised nursing staff, procedures for redeployment of staff in emergency situations were not contemplated in collective agreements at that time.

Staff movement between facilities had an impact on hospitals' abilities to provide service. Up to 40% of nursing staff at our institution were either casual or part time, and typically worked shifts at several hospitals. During the outbreak, these nurses had to choose one facility to work at, thus foregoing part of their income. This situation created a conflict between obeying public-health orders and protecting one's income.[26] This situation was resolved after the outbreak was declared over by the passing of legislation that allowed eligible health-care workers to retroactively claim unemployment insurance benefits if they were excluded from the workplace during the SARS outbreak.[27]

A solution to the described staffing issues lies in the development of human resources policies that clearly spell out the obligations of employees in the time of an emergency. It is crucial to recognise the important roles of volunteers and visitors in patient care since hospitals cannot do without these services.

Emergency planning at the MOHLTC now includes a committee specifically dedicated to these human resource issues.

Students and researchers

Medical and other allied health-care students were excluded from hospitals during the outbreak out of concern for their safety.[28] Thus, medical students were unable to complete part of their training, yet could not make up the lost time given the rigid schedules of school and subsequent residency training.[29,30] Senior students were unavailable to provide patient care, putting a greater load on hospital staff. In the end, affected students were allowed to graduate. In the future, we suggest universities consider the possibility of disrupted training due to external disasters and develop contingency plans.

Researchers were considered "non-essential" staff and thus were required to not enter hospitals. The impact of this restriction on academic progress, related to missed deadlines and submission for funding grants, competition for first publication of similar work, spoiled time-sensitive experiments, etc, is difficult to estimate. At our institution, allowances were made for researchers who had important deadlines and could not work from home. Similar allowances had to be made for staff who cared for research animals.

An argument can be made, given this experience, that the common practice of combining clinical and research space in the same building should be reconsidered, so that in the event of an external disaster, research activities would be less disrupted.

Revenue

Volume-funded programmes that are remunerated on a per caput basis by the Ministry of Health saw a dramatic decrease in revenue. Other revenue sources such as parking lots, retail space, and office space rentals also experienced a decrease. Overall, it is estimated that limiting entry during the first 8 weeks of the outbreak cost the University Health Network $4·7 million, largely because staff were paid yet no care was provided.[15] After the outbreak was over, Ontario

hospitals were compensated by the MOHLTC for losses incurred by MOHLTC-funded programmes, whereas retail and other non-MOHTLC income was lost.

Physicians

Because almost all Ontario physicians are remunerated by the MOHLTC on a fee-for-service basis, most were greatly affected by limiting patient access to health care. An agreement was reached during the outbreak whereby physicians were forwarded 80% of their projected earnings. This agreement allowed continued cash flow and likely improved physician compliance with the patient-volume restrictions. Unlike hospital employees who were paid whether or not they worked during the outbreak, physicians were expected to make up their lost billings: if they did not, the difference in revenue was reclaimed by the MOHLTC.

Non-salaried physicians are considered self-employed and hence, are not eligible for government disability insurance should they develop a work-related injury such as SARS. As self-employed workers, it is also very difficult for hospitals to direct their practice: the reassignment of physicians to SARS units for example, was reliant on physician goodwill.

Physicians have unique relations with the health-care system, and future planning must take this into account. The issue of physician remuneration created considerable concern, which could have been avoided with pre-negotiated agreements. Similarly, the inability of hospitals to assign physicians to certain roles in the event of an emergency could have been considered as a condition of granting hospital privileges.

Surveillance

Temperature and symptom surveillance was instituted at hospital entrances with the intent of detecting SARS cases before entry and thus stopping transmission (figure 2). Although surveillance was necessary, it had limitations. We found that it was not uncommon for individuals to be dishonest about symptoms: at least two individuals passed through screening to subsequently be reported as ill by their co-workers. In one of these cases, the ill individual had SARS and required prolonged hospitalisation. The reliability of tympanic temperature measurements during a cold spring season was believed to be poor. Finally, screening for epidemiological links is, by nature, reactive; one cannot do surveillance for exposure to outbreaks in other hospitals before those outbreaks have been identified.

