

Responding to global infectious disease outbreaks: Lessons from SARS on the role of risk perception, communication and management

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Abstract

With increased globalisation comes the likelihood that infectious disease appearing in one country will spread rapidly to another, severe acute respiratory syndrome (SARS) being a recent example. However, although SARS infected some 10,000 individuals, killing around 1000, it did not lead to the devastating health impact that many feared, but a rather disproportionate economic impact. The disproportionate scale and nature of this impact has caused concern that outbreaks of more serious disease could cause catastrophic impacts on the global economy. Understanding factors that led to the impact of SARS might help to deal with the possible impact and management of such other infectious disease outbreaks. In this respect, the role of risk—its perception, communication and management—is critical.

This paper looks at the role that risk, and especially the perception of risk, its communication and management, played in driving the economic impact of SARS. It considers the public and public health response to SARS, the role of the media and official organisations, and proposes policy and research priorities for establishing a system to better deal with the next global infectious disease outbreak. It is concluded that the potential for the rapid spread of infectious disease is not necessarily a greater threat than it has always been, but the effect that an outbreak can have on the economy is, which requires further research and policy development.

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Introduction

Globalisation increases the likelihood that an infectious disease appearing in one country will spread rapidly to another. Although not unique in this respect, severe acute respiratory syndrome (SARS) is a recent example. Within a matter of weeks in early 2003, SARS spread from the Guangdong province of China to rapidly infect

individuals in some 37 countries around the world (Wang & Jolly, 2004). The first case of SARS outside China was reported on 26 February 2003. By 31 May the number of probable cases reached 8359, with the mortality rate outside China climbing to around 14%. However, from June this increase slowed sharply, and by July the number of probable cases had climbed by just 89 cases, to 8448, with a total of 774 deaths (<http://sarsreference.com>).

During the outbreak there was great concern, from medical as well as lay and political

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communities, that high mortality and morbidity rates mimicked—possibly rivalled—the 1918 influenza pandemic, which killed around 40 million people (Brown & Tetro, 2003). However, although SARS eventually infected some 10,000 individuals, killing around 1000, it did not lead to the devastating health impact that many feared. Rather, what was unique about SARS was the disproportionate economic impact.

A number of studies place the global macro-economic impact of SARS at US\$30–100 billion, or around US\$3–10 million per case (Chou, Kuo, & Peng, 2004; Fan, 2003; Hanna & Huang, 2004; Lee & McKibbin, 2004; Smith & Sommers, 2003; Wen, Zhao, Wang, & Hou, 2004). These costs were distributed across a wide range of sectors—although principally travel and tourism—and countries, leading to a far higher economic shock than expected given the health impact (Barreto, 2003; Blendon & Benson, 2004). The rather disproportionate scale and nature of this economic shock has caused concern that outbreaks of more serious disease—such as a flu pandemic—could have a catastrophic effect on the global economy (Nesmith, 2003). Understanding the factors that led to this impact of SARS might help deal with the possible repercussions and management of other infectious disease outbreaks.

Perhaps most significant of these factors is the perception, communication and management of the risk presented by SARS, which is the subject of this paper. In considering this, it is important to locate the analysis with respect to the two broad models of risk used in the social sciences. The first is the ‘realist’ approach, where risk is seen as an objective threat or danger that can be measured independently of the social context within which it occurs (Kahneman, Slovic, & Tversky, 1982). The second is the ‘social constructionist’ approach, which sees risk as a threat or danger that is constructed through social and cultural processes, and cannot be demonstrated to be independent of such processes (Joffe, 2003; Lupton, 1999; Washer, 2006). The latter is increasingly seen as a key conceptualisation; indeed, the term ‘risk society’ has been coined to describe the apparent perception of the post-industrial post-modern society as being at constant ‘risk’ of something, from credit-card fraud to terrorist attack (Beck, 1992). Although this has been challenged in some cases (e.g. Kitzinger & Reilly, 1997), what is important in this conceptualisation is not necessarily that populations are in

permanently heightened states of anxiety, but how populations develop defence mechanisms to control their anxiety (Joffe, 1999). In this paper a more ‘material-discursive’ position is adopted that views both conceptualisations as having some validity; that a ‘risk’ contains both a materially measurable element of the probability of an event, and a socially constructed element of how that probability/event is perceived by the individual and society (Yardley, 1997). In this way a contrast can be seen through the examination of the impact of SARS between what is understood from a realist perspective (the materially measurable probability of, for instance, infection with SARS, various outcomes of infection and the effectiveness of different strategies to prevent infection) versus the social constructed perception of those probabilities as ‘risk’.

