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Editorial

Documenting the SARS epidemic in mainland China

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In 2003, the world was confronted with the emergence of a new and in many cases fatal infectious disease, severe acute respiratory syndrome (SARS). SARS was caused by a novel coronavirus, which was provisionally termed SARS-associated coronavirus (SARS-CoV) (Drosten *et al.* 2003; Ksiazek *et al.* 2003). The earliest cases of SARS occurred in mid-November 2002 in Guangdong Province, China. SARS was first recognised in February 2003, when cases with an atypical pneumonia of unknown cause began appearing among hospital staff in Guangzhou, China. Within weeks, similar outbreaks occurred in Hanoi, Hong Kong, Toronto, Singapore and Taiwan. Soon thereafter, cases were being reported from 32 countries and areas (later corrected to 29). After July 2003, SARS came under control thanks to enormous efforts made by national and international organisations. More than 8000 cases were reported worldwide, with over 5000 from mainland China, making the country the epicentre of the outbreak (WHO 2004).

During the SARS outbreak in China, epidemiological and clinical information were obtained in difficult circumstances. The available data were only to a limited extent analysed and reported, and mainly in Chinese literature. There is a need for a comprehensive documentation of the SARS epidemic in China, accessible to the international scientific community. Following the epidemic, the European Union provided research funds to increase European preparedness for emerging infectious diseases, and as an important component to learn as much as possible from the experience of the People's Republic of China with regard to controlling SARS. This research programme was titled SARS*Control*: 'Effective and Acceptable Strategies for the Control of SARS and new emerging infections in China and Europe'. From 2005 to 2008, multidisciplinary research activities were undertaken, including in-depth studies of the Chinese situation, which are now reported in this supplement.

The supplement covers a wide range of studies. The first essential step was to bring together all available epidemiological data in one comprehensive database, which required data collection and cleaning, where necessary returning to original hospital records. This exercise resulted in a database containing epidemiological information of all known 5327 SARS cases, including 343 deaths, from mainland China. The first paper in this supplement presents the database and describes the context in which the data were originally collected (Feng *et al.* 2009a). The following three papers exploit the database through a description of, respectively, the geographic spread of SARS (Fang *et al.* 2009); case fatality ratio (Jia *et al.* 2009); and key epidemiological parameters such as duration of onset of disease to recovery or death (Feng *et al.* 2009b). These first four papers are followed by two comparative reviews. One is on the major control measures taken by China and other SARS-affected countries and areas (Ahmad *et al.* 2009). The other is on serological confirmation of SARS to assess possible over-reporting of SARS patients in mainland China (Liu *et al.* 2009a). Next, three hospital-based papers provide, respectively, a case–control study of risk factors among healthcare workers in Beijing, including the impact of protective measures (Liu *et al.* 2009b); a description of clinical characteristics of SARS patients in a hospital in Tianjin that experienced a large outbreak (Wei *et al.* 2009); and an analysis of the transmissibility of SARS and the effectiveness of control measures in three major hospital outbreaks (Cooper *et al.* 2009). Some consequences of SARS are described in the following three papers: an important long-term clinical consequence is the high proportion of avascular osteonecrosis in SARS patients treated with corticosteroids, as described in a cohort study of former SARS patients (Lv *et al.* 2009). The economic impact of the outbreak is described in a paper analysing indicators of social and economic activity in Beijing, such as leisure activities, transport, and tourism (Beutels *et al.* 2009). A positive consequence of SARS is illustrated by a review of Chinese literature describing the stark increase of papers on modelling of infectious diseases following the outbreak, representing scientific capacity building in China (Han

et al. 2009). The supplement is completed with a succinct assessment of the impact of public health control measures during the outbreak in mainland China (De Vlas *et al.* 2009). This analysis is based on the course of the epidemic as expressed in the effective reproductive number in relation to the timing of important interventions.

This unique series of articles provide a number of important insights for the SARS outbreak in mainland China. These insights are not necessarily new, but they are now documented with sufficient scientific rigour. Above all, it is clear that after an initial difficult phase, the SARS epidemic was contained successfully with traditional epidemiological methods at hospital and population level. The key to success was the moment that the Chinese authorities gained full control of all activities to combat SARS. Interestingly, it is shown in hindsight that many control measures that seriously affected public life – and that caused much of the economic consequences – were implemented when the epidemic was already dying down. Another important observation is that the case fatality ratio of about 6% in mainland China is substantially lower than in other parts of the world. This can be explained in part by the fact that the Chinese epidemic occurred mainly in the general population, resulting in younger cases and fewer patients with comorbidity. Over-reporting of SARS is a minor issue at most. It is also important to realise that many surviving patients now suffer from bone necrosis as a result of their treatment. Finally, although the economic impact was considerable at the time of the outbreak and shortly afterwards, there has been no permanent impact on the long-term economic development of the People's Republic of China.

Although SARS has not returned (apart from a number of isolated laboratory-based incidents), the studies in this supplement are very important. First, it cannot be known for certain that SARS will not re-emerge. Ebola, for example, re-emerged many years after the initial outbreak (Sanchez *et al.* 1995). The re-emergence of SARS is even likely, as the animal reservoir probably persists. Second, the SARS outbreak has provided valuable information and lessons relevant in controlling outbreaks of newly emerging infectious diseases that are surely due to come. Avian influenza and the novel A (H1N1) influenza threat are already knocking at our doors! Careful documentation of the SARS epidemic is therefore essential. Furthermore, the SARS outbreak highlighted the need for a tool for estimating the reproduction number during an epidemic in order to follow the course of the epidemic and the impact of interventions. Such tools have been developed since the outbreak (Cauchemez *et al.* 2006). The case fatality ratio is another key parameter determining the public health impact of an emerging disease (Galvani 2004). Methods to estimate this ratio during an epidemic (in real time) have now also been developed (Ghani *et al.* 2005).