The surveillance programme resulted in the formation of tightly bunched queues at entrances during times of high traffic. It was not unusual to wait 20 minutes or more with other health-care workers, some of whom worked directly with SARS patients. This queuing occurred despite the hospital hiring 160 additional staff to aid with front-door surveillance. Although there is no evidence that queuing resulted in SARS transmission, it is conceivable that it could facilitate the spread of airborne or droplet-transmitted diseases.

There is no obvious solution to the aforementioned limitations in surveillance besides ongoing education of those involved. It is important to recognise that while these limitations exist, surveillance has an important part to play in outbreak management.

Patient (case) isolation

Ontario isolation protocols,[31] and those from other jurisdictions[12,32,33] required that SARS patients be cared for in negative-pressure rooms. During the first wave of the Toronto outbreak, hospitals with greater than 500 beds were required to provide a 30-bed negative-pressure isolation unit.[34] Most, if not all, Ontario hospitals were ill-prepared for such a requirement. Other hospitals were required to open SARS assessment clinics, which were to be rapidly operational. Issues of adequate staffing, personal protective equipment, and proper construction were left to the individual hospitals to resolve. Hospitals dealt with the isolation requirement in different ways: some installed temporary facilities using HEPA filtration units, whereas others elected to construct permanent banks of rooms with dedicated ventilation systems. Some facilities that have constructed permanent facilities have expressed concern that they now may be considered natural candidates to have a leading role in a future infectious disease epidemic, a role they do not wish to fill.

Figure 2. A hospital employee undergoing SARS screening at the Toronto General Hospital entrance.

A new strategy employing four SARS isolation hospitals was attempted during the second wave of the Toronto outbreak.[35] The rationale for this strategy was to help protect the capacity of the health-care system by providing specialised units with dedicated staff, resources, and supplies. The SARS hospitals were to be the first to receive supplies and were to have special funding agreements for staff. Although the bulk of the SARS cases during the second wave were indeed cared for in these hospitals, this was largely a result of prior nosocomial transmission resulting in a large number of SARS inpatients within two of these hospitals, rather than subsequent transfers from non-SARS hospitals.

Many hospitals continued to care for SARS patients and argued that they too should be a high priority for supplies and special funding. The original plan called for increased pay for staff willing to work in the SARS hospitals; however, in the case of unionised nursing staff, this plan was rejected by the nurses' union and to date remains unresolved.

It is unclear what role the use of dedicated SARS hospitals had on the termination of the outbreak due to the fact that the outbreak ended quickly. Although the consolidation of SARS cases may have allowed other hospitals to resume services, it is also well recognised that infections tend to transmit before they have been identified, hence their impact on affecting the chain of transmission may be limited. Regardless, if this strategy is to be employed in future outbreaks, these issues discussed must be adequately addressed beforehand.

Public education

The public was kept informed through daily press conferences involving the POC leadership, public health officials, and often academic infectious disease or microbiology experts. There was no one spokesperson; rather, each person at the press conferences spoke freely. The academic experts were typically directly involved in the epidemiological investigation, controlling the outbreak, and in some cases, treating patients. Although while in the press conferences, the experts were probably viewed as speaking on behalf of the Ministry of Health, they would also be interviewed by the media at other times in their university or hospital setting. This practice led to confusion because the public received mixed messages, and it has been suggested that the WHO advisory against travelling to Toronto was partly as a result of inconsistent messaging.[36,37]

Similar to the creation of a specific human-resources committee to address outbreak-related concerns, the MOHLTC has paid considerable attention to communications issues in future planning. Emergencies are typically difficult times to effectively communicate to a frightened public; however, it is during such events that communication is the most critical.