Following this introduction, the paper looks at the role that risk, and especially the perception of risk, played in driving the economic impact of SARS. The paper then moves on to consider the public health response to SARS, and the response to the perceived risks presented by SARS. This is followed by an exploration of the importance of communication in risk perception, looking at the role of the mass media, and a summary of lessons for responding to future SARS-like situations. The paper concludes with a future research agenda in the area of risk and infectious disease.

The role of the perception of risk in driving the

Economic impact of sars

Although the direct costs of an epidemic on the health service can be substantial, the indirect costs on other sectors of the economy may be more significant (Smith, Yago, Millar, & Coast, 2005). SARS certainly demonstrated this (Chou et al., 2004; Fan, 2003; Hanna & Huang, 2004; Lee & McKibbin, 2004; Smith & Sommers, 2003; Wen et al., 2004). The indirect costs of an epidemic are driven almost solely by the public’s perception of the risk of becoming infected, and the risks associated with the different consequences of that infection. A disease that is thought to be spread by direct contact with infectious cases is likely to lead to reductions in unnecessary contact (Lau et al., 2005). Where individuals feel some ‘control’ over their exposure to infection, such as HIV, this reduction may be more limited (Blendon & Benson, 2004). However, in cases where perceived control is

less, such as with SARS, there is likely to be a fall in demand, particularly for tourism, transport, retail sales and leisure activities, as individuals avoid contact with others. Countries in which these sectors of the economy are relatively important are going to be most affected. The fear of the disease spreading through international travel can also lead to an additional reduction in economic activities in unaffected countries. Uncertainty over the future course of the epidemic, and its impact on demand, reduces confidence in the affected economies, leading to further possible reductions in investment (Edmunds & Gay, 2006).

There are a number of aspects of a disease that may make such a loss in confidence more likely, particularly if a number of these combine:

- Whether members of the public are potentially at risk of infection. This may arise from the widespread consumption of a product that may be contaminated, such as with variant Creutzfeldt Jacob Disease, or if the infection is directly transmitted from person to person, as with SARS. To avoid exposure the public may avoid a wide range of products, or unnecessary contact with potentially infectious individuals.
- Whether the outcome of infection is perceived to be serious. If the infection results in death or serious sequelae in a significant proportion of cases it is likely to cause widespread concern. This concern would be exacerbated by the lack of an effective treatment or therapy, but even though some infections may be treatable their perceived severity may cause disproportionate concern.
- Instances where there is a lack of protection or prevention measures (e.g. vaccines). Feelings of vulnerability are heightened when the public feel that they can do little to 'control' their exposure to the risk of infection.
- Where a rapid increase in cases or deaths, or a rapid appearance of cases distant from the index cases, reduces confidence in public health measures.
- Where there is uncertainty regarding, for instance, routes of infection, the outcome of infection, particularly if it might be serious, and the efficacy of therapeutic or preventative measures. This may lead to conflicting messages, further heightening concerns.
- Suspicion that risks are being downplayed. Here the role, and the perceived trustworthiness of,

information sources, such as media, government and international bodies, is a significant factor determining the level of perceived risk and control over an outbreak (Pickles & Goodwin, 2006).

SARS demonstrated many of these features, and in particular a combination of two key forms of risk. First, there was substantial scientific uncertainty about the cause of the outbreak, including the identity and nature of the pathogen, and thus the likelihood and means of infection. Second, there was considerable uncertainty about the degree of effectiveness of specific interventions or measures to reduce the likelihood or consequences of infection (Lau et al., 2005). These are consistent with the 'dread' factors highlighted in discussions of risk perception (Slovic, 1987). Although as time progressed levels of 'dread' were reduced, initially all that was known about SARS was that it was transmissible directly via the airborne route, infection had a high case-fatality ratio of around 10% and there were no vaccines or specific therapeutics. This created widespread public anxiety that then translated in to a severe economic impact (Lau et al., 2005).

