

Emerging infectious disease: trends in the literature on SARS and H7N9 influenza

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Received: 19 July 2015 / Published online: 13 August 2015
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Abstract Severe acute respiratory syndrome (SARS) and human infection H7N9 influenza are emerging infