Severe Acute Respiratory Syndrome (SARS): Loud Clang of the Leper’s Bell

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Severe acute respiratory syndrome (SARS) or the “Chinese Chernobyl” emerged against an alarming background of rising infectious disease in poor rural China and to a backdrop of interregional and global polarization of population well-being and vulnerability. SARS has added its own dissonant note to “health disturbance”, caused fear and panic and disrupted international commerce. Its emergence should be perceived as a disturbing alarm that underscores the need to strengthen public health and facilitate construction of a human security “umbrella” in the event of future disasters. Although SARS has produced a relatively insignificant level of damage when compared to other threats, its long-term effects on health should not be underestimated, based on its unexpected appearance and still unknown properties. This essay presents a qualitative flowchart that follows SARS from its origin in China to the accumulation of global damage. Two future scenarios were formulated, covering a worse-case outcome and containment outcome, which currently appears to be the case. In the event of the worst-case scenario it is doubtful whether any health service in Europe could cope. In either case, the development of a European Union Center for Disease Control is mandatory.

Key words: China; public health practice; severe acute respiratory syndrome; virology

In a world surrounded by hazards of varying type and magnitude, the epidemic of severe acute respiratory syndrome (SARS) must be kept in strict perspective (1). Risk of damage to individuals, population, and society at large are sometimes ignored, overestimated or naively compared by the media and public alike. To some extent this is true within the scientific community and in governmental agencies. Thus, the Framework Convention for Tobacco Control aims at tackling the epidemic of tobacco-related disease with a mortality rate of 50%, from which 550,000 European citizens die annually and 5 million worldwide. Consider the approximate daily death rate of 8,000 from acquired immunodeficiency syndrome (AIDS) and 5,000 from tuberculosis – diseases that the World Health Organization (WHO) declared international emergencies a decade ago – or the global problem of influenza (2-5). Although two million children die each year from lack of water or waterborne diseases, this “steady drip, drip, drip of daily dying has not lead to a political crisis” (6), as with AIDS in Africa.

So far, the global case numbers and deaths from SARS are approximately 8,000 and 900, respectively (October, 2003) (7,8), with a general mortality rate of 10%, which is a small and relatively insignificant level of damage compared with other health threats (ref. 9, Table 1). However, the unexpected appearance of SARS, its unfolding characteristics, and still unknown properties call for circumspection (10). The uncertainty it can still generate in regard to health damage should not be underestimated. Although SARS seems to be contained, it can still get worse. Its sudden emergence presents a unique opportunity to examine the state of public health and strengthen its essential functions, as well as to develop crisis management tools for disaster mitigation and improve related research (11). It presupposes improved measures internationally and in all countries to deal with SARS and all future threats. SARS draws attention to the need for a strengthened global provision lead by the WHO, which would monitor and control health threats to the public and help reduce damage in the event of either man-made or natural disasters (12-14). Monitoring current health conditions and status and availability of appropriate health services are important to the functioning of an early warning system to identify pockets of slowly growing vulnerability, as well as to track rapidly emerging disasters (15,16). SARS has demonstrated that public health infrastructures are in need of preservation. In some countries, their rehabilitation is essential. Political and policy inspiration can be drawn from the past achievements of public health measures, which have made the world a healthier place by eradicating or reducing the scourge of contagious disease.

Warning Bell

SARS spread along international air routes to more than 30 countries on five continents, demonstrating the universal risk from new and unexpected
epidemics (17-21). Inadequacies in existing structures to
deal with hazard and risk have been uncovered,
and the need for “fear and panic” control and truthfulness
in reporting emphasized. Analogous to the bell
of the wandering leper, SARS should be perceived as
a reverberating early alarm, which has added its own
dissonant note to the global health disturbance. It
should be heard as a call for further interdisciplinary
public health development as an instrument for uni-
versal public good. Dealing with large unpleasant sur-
prises and protecting the health of the population
should become a more integrated component of orga-
nized society’s umbrella for human security. How-
ever, the world is preoccupied with “business as us-
ual” and the impact on tourism of SARS rather than
with ensuring the health and safety of the public.