We now know that SARS actually spread relatively slowly, infectivity was largely confined to when individuals were unwell, and infection largely affected adults. This meant that traditional public health measures, such as tracing and isolating cases, were effective public health measures (Baker, 2003). That these public health measures were effective had implications for how the public came to view the risks associated with SARS, and the development of public behaviour over the course of the outbreak.

Public health response

SARS is perhaps the most striking example in modern times of the widespread use of traditional, non-medical, public health measures to contain an infectious disease outbreak. These measures can be divided into two categories. First, those decreasing contact between infectious and susceptible people, such as isolation and quarantine, travel restriction and increased social distance. Second, those decreasing effective contact—the likelihood of transmission occurring should contact between infectious and susceptible persons occur—through case and contact hygiene, including washing hands and wearing masks, and environmental hygiene, such

as disinfection and ventilation (Lau, Tsui, Lau, & Yang, 2004; Lau, Yang, Tsui, Pang, & Kim, 2004).

The likelihood of these measures working depends on the characteristics of the disease and affected population. This includes the mode of transmission, incubation period, timing, duration and degree of infectiousness, age group most affected and age structure and contact behaviour of the population. Uncertainties surround these factors, especially at the beginning of an outbreak. In retrospect, although SARS was transmitted primarily through the respiratory route it usually did not behave as a highly infectious agent and certain parameters facilitated its containment through traditional public health interventions. These parameters included the lack of pre-symptomatic transmission, a low level of infectivity at the onset of illness, and that transmission was primarily through respiratory droplets and occurred primarily in healthcare or household settings involving close person to person contact (with the important exceptions of Hotel M. and Amoy Gardens in Hong Kong (Tomlinson & Cockram, 2003)). In addition, although the reproductive number for cases was approximately three its serial interval was relatively long at 8–10 days between onset of symptoms in one person and onset of symptoms in the next person in the chain of transmission. These factors made it relatively easy to reduce transmission by promptly isolating cases, quarantining close contacts, and introducing and enforcing infection control and hygiene measures (Lipsitch, Cohen, & Cooper, 2003; Lipsitch et al., 2003; Pang, Zhu, & Xu, 2003; Riley, Fraser, & Donnelly, 2003; Svoboda, Henry, & Shulman, 2004; WHO, 2003a, b). However, it is also the case that for these public health measures to be effective, the acceptance of, and compliance with, them by the public was critical which may not always be the case. For example, there has been some research on the H7N7 avian influenza outbreak in the Netherlands in 2003 that suggests that compliance with preventive measures in that context was very low (Stegeman et al., 2004).

The use of such traditional infection control measures in the modern age is especially interesting because of their impact on public perception of risk. On one hand heightening the perception of serious risk of infection, and on the other giving reassurance that action is occurring that reduces that risk (Brug et al., 2004). For example, it is felt that much of the highly visible public health activity in China

concerning twice-daily temperature readings for children, wearing masks and infrared screening at airports, may not have been effective in direct disease control, but provided a high level of reassurance to the population, thus reducing the economic impact of the outbreak (Hesketh, 2003; Lee, Chen, & Su, 2003; Pang et al., 2003).

Interesting here is that, despite the millions spent on public health measures concerning infectious disease, relatively little has been invested in considering the behavioural response to infectious disease outbreaks, and how this affects the epidemiology of disease and its wider, predominantly economic, repercussions. Clearly some of the changes in behaviour that individuals undergo when faced with a communicable disease outbreak, such as reductions in visits to restaurants, cinemas and sports, have both an economic and epidemiological impact. Knowledge of how a certain behaviour change might affect the course of the epidemic, and what its possible economic impact would be, would help decision-makers give appropriate advice. Thus, quantifying the behavioural changes that might be expected in the face of different threats would significantly help improve both epidemiological and economic forecasting (Blendon & Benson, 2004). Similarly, understanding the relative importance of risk perception in influencing behavioural change, compared with other factors, such as knowledge, attitude and perceived effectiveness of protection measures, would also help in the management of infectious disease outbreaks.

Risk perception and communication

The public, business community and other institutions make decisions on different bases. The ‘classical’ position is that the public typically make decisions based on their perception of the risk, rather than the actual risk, whereas governments and other institutions are more likely to make their decisions based on the actual risk (Fischhoff, Bostrom, & Quadrel, 2002; Fischhoff, Slovic, & Lichtenstein, 1983). However, these institutions also have their decisions tempered by other factors, such as the political or economic ‘demands’ of the public. How risk is perceived by individuals, and transmitted through these institutions, is therefore fundamental to actions taken in the face of a new, or changing, risk of an event (Slovic, 2000).

The difficulty this presents for risk communication, and policy development, was well typified

during the SARS crisis. How members of the public and investors come to their estimates is a complex area, which is difficult to elucidate. For instance, there may be an element of herd behaviour, in which individuals partly base their decisions on the behaviour of others (Edmunds & Gay, 2006; McInnes, 2005). This would tend to result in behaviour that is sensitive to random events and dependent on the choices of those that first react, but is also sensitive to new information and thus easily reversed (Bikchandani & Sharma, 2001). Alternatively, the rapid and widespread reduction in travel and tourism, for instance, in SARS affected areas may simply have been the result of large numbers of people making similar decisions given roughly similar data sets. This behaviour is less sensitive to new information and less easily reversed. The reasons behind observed actions are therefore important as they can affect the likely impact of different risk communication strategies and the rapidity by which demand recovers following an outbreak.

Clearly the key actors in this situation are the public—as political and economic ‘demanders’—and it is important to consider how members of the public receive information on which they base their expectations and consequent behaviours. Public conceptions of risk are complex, and influenced by factors such as whether the risk involves possibly fatal consequences, is uncontrollable and unknown (Slovic, 1987). SARS matched all these features. Indeed, in Taiwan the public perception was that the risk of SARS was 4.5 on a scale from 0 (no threat) to 5 (severe risk) (Liu, Hammitt, Wang, & Tsou, 2005). Moreover, this study showed that the perceived fatal nature of SARS was a significant driver of actions taken to avoid contagion. Thus, while SARS posed some medical risk, it exerted a disproportionately large psychological impact on people in relation to its relatively low morbidity and mortality (Lau et al., 2005).

The pronounced psychological impact of SARS can be attributed to the combination of two aspects of information about the illness. First, the almost costless and rapid transmission of information, through modern media and communication technologies, not only maintained attention on the development and spread of disease but also meant that conflicting and confusing information was disseminated in the urgency to report in ‘real time’ (Donnelly & Ghani, 2004; Feng, 2003; Hughes, 2004). Second, the lack of sufficient medical

information on SARS meant that, although there was a rapid flow of information, often this was not robust scientific information. Rather, much of the information presented during the outbreak was based on opinion, guesswork and preliminary results (Chang et al., 2005; Drazen, 2003).

SARS and the mass media

The role of the mass media in risk communication, within health and more generally, has been debated for many years (Griffin & Dunwoody, 1998; Harrabin & Coote, 2003; Hill, 2001; Lichtenberg & MacLean, 1991). Recently, this debate has included work related to SARS. Muzzatti (2005), for instance, demonstrates how such threats to public health are manufactured by the media and how these threats draw upon past and present cultural myths of dangerous ‘others’, and in so doing contribute to unwarranted public fear, intolerance, and distrust. Wallis & Nerlich (2005) explore the metaphorical framing of infectious disease reporting, finding that SARS was unusual as militaristic language was largely absent. Bergeron & Sanchez (2005), in a survey of Canadian undergraduate students, conclude that the Canadian media communicated conflicting messages and confusion to the public. Overall, the general consensus is that the media coverage of SARS was excessive, sometimes inaccurate, and sensationalist (Rezza, Marino, Farchi, & Taranto, 2004).

However, much is still not understood about the process by which ‘risk’ is communicated or, perhaps more importantly, understood and acted upon. For instance, there is a lack of evidence concerning the relative role of the media, government or other agencies in heightening public concern and instilling alarm compared with providing reassurance. Thus, especially in the unusual circumstances of an infectious disease outbreak of global concern, specific case-studies of the relationship between the mass media and risk communication in the context of, for example, SARS are vital in the development of the understanding of the role of the media and the implications of this for the management of future outbreaks.

In this respect, the reporting of SARS tended to follow that of other infectious disease outbreaks, following two distinct phases (Ungar, 1998). The first phase characterises the outbreak as a frightening threat. Microbes are on the rampage, are cleverer than us and know no boundaries, and that

somehow this potential ‘new plague’ is the result of population growth, environmental degradation and globalisation. For instance, [Wilson, Thomson, and Mansoor \(2004\)](#), in a study of the media representation of SARS by the New Zealand Herald in the first three months of the outbreak, found that headlines and particular words that could be considered alarming (e.g., ‘deadly’) were frequently used, and comments were often overly pessimistic. Indeed, [Razum, Becher, Kapaun, and Junghanss \(2003\)](#) predicted that within two years every citizen of Hong Kong would be infected with SARS. However, phase two soon occurs, which stresses that this, still relatively abstract, threat is happening in a geographically and/or culturally distant population, that containment of the threat will therefore occur through ‘othering’, and that the promise of medical progress will soon diminish the threat ([Douglas, 1992](#)).

This is well illustrated in an in-depth study of media representation of SARS conducted in the UK. [Washer \(2004\)](#) found that the media represented SARS as a dangerous threat to the UK, whilst simultaneously suggesting that this threat had been ‘contained’—that SARS was unlikely to affect the British as it had the Chinese, as the Chinese are so ‘different’. In this sense, the media can contribute to stigmatisation and discrimination, which in the case of SARS was evident against those with an Asian appearance ([Chang, 2003](#); [Person et al., 2004](#)). This resonates with the presentation by the media of outbreaks of other infectious disease in previous years, such as Ebola ([Joffe & Haarhoff, 2002](#)). Important, however, is Washer’s view that the combination of infectious diseases, and re-emerging infections, in recent years has reduced the confidence of the British populace in the ability of Western medicine to successfully ‘conquer’ infectious disease. If Washer is correct, this reduction in faith in modern medicine may heighten the perception of risk in future years, and thus emerge as an increasingly significant factor in the management of future infectious disease outbreaks. However, it is worth noting that at present the impact of this is a moot point, as the success of traditional public health measures in the case of SARS may, alternatively, contribute to a strengthening of the confidence in Western medicine.

The role of the WHO in infectious disease outbreaks

The WHO was a significant presence in mediating and communicating the risks concerning SARS. In

the last decade or so the WHO—through the Office of Alert and Response Operations, Cluster on Communicable Diseases—has established programmes to support Member States in detecting and responding to epidemic emergencies; especially those that have the potential for serious international impact and involvement. The purpose of these programmes is to facilitate a rapid and appropriate response. For this the WHO has developed response assistance mechanisms at the country, regional and headquarters levels and, when necessary, can call upon the technical expertise of more than 120 partner institutions worldwide in the Global Outbreak Alert and Response Network (GOARN) ([Heymann & Rodier, 2004](#)).

Since 2000, this mechanism has mobilised international responses to 32 outbreak events in 28 countries. In the case of SARS, a network of scientists from 11 countries was established by WHO to identify the causal agent and develop a diagnostic test for SARS ([Stohr, 2003](#)). When an outbreak has serious international implications WHO may also offer assistance to other States to protect their populations and prevent the international spread of the health threat. SARS was somewhat unique in recent times in being felt to be of such potential concern that, for the first time in a decade, a global alert was issued, together with travel advisories ([Zambon, 2003](#)).

SARS thus served as an important opportunity to test existing international information systems. Notable was the speed with which the international community mobilised in response to the outbreak. For instance, despite an initial five-month period of denial by the Chinese government, within two weeks of the Hong Kong outbreak WHO issued a global health alert regarding cases of atypical pneumonia on 12 March 2003, and by 17 March a WHO collaborative multi-centre research project on SARS diagnosis was established to identify the causative agent and develop a diagnostic test. The project brought together 11 laboratories in nine countries using electronic communications to analyse samples from one patient in parallel in several laboratories, with the results shared in real time ([WHO, 2003a, b](#)).