Important lessons have been learnt in China from the SARS outbreak, including the need for more honesty and openness, improvement of surveillance, laboratory facilities and case management (Zhong & Zeng 2006). Also, public health measures to control infectious diseases, reporting systems, and central command and coordination came under scrutiny. Another lesson was the need to inform and involve the public timely and adequately regarding control measures; such issues have been dealt with separately in the SARS*Control* programme (Brug *et al.* 2009). The lessons learnt have led to fundamental changes in the Chinese health system (Wang *et al.* 2008) and were also instrumental in changes and improvements made in many other countries in the area of epidemic preparedness.

Conflicts of interest

The authors have declared that they have no conflicts of interest.

References

Ahmad A, Krumkamp R & Reintjes R (2009) Controlling SARS: a review on China's response compared with other SARS-affected countries. *Tropical Medicine & International Health* **14** (Suppl. 1), 36–45.

Beutels P, Jia N, Zhou QY, Smith R, Cao WC & de Vlas SJ (2009) The economic impact of SARS in Beijing, China. *Tropical Medicine & International Health* **14** (Suppl. 1), 85–91.

Brug J, Aro AR & Richardus JH (2009) Risk perceptions and behaviour: towards pandemic control of emerging infectious diseases : international research on risk perception in the control of emerging infectious diseases. *International Journal of Behavioural Medicine*, **16**, 3–6.

Cauchemez S, Boelle PY, Thomas G & Valleron AJ (2006) Estimating in real time the efficacy of measures to control emerging communicable diseases. *American Journal of Epidemiology*, **164**, 591–597.

Cooper BS, Fang LQ, Zhou JP *et al.* (2009) Transmission of SARS in three Chinese hospitals. *Tropical Medicine & International Health* **14** (Suppl. 1), 71–78.

De Vlas SJ, Feng D, Cooper BS, Fang LQ, Cao WC & Richardus JH (2009) The impact of public health control measures during the SARS epidemic in mainland China. *Tropical Medicine & International Health* **14** (Suppl. 1), 101–104.

Drosten C, Gunther S, Preiser W *et al.* (2003) Identification of a novel coronavirus in patients with severe acute respiratory syndrome. *New England Journal of Medicine*, **348**, 1967–1976.

Fang LQ, de Vlas SJ, Feng D *et al.* (2009) Geographical spread of SARS in mainland China. *Tropical Medicine & International Health* **14** (Suppl. 1), 14–20.

Feng D, de Vlas SJ, Fang LQ *et al.* (2009a) The SARS epidemic in mainland China: bringing together all epidemiological data. *Tropical Medicine & International Health* **14** (Suppl. 1), 4–13.

Feng D, Jia N, Fang LQ *et al.* (2009b) Duration of symptom onset to hospital admission and admission to discharge or death in SARS in mainland China: a descriptive study. *Tropical Medicine & International Health* **14** (Suppl. 1), 28–35.

Galvani AP (2004) Emerging infections: what have we learned from SARS? *Emerging Infectious Diseases*, **10**, 1351–1352.

Ghani AC, Donnelly CA, Cox DR *et al.* (2005) Methods for estimating the case fatality ratio for a novel, emerging infectious disease. *American Journal of Epidemiology*, **162**, 479–486.

Han XN, de Vlas SJ, Fang LQ, Feng D, Cao WC & Habbema JD (2009) Mathematical modelling of SARS and other infectious diseases in China: a review. *Tropical Medicine & International Health* **14** (Suppl. 1), 92–100.

Jia N, Feng D, Fang LQ *et al.* (2009) Case fatality of SARS in mainland China and associated risk factors. *Tropical Medicine & International Health* **14** (Suppl. 1), 21–27.

Ksiazek TG, Erdman D, Goldsmith CS *et al.* (2003) A novel coronavirus associated with severe acute respiratory syndrome. *New England Journal of Medicine*, **348**, 1953–1966.

Liu W, Han XN, Tang F *et al.* (2009a) No evidence of over-reporting of SARS in mainland China. *Tropical Medicine & International Health* **14** (Suppl. 1), 46–51.

Liu W, Tang F, Fang LQ *et al.* (2009b) Risk factors for SARS infection among hospital healthcare workers in Beijing: a case control study. *Tropical Medicine & International Health* **14** (Suppl. 1), 52–59.

Lv H, de Vlas SJ, Liu W *et al.* (2009) Avascular osteonecrosis after treatment of SARS: a 3-year longitudinal study. *Tropical Medicine & International Health* **14** (Suppl. 1), 79–84.

Sanchez A, Ksiazek TG, Rollin PE *et al.* (1995) Reemergence of Ebola virus in Africa. *Emerging Infectious Diseases*, **1**, 96–97.

Wang L, Wang Y, Jin S *et al.* (2008) Emergence and control of infectious diseases in China. *Lancet*, **372**, 1598–1605.

Wei MT, de Vlas SJ, Yang Z *et al.* (2009) The SARS outbreak in a general hospital in Tianjin, China: clinical aspects and risk factors for disease outcome. *Tropical Medicine & International Health* **14** (Suppl. 1), 60–70.

WHO (2004) *Severe Acute Respiratory Syndrome (SARS)* [Online]. WHO. Available from: http://www.who.int/csr/sars/en/ (accessed 12 June 2009).

Zhong N & Zeng G (2006) What we have learnt from SARS epidemics in China. *British Medical Journal*, **333**, 389–391.

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