Danger to the Poor, Threat to the Rich

China, where SARS first surfaced and where the
highest level of disease exists, is a good example of a
country with failing health measures (22). SARS
emerged against a background of rising infectious dis-
ease in poor rural China, which contains two-thirds of
the country’s population, mostly farmers. According
to Xueqin (23), rural China can afford neither school-
nor basic health care and incomes are much lower
than in cities. He also notes, “If rural poverty is com-
monplace, urban poverty is perhaps harder to bear,
because those in the cities see firsthand the gap be-
tween them and the elite” (23). China’s public health
services, preventive care, disease surveillance, and
health controls are all run down, whereas household
health costs have increased several-fold and govern-
mental funding has been reduced and spent dispro-
portionately. At the same time, tuberculosis, AIDS,
hepatitis, and neonatal tetanus are increasing. Mortal-
ity and morbidity from readily treatable diseases are
high, which is a result of endemic poverty, unemploy-
ment, inadequate health service, as well as govern-
ment indifference (24). Surprisingly, the disease has
not spread to some less developed countries with ex-
tremely limited health resources, e.g., Burma, Laos,
and Cambodia, where containment would prove even
more difficult.

WHO’s Aim of Containment

The first aim of the WHO is containment of SARS
by measures that improve the hygiene and sanitary
shield in China and wherever else the disease has
spread, notably Canada (25). Chinese officials de-
layed the notification of the event to world bodies re-
sponsible for disease control. Fearing its economic
and political impact, they first attempted to minimize
the extent and danger of the outbreak. Given the de-
lay in reporting its outbreak, containment in such a
large country as China is difficult. Its spread within
South East Asia and to Canada highlights the health
risk the process of urbanization carries and the vul-
erability of populations in large congested cities,
as well as the threat to public health workers themselves
(26, 27). Before SARS runs its course, either in its least
or a more damaging form, health and commerce will
have already been seriously impacted (Fig. 1). To
think that containment is an easy matter or to simply
rule out a more damaging outcome is in itself a risk to
the affluent. Risk to the poor is much greater (31, 32).

Political Reactions

Feeling “pressured” by the public opinion and a
resulting economic crunch from SARS, politicians in
Canada criticized the WHO for its “travel advisory”,
an action taken based on the magnitude of the out-
break in Toronto and its spread from hospital workers
into the community and to other countries. No other
city outside of the Asian-Pacific region has been more
adversely affected than Toronto. At least 32 deaths
have occurred and more than 60 current SARS cases
exist. Canadian nurses have made a demand for a
public inquiry into the official handling of the out-
break (33). They demanded better protection for
health care workers treating patients suspected of
having SARS. WHO’s rational temporary travel advi-
sory was made “to protect public health and reduce
opportunities for further international spread.” Quar-
antine and isolation either relating to the patient or
the proscription of “off limits” regions are logical mea-
sures for collective safety. Canada’s defensive re-

dence coming as it does from a country that has pro-
vided the world with great insights into health matters
is all the more disturbing. Even more unfortunate,
WHO came under attack at a time when the United
Nations (UN) had been seriously weakened over the
war in Iraq. Deficits in global health policy, lack of
understanding or support for public health by na-
tional governments, and inadequately trained work-
force continue to feed into this socially damaging pro-
cess. Human security based on the ethical value
systems of the UN, WHO, and the Council of Europe
should receive greater universal emphasis.

Lessons Learned and Unresolved Issues

SARS is one more example how health troubles
in one part of the world can provoke health and
health system problems elsewhere and how disease
spread can be facilitated by social and political ar-
rangements of various kinds and at several levels. It is
an example of the complexity and multiple dimen-
sions of disease, either in a direct sense, relating to un-
healthy, unhygienic living conditions, or indirectly,
as in global economies. To the historian of health mat-
ters, it brings to the mind mid-19th century reactions

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Table 1. Cumulative number of reported probable cases of
SARS (source: WHO)

<table>
<thead>
<tr>
<th>Country</th>
<th>Cumulative number of cases</th>
<th>Number of deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>5,328</td>
<td>332</td>
</tr>
<tr>
<td>China, Hong Kong special administrative region</td>
<td>1,739</td>
<td>278</td>
</tr>
<tr>
<td>China, Taiwan</td>
<td>676</td>
<td>81</td>
</tr>
<tr>
<td>Singapore</td>
<td>206</td>
<td>31</td>
</tr>
<tr>
<td>Canada</td>
<td>188</td>
<td>30</td>
</tr>
<tr>
<td>United States</td>
<td>66</td>
<td>0</td>
</tr>
<tr>
<td>Vietnam</td>
<td>63</td>
<td>5</td>
</tr>
<tr>
<td>Europe</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>Other</td>
<td>58</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>8,360</td>
<td>764</td>
</tr>
</tbody>
</table>