This extensive use of global communications enabled the many institutions involved to keep astride of a rapidly changing situation. This included the establishment of a large number of additional websites by various agencies to disseminate information widely and quickly ([Larkin, 2003](#)).

Thus, although SARS tapped in to the fears surrounding globalisation reducing the levels to which people are in control of their destiny and subject to external forces—whether these be deliberate acts, such as terrorism, or not, such as environmental disaster and infectious disease outbreaks—SARS also illustrated the positive aspects of globalisation; global communication enabled researchers to share information in real-time and an international response be co-ordinated.

Policy lessons from SARS for dealing with infectious disease and risk

In many ways SARS could be dismissed as a ‘flash in the pan’, going from the report of the first outbreak to apparent worldwide panic and back to silence again all within the space of around three months. Yet SARS evoked a worldwide response far in excess of that generated by many more serious infectious disease threats of recent years. Why was this and what lessons does the experience hold, if any, for how future outbreaks may be managed?

Explaining the reaction to SARS

There are perhaps two important factors that encouraged the response. First was the general world context of a ‘climate of fear’ that was undoubtedly generated by events since 11 September 2001 and the general ‘war on terror’ mindset. More specifically, the war in Iraq had only just commenced when SARS began to make an impact. Second was the rapid geographic spread of an unclassified disease; SARS was a ‘mystery’ disease, with the aura of being able to strike anyone, anywhere, anytime. The relatively high case-fatality rate, methods of transmission, novelty of the disease and uncertainty over identification and control of the disease all contributed to public alarm, whether they were directly affected by SARS or not. This psychological effect created a sense of urgency that may not be found in other disease areas.

Responding to SARS-like situations in the future

Perhaps the most significant factor facilitating the response to, and management of, the SARS outbreak was modern technology and the positive results of globalisation in media and communications. The quality, speed and effectiveness with which the international public health community

responded to the SARS outbreak validated the efforts that have been made in networking global public health. The WHO deserves credit for initiating and coordinating this international response, through the GOARN, as do those involved in this network (Heymann & Rodier, 2004). In the future it is to be expected that this network will be strengthened, in the light of the SARS experience, but also recent concerns over bioterrorism, and have the capacity to respond to outbreaks of a greater magnitude than SARS. Further, the recent upturn in efforts to prepare for possible bioterror attacks should encompass and enrich strategies for dealing with infectious disease. After all, one does not generally know at the outset of an outbreak whether it is one that is natural or manmade and, in either case, a robust and prepared system will be required to rapidly and effectively respond to contain disease spread and impact (McFee, Leikin, & Kiernan, 2004).

There are also several other lessons for policy concerning risk and infectious disease that may be learnt from the SARS experience. First, a change in attitude from emergency responsiveness to preventive preparedness is needed, as part of a more holistic and strategic approach to planning for infectious disease outbreaks. By definition, emergencies offer a limited timeframe for taking action, and would thus benefit from a clear chain of command, strong coordination among relevant institutions, and strong political leadership. Clarity of responsibility, authority and accountability during outbreaks, from local to the global levels, is imperative for effective action. This includes institutions beyond the health sector, such as transportation, immigration, communications, finance, water and sanitation, defence, housing and education. When multiple sectors are involved, when there is scientific uncertainty, and when the timeframe is urgent, political leadership becomes especially important.

Further, when an outbreak occurs, decisions need to be taken by a diverse range of actors, from different perspectives and at varying points in the policy making process. Given the nature of public health emergencies, in terms of timeframe, potential unknowns and geographic reach, this decision making process can be complex and highly challenging. Yet the effectiveness of the emergency response can ultimately hinge on the quality of decision-making. For example, during the SARS outbreak there were different ways of organising

health controls for incoming passengers in the EU which had a negative effect on the trust placed by the public on the responsible official bodies. Such reductions in trust ‘make a suspicious public sceptical of official health warnings’ (Pickles & Goodwin, 2006; p. 11). Effective decision-making is characterised by such features as timeliness, accuracy, appropriateness, feasibility and clarity of purpose and message. It is therefore essential to reflect on how decision-making can best be carried out during public health emergencies.