Contact tracing and quarantine

Analytical models assessing the effectiveness of infection-control measures have suggested that SARS coronavirus is not highly contagious, but rather could be contained through basic public-health measures in keeping with other droplet-transmitted diseases.[38,39] SARS primarily spread in Toronto when the virus had not yet been recognised.[40] It has been calculated that for every case of SARS, health authorities should expect to quarantine up to 100 contacts of the patients and to investigate eight possible cases,[40] a huge undertaking given the 225 confirmed cases of SARS in Toronto alone. In the end, Toronto Public Health identified 23 103 contacts of SARS patients requiring quarantine, with a maximum of 6995 people meeting this definition at a single point at the height of the outbreak.[40] This number of quarantined individuals, representing almost 1% of the population of the city of Toronto, had not been experienced for decades, if ever, in the history of the city.

The decision to quarantine cannot be made lightly. One study demonstrated a high prevalence of psychological distress, with symptoms suggestive of post-traumatic stress disorder and depression occurring in about 30% of quarantined individuals.[41] Ironically, although this high psychosocial cost was incurred, it is estimated that only 58% of those placed in quarantine actually complied with the order.[40] In the Taiwan SARS outbreak, public-health authorities recognised that for people to forgo their freedom for the common good, economic compensation was required in the name of fairness. Needless to say, this decision provided incentive to comply with quarantine requests as well.[42] As with health-care workers who were prevented from working as a result of SARS, the Ontario government retroactively enabled quarantined individuals to have access to benefits.[28]

It is beyond the scope of this paper to discuss the effectiveness of quarantine in controlling SARS. In general, however, quarantine will be most effective in situations involving highly infectious diseases where those quarantined are compliant. Although public-health officials once posted quarantine notices to ensure compliance, this is no longer done out of privacy concerns. Furthermore, modern society has become unaccustomed to the concept of quarantine. In future outbreaks, public health programmes should consider developing incentives such as those that were used in Taiwan to improve compliance.

Conclusion

Similar to the experience in other parts of the world, the Toronto SARS outbreak caught the Ontario health-care system unaware. Ontario did not have a preconceived plan to deal with a large infectious disease outbreak such as pandemic influenza, let alone a new, unknown pathogen. This lack of a plan, combined with prolonged neglect of public-health and infection-control programmes and a decentralised health-care system meant that extraordinary measures had to be applied to control the outbreak.[43] It has been estimated that the total cost of the SARS outbreak to the Toronto-area economy was over $1 billion.[44] To the credit of those involved, extraordinary measures were quickly devised and disseminated, and the outbreak was contained.

We have discussed the key points learned from our experience as well as suggested possible solutions. First and foremost, many of the downstream challenges discussed in

this paper such as supply chain and human resource issues could have been at least partly prevented through planning. By contrast, other downstream effects that occurred as a result of substantial deficiencies in the health-care system could not have been averted by planning alone.

In addition to changes to provincial planning, the SARS experience has brought about many positive changes in Ontario hospitals. It has conditioned health-care workers to demand that their safety be given a high priority and hospitals are responding to this demand through improved education programmes, staff surveillance, and training. Infection control and occupational-health programmes have received a considerable boost in recognition and funding.

The management of future Canadian outbreaks will inevitably be compared to Toronto's battle with SARS in the spring of 2003. We now face the difficult challenge of educating the public and health-care workers that the scale of the SARS response was atypical and may not be appropriate for the management of future outbreaks.

Given the post-SARS introspection and planning that is now occurring, the public will expect that future outbreaks be well managed with as little disruption to the health-care system as possible. There will be no tolerance for repeating the same mistakes. It is only by learning from the past that we can successfully achieve this for the future.

Conflicts of interest

We declare that we have no conflicts of interest.

References

1 Health Canada. Summary of severe acute respiratory syndrome (SARS) cases: Canada and international. 2003. http://www.hc-sc.gc.ca/pphb-dgspsp/sars-sras/eu-ae/sars20030623_e.html (accessed July 7, 2004).