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675
in Britain to early public health legislation, where those who could make money out of unhealthy conditions or loose money as a result of the proposed changes vigorously opposed sanitation measures (34, 35). The devastating pandemic of the “Black Death” (1346-1353) played an influential role in the unfolding of the new world order. Other epidemics, such as English Sweating Sickness (1485-1552) and Pichardy Sweats (France) in the 18th and 19th centuries appeared and then disappeared. Spanish flu in 1918 (36) infected half the world’s population and killed 25 million people, while the “Asian” in 1956 and “Hong Kong” flu in 1968 together killed 4.5 million. The incubation and spread of a disease find a perfect environment in poor and filthy living conditions (37), as it occurred during Britain’s industrial revolution, or where there is inadequate hygiene and domestic water supply, as is the case in parts of the Balkans today (38), or in rural China where an animal virus recently crossed over into the human population. It is thought that this is how the SARS infection first originated (39-41). Once China did respond, a more efficient response than in Canada seems to have been mounted.

**Virus Transmission**

The cause of SARS is a strain of the normally benign corona virus responsible for the common cold, which has mutated and jumped from animal species (ruminant: muskrat, badger, and ferret) to infect man.

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**Figure 1.** Severe acute respiratory syndrome (SARS): cradle of birth, health disturbance, and mitigation. A. A qualitative map or flowchart for SARS from birth to damage accumulation over geographical space and time. B. Dynamics of the epidemic in a theoretical construct, designated the B Curve for health disturbance (HD) resulting from an event. This curve draws attention to a hypothetical relationship between the concepts of preparedness (P) and vulnerability (V), and the growing need for analysis and disaster research, e.g., using the Utstein Template (28-30). Different scenarios for the B curve: (a) most optimistic scenario, when P is optimized and V is minimized; (b) and (c) intermediate scenarios; (d) pessimistic scenario, when V is maximized.
its incubation period is 2-10 days, which allows those infected to infect others without knowing that they themselves carry the disease. It attacks with an infection rate less than influenza and with a suggested average fatality rate of about 10%, being significantly greater in the elderly. It has also been reported that 1 in 5 (20%) of those who contract SARS die of the disease. Transmission occurs through direct contact or exchange of body fluids, such as droplets released by coughing. Blocking transmission depends on the speed of quarantine and isolation (44). Depending on the mix of biological, genetic, and environmental causes, some patients may be “super-spreaders” of the disease. At the level of the patient, early diagnosis is the key to a good prognosis (45). At the level of a country, containment is necessary, though a restricted form of quarantine may be less effective than targeting symptomatic individuals (46). This seems to be another lesson learned from Vietnam’s success in limiting spread (46).

**Information Deficit and the Public**

With respect to SARS, we are dealing with hazard, risk, and probabilities in a framework of limited information, knowledge, and uncertain predictive models. One analytic approach relates to its most probable point of origin in China, its relative low level of contagiousness and slow temporal growth, as well as its geographical spread over a period of months, balanced by expert viewpoints of public health professionals and the positioning of the WHO (Fig. 1A). Figure 1A draws upon classical epidemiology (agent-, professionals and the positioning of the WHO (Fig. 1A). Figure 1A draws upon classical epidemiology (agent-, host-, or environment-related confounding factors) and the concepts of mutagenicity of a virus in a changing ecology with a shrinking “ecological barrier”. It traces the origin of SARS, disease transmission, geographical spread, and ensuing damage in terms of "health disturbance", commercial losses, and psychological impact on the population. Health disturbance estimates for the best and worst outcomes are not negligible (Fig. 1B). The prediction of outcome in the event of a re-escalation of SARS would be useful. Given the available data on SARS, some estimates of global danger to human life and costs to commerce have been made.