Second, as a part of this decision-making process, there is a need for understanding more fully the costs and benefits of effective responses. Economic data is currently focused on direct and immediate costs, such as drugs, other interventions, health care services, to the relevant national health sector. A fuller and wider account of macroeconomic costs will underpin a more strategic approach to decision making, and contribute to more informed decisions that are taken proactively, rather than reactively, prior to and during emergencies. Although macroeconomic modelling of health issues is very novel, with only a few applications (e.g. Lee & McKibbin, 2004; Smith et al., 2005), a current European Union Framework 6 project is developing this approach, using the case of SARS (http://icadc.cordis.lu/fep-cgi/srchidadb?CALLER=FP6_PROJ&ACTION=D&RCN=73835&DOC=5&CAT=PROJ&QUERY=1). Work such as this is required to provide the foundations for recommending how such economic information may best be assessed and best incorporated in to the decision-making process for outbreak response.

Third, SARS demonstrated the importance of a worldwide surveillance and response capacity to address emerging risks through timely reporting, rapid communication and evidence-based action (Greaves, 2004). Since international infectious disease outbreaks may arise in resource poor countries, international agencies and wealthy countries must be encouraged to support policies, mechanisms and technologies that help resource poor countries to tackle these threats, whilst at the same time ensuring that national public health priorities are not distorted. One clear lesson from SARS and other outbreaks is the need for a more effective incentive system to encourage countries to notify these outbreaks.

Fourth, it will be critical to ensure that interventions respect public health ethics and fundamental human rights. Many of the public health measures

used during the SARS outbreaks, especially isolation and quarantine, may conflict with certain human rights. In order to plan a response to global infectious disease outbreaks it will therefore be important to consider a range of issues concerning the nexus between containment and human freedoms. For example, taking isolation and quarantine, there needs to be consideration of the level of transparency with which such policies are enacted and enforced, proportionality in the imposition of these policies compared with the benefits they offer and the assurance of a safe and habitable environment for persons subject to these measures (Gostin, Bayer, & Fairchild, 2003).

Finally, SARS emphasised the importance of communications with domestic and international policy makers, financial markets, the travel industry and other key sectors. However, perhaps the most important lesson from SARS was the importance of effective communication to the public. For example, social cohesion and compliance with quarantine in Toronto may be attributed to, at least in part, clear communication and practical guidance by authorities (Health Canada, 2003). However, the constant coverage by the press, and the manner with which some of the travel advisories were handled, were linked by some to ‘over reaction’ (Gatehouse, 2003; Hurst, 2003; Lam & Hong, 2003). It is therefore important in the future to accompany advisories with educational messages designed to help the public understand the risks of infection, and an appropriate response. To assist this there is a need for research to identify how the public responds to such a public health threat and what may be done to better manage this.

Conclusion—future research priorities

Serious infectious disease outbreaks need to be identified and dealt with quickly. Adverse health and economic effects can be reduced by early detection and response. Clearly, this will require taking action before all the facts are known and investigations are completed, and thus acting on incomplete information. In this respect, a concrete development could be to invest in epidemiological and economic modelling. Indeed, there has been a recent call for the development of such an integrated epidemiological and economic modelling approach, stemming directly from the SARS outbreak (Smith, Drager, & Hardimann, 2006). Key in this development will be the integration of the impact of risk

perception upon actions by actors (population, government, nations and so forth), and the effect of different strategies on this perception, and hence action. At present little is known about how uncertainty concerning the outbreak in question, or its level of risk, affects behavioural response. For instance, how do people determine their own risk of exposure? How does this perceived risk affect behaviour? Assessment of these factors in modelling the likely impact of an outbreak is therefore crucial.

In addition, there is need for better understanding and managing of risk surrounding infectious disease outbreaks. For example, understanding the relationship between infectious disease flows and flows of goods, services and people can help decision makers assess the relative risk of and to specific countries during an outbreak. This can contribute to more informed decisions that are taken proactively, rather than reactively, prior to and during emergencies.

Risk assessment can also be used to improve public communication. Research shows that some hazards or events deemed by experts as presenting a low risk become the focus of social and political concern, or amplification (Department of Health, 2003). In other cases, where experts perceive there to be a high risk, there can sometimes be insufficient social or political concern, or attenuation (Sandman 2004). An understanding of what drives the perception of risk is therefore sorely needed.

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