2 World Health Organization. Summary of probable SARS cases with onset of illness from 1 November 2002 to 31 July 2003. 2004. http://www.who.int/csr/sars/county/table2004_04_21/en/ (accessed July 7, 2004).

3 Campbell AR. The SARS commission interim report. SARS and public health in Ontario. Toronto, Ontario: Government of Ontario, 2004.

4 Walker DH. For the public's health. Initial report of the Ontario expert panel on SARS and infectious disease control. Toronto, Ontario: Ontario Ministry of Health and Long Term Care, 2003.

5 Naylor CD. Learning from SARS. Renewal of public health in Canada. Ottawa, Ontario: Health Canada, 2003.

6 Zoutman DF, Byce E, Gourdeau M, Hebert G, Henderson E, Paton S. The state of infection surveillance and control in Canadian acute care hospitals. *Am J Infect Control* 2003;**31:** 266–73.

7 Public Hospitals Act. Toronto: Government of Ontario, 1990.

8 Ontario Ministry of Health and Long Term Care. Ontario heightens response to SARS. http://ogov.newswire.ca/ontario/GOPE/2003/03/26/c4478.html?Imatch=&lang=_e.html (accessed July 7, 2004).

9 Schabas R. SARS: prudence, not panic. *CMAJ* 2003; **168:** 1432–34.

10 Peiris JS, Yuen KY, Osterhaus AD, Stohr K. The severe acute respiratory syndrome. *N Engl J Med* 2003; **349:** 2431–41.

11 Public health guidance for community-level preparedness and response to severe acute respiratory syndrome. Supplement C: Preparedness and response in healthcare facilities. IV. Recommended preparedness and response activities in healthcare facilities. http://www.cdc.gov/ncidod/sars.guidance/C/recommended.htm (accessed July 7, 2004).

12 World Health Organization. Hospital infection control guidance for severe acute respiratory syndrome (SARS). http://www.who.int/csr/sars/infectioncontrol/en/ (accessed July 7, 2004).

13 Gopalakrishna G, Choo P, Leo YS, et al. SARS transmission and hospital containment. *Emerg Infect Dis* 2004;**10:** 395–400.

14 Oh VM, Lim TK. Singapore's experience of SARS. *Clin Med* 2003; **3:** 448–51.

15 Achonu C, Laporte A, Gardam MA. The financial impact of controlling a respiratory virus outbreak in a teaching hospital: lessons learned from SARS. *Can J Public Health* (in press).

16 Cluster of severe acute respiratory syndrome cases among protected health-care workers—Toronto, Canada, April 2003. *MMWR Morb Mortal Wkly Rep* 2003; **52:** 433–36.

17 Provincial Operations Centre. Directives to all Ontario acute care hospitals for high-risk procedures involving SARS patients in critical care areas. 2003; 03–06(R).

18 Ontario Nurses Association. Nurses to Eves: "Huge Concerns". http://www.ona.org/home/ona/pres_rel.shtml?sh_item=c85e8cd949e124e7b95a13664eb71baf (accessed July 7, 2004).

19 Ontario not ready for SARS 3; angry nurses ask what has changed since death of nurses. Ontario Nurses Association, 2003.

20 Varia M, Wilson S, Sarwal S, et al. Investigation of a nosocomial outbreak of severe acute respiratory syndrome (SARS) in Toronto, Canada. *CMAJ* 2003; **169:** 285–92.

21 McDonald LC. SARS in healthcare facilities, Toronto and Taiwan. *Emerg Infect Dis* 2004;**10:** 777–81.

22 Scales DC, Green K, Chan AK, et al. Illness in intensive care staff after brief exposure to severe acute respiratory syndrome. *Emerg Infect Dis* 2003; **9:** 1205–10.