**Health Disturbance**

Any event provoking a transient health disturbance of some magnitude and time course is descriptively represented by Burkle’s B Curve, a theoretical dynamic of accumulating “health disturbance” (Fig. 1B). When a transformation from hazard (H) to risk (R) occurs, as in the case of SARS, health is impaired. The summation of all B Curves is the “global health disturbance” (rural China, Hong Kong, South-East Asia, Canada, and so on). Its inverse configuration is a measure of health status depression as a result of the event. The closest approximation to the B curve for SARS is an extraction or extrapolation from the real time-bar graphs and spatial distributions of all cases on a regional and global basis as provided by WHO. Two additional functions, “P” for the preparedness of the community or society and “V” the vulnerability of the community or population are also postulated (Fig. 1B). A low P and a high V or a relatively high P and low V would be posited for China and Canada, respectively, with expected outcomes of high and low health disturbance in the event of a health disaster, respectively. There were 8,360 cases with 764 deaths and 5,264 recovered patients worldwide as of June 1, 2003; respective numbers for China are 5,328 cases, 332 deaths, and 3,371 recovered, and for Canada 188 cases, 30 deaths, and 141 recovered (Table 1).

B Curve (d) is representative of a less likely and more pessimistic outcome for health disturbance (Fig. 1B), which can unfold when P is low and V high, when interventions are not knowledge based or are poorly designed, and where the management function is counter productive. This is a state most probably operable in the developing world. B Curve (a) represents the best response or least damaging outcome and fits the conditions when P is optimized and V is minimized as a result of proactive policy (Fig. 1B). Under these conditions, timely and optimal interventions and effective management in the immediate response and rehabilitation phases would be implemented subsequent to an event. This is the case that applies most probably in the developed world. It can be argued that the cost to the society to promote an incremental increase in P (ΔP) and an incremental decrease in V (ΔV), will be more than offset by the savings gained as a result of an incremental reduction in health disturbance (ΔHD). This will have a tendency to shift the B Curve from position (d) (pessimistic) to (a) (optimistic), thereby limiting the health disturbance and reducing treatment costs. While the inter-relationship between the two functions V and P is not known, a first order theoretical approximation has been assumed with the constraints that V can never be zero even with the most effective policy because hazards of all kinds and of varying magnitude are ever present, and P is strongly resource-dependent.

**Dynamic Tracking**

To track the overall dynamics of SARS or any other epidemic and chart the resulting “health disturbance”, which is designated (Σ [B Curves]) in Figure 1A, requires an integrated global database and the health leadership of the WHO. The database will contain information on epidemiological, demographic, and clinical variables and provide real-time detection and assessment of disease outbreak. This has been done for Hong Kong, where estimates of infection to onset, onset to admission, admission to death, and admission to discharge have been assembled into an integrated database and associations between the estimated case fatality rate and patients’ age and the time from onset to admission have been derived (43,44).

**The Utstein Template**

The Utstein Template adds several more parameters to disaster analysis and provides another, rather interesting, approach (28-30). Its basis is a more generic formula to facilitate the distinction between risk, hazard, vulnerability, mitigation, and management when dealing with disasters. The derived formula
P_0 = f(R_0)(H_{man} + H_{nat})(V_{nat} + a_1 + a_2 + b_1 + b_2), provides insight into disaster analysis where P_0 is the probability that an event (cross over of the corona virus from animal to man in the case of SARS) will inflict damage on a society at risk. H represents the hazard (corona virus and its mutagenicity); f is a function of the relationship between all of the given variables; R_0 is the risk that an event may result in damage and is non-zero; H_{man} and H_{nat} represent the human and natural components responsible for the hazard respectively; V_{nat} is natural vulnerability, whereas a_1 and a_2 designate vulnerability augmentation and mitigation and b_1 and b_2 designate counter-productive and productive management, respectively. In the management of a disaster, the ultimate objective is to bring the probability that damage will occur (P_d) as close as possible to zero. This can be achieved by bringing the net value of any of the brackets in the formula to zero. In rural China H_{man}, H_{nat}, a_1, and b_1 are high and a_2 and b_2 are low for SARS. In Canada, the mathematical signs for (a) and (b) are opposite of those for China.

Optimistic and Pessimistic Scenarios

The formulation of future scenarios of health outcome offers means for a more rational allocation of scarce resources, even recognizing that there is a risk of being wrong in any prediction of event outcome and damage estimate. An unlikely worse case outcome, as well as the more likely outcome of containment is considered in Figure 1B. If appropriate, well-designed measures and interventions are applied in a timely fashion, and health disturbance can be limited, constrained, contained, or minimized. A more detailed knowledge of P and V functions locally and globally will provide some qualitative insights into the probable unfolding dynamics of SARS and some additional basis for policy development. In the pessimistic scenario, the disease will reach some threshold or “tipping point” when a small change in some parameter can make a much larger difference and accelerate the epidemic into its full swing. In this scenario, the virus (agent) can act locally and globally, aggravated by unhealthy conditions (environment) and a lack of adequate counter measures of mitigation and management, or it can mutate within its host population (Fig. 1A). If the virus mutates when attached to its new host (man), or if the case number is great, or if the ratio of human carriers to cases grows, the cure and containment can become more complicated. Commensurate with this viewpoint there is growing concern that containment efforts can prove futile and that this pessimism should guide action. In the case of non-containment, the B Curves for global health disturbance will become “double-humped” (bimodal) as the disease unfolds over time. Under such conditions, the cost to construct negative pressure isolation facilities will seem infinitesimally small.

With equal, less, or greater probability (the latter momentarily), SARS may be contained at a somewhat higher level, taper off, and behave in a more self-limiting way [Fig. 1B, B Curve (a)]. In the case of a more likely optimistic outcome, the number of cases should not exceed 10,000. The goal of containment seems to have been more feasible in certain regions and they provide additional lessons. Advance warning and specific policy have played a role. Although there are estimates of commercial losses, so far there are no cost-benefit studies regarding policies and other measures geared to an incremental reduction in population vulnerability (V-function) or to an incremental increase in the level of societal preparedness (P-function) when health is threatened by a disaster. Assuming total containment, the cost of the SARS outbreak worldwide has been estimated at 30 billion Euros (47). If increased health expenditures incurred relative to health disturbance are accounted for, the estimate is placed at about 160 billion Euros. In the less likely event of a pessimistic scenario, the costs will be far greater and outside the budgetary allocations for health.

Future of Infectious Disease Mapping

The dynamics of the ongoing epidemic is such that in the event of either scenario, its different growth and decay rates will occur over the next few years. By then, science may have provided a complete understanding of the virus, the extent of its geographical range, knowledge of all contributing and confounding factors, its age-dependent response, and the resistance and resilience of man to its worst effects. Trapping and identifying any virus, vaccine development, and understanding the ability of a virus to go “underground” and avoid eradication is in itself a painstaking and complex scientific undertaking. In the case of SARS, its genome sequence has been completely worked out in a record time, which demonstrates the successful networking of the scientific centers (www.sciencemag.org/feature/data/sars).

SARS, the European Union, and Member States

“Yesterday” the disease reached Canada from China. “Tomorrow” it can spread within Europe. Foreswarned by the relatively long incubation period compared with cross continental flight times, Europe has had just a small number of confirmed cases so far (Finland, France, UK, and Russia-close to the Chinese border), while false alarms have gone off in Bulgaria, Greece, and Italy. In response to the emergence of SARS and proactively with respect to all unexpected future threats, the EU should maintain a stricter vigilance and address these issues at all levels. As yet its response is mild and mainly bureaucratic. Passengers arriving in the EU from SARS-infected countries have filled out questionnaires, a measure in line with WHO recommendations (which advocates screening passengers also on departure). At the same time, there is a potential for the development of a European Union Center for Disease Control, which ought to be mandatory taking into aaccount 25 countries and the given health disparities between West and East (48).

The current approach to the inauguration of a European Center for Disease Control may be little more than a poll of member states’ expertise but it would be a start. A center for manufacturing vaccines against various illnesses is also needed. Hygiene, pri-
ary health care, health promotion and facilities improvement as well as human resource development are some of the implied measures necessary for Europe. European disaster preparation, response, and mitigation measures should be further developed. The targets of health care reform should include the reduction of poverty and the improvement of surveillance systems as part of the mechanics of response to new health threats. Reform should embrace the principle of fairness, which implies being “fair to those who have been most unfairly treated” to preserve the European principle of solidarity and promote societal stability.

Role of the International Community

Although SARS continues to unfold at a much slower rate, it does so to a background of reemerging infectious and rising chronic diseases as well as to an alarming interregional and global polarization of population well-being and vulnerability. While SARS is a shining example of the success of interdisciplinary science, at the same time it points to major failures in the implementation of appropriate public health policy and modernization of surveillance systems and control capacities. The international community (UN, WHO, Council of Europe, and others) must continue to act and develop a global provision for public health and an “umbrella” for ecological security with efficient and effective coordination.

Should SARS resurge, much can be done now in the preparation for its potential danger, attenuation of its damaging effects, and its overall management. Garret’s advice that “ultimately, humanity will have to change its perspective on its place in Earth’s ecology if the species hopes to stave off or survive the next plague” (19) should not be treated lightly.

References