23 Chen YC. SARS in hospital emergency room. *Emerg Infect Dis* 2004; **10:** 782–8.

24 Seto WH, Tsang D, Yung RW, et al. Effectiveness of precautions against droplets and contact in prevention of nosocomial transmission of severe acute respiratory syndrome (SARS). *Lancet* 2003; **361:** 1519–20.

25 Woodward G, Stukel T, Schull M, Gunraj N, Laupacis A. Untilization of Ontario's health system during the 2003 SARS outbreak. Toronto: Institute for Clinical Evaluative Sciences, 2004.

26 Gostin LO, Bayer R, Fairchild AL. Ethical and legal challenges posed by severe acute respiratory syndrome: implications for the control of severe infectious disease threats. *JAMA* 2003; **290:** 3229–37.

27 SARS assistance and recovery strategy act. Government of Ontario, 2003.

28 Wong J. SARS outbreak has university impact. news@UofT. http://www.newsadevents.utoronto.ca/bin4/030331c.asp 2003 (accessed July 7, 2004).

29 Wong J. SARS update: public health issues stricter directives: instructors asked to make allowances. news@UofT. http://www.newsandevents.utoronto.ca/bin4/030417a.asp 2003 (accessed July 8, 2004).

30 Wong J. Med school cancels hospital clerkships. Re-entry of third and fourth year students on hold. news@UofT. http://www.newsandevents.utoronto.ca/bin4/03/04/21j.asp (accessed July 8, 2004).

31 Anon. Directives to all Ontario acute care hospitals regarding infection control measures. Toronto: Provincial Operations Centre, 2003.

32 Centers for Disease Control and Prevention. Updated interim domestic infection control guidance in the health-care and community setting for patients with suspected SARS. http://www.cdc.gov/ncidod/sars/infectioncontrol.htm (accessed July 7, 2004).

33 Health Canada. Infection control guidance for health care workers in health care facilities and other institutional settings. Severe acute respiratory syndrome (SARS). http://www.hc-sc.gc.ca/pphb-dgspsp/sars-sras/pdf/sarsfactsheetinstitutions06-03-03_e.pdf (accessed July 8, 2004).

34 Anon. Directives to GTA/Simcoe county hospitals. Toronto: Provincial Operations Centre, 2003.

35 Ontario Ministry of Health and Long Term Care. Eves government announces four hospitals to lead coordinated fight against SARS. Media release. http://ogov.newswire.ca/ontario/GPOE/2003/05/27/c6187.html?Imatch=&lang=_e.html (accessed July 8, 2004).

36 Sandman P. SARS communication: What is Singapore doing right? http://www.psandman.com/articles/sars-3.htm (accessed July 8, 2004).

37 Nicolle L. A SARS commentary. *Can J Infect Dis* 2003; **14:** 141–42.

38 Riley S, Fraser C, Donnelly CA, et al. Transmission dynamics of the etiological agent of SARS in Hong Kong: impact of public health interventions. *Science* 2003; **300:** 1961–66.

39 Lipsitch M, Cohen T, Cooper B, et al. Transmission dynamics and control of severe acute respiratory syndrome. *Science* 2003; **300:** 1966–70.

40 Svoboda T, Henry B, Shulman L, et al. Public health measures to control the spread of the severe acute respiratory syndrome during the outbreak in Toronto. *N Engl J Med* 2004; **350:** 2352–61.

41 Hawryluck L, Gold WL, Robinson S, Pogorski S, Galea S, Styra R. SARS control and psychological effects of quarantine, Toronto Canada. *Emerg Infect Dis* 2004; **10:** 1206–12.

42 Anon. Use of quarantine to prevent transmission of severe acute respiratory syndrome—Taiwan, 2003. *MMWR Morb Mortal Wkly Rep* 2003; **52:** 680–83.

43 Naylor CD, Chantler C, Griffiths S. Learning from SARS in Hong Kong and Toronto. *JAMA* 2004; **291:** 2483–87.

44 Manley's comments show lack of understanding of SARS. News release of Canada NewsWire. June 27, 2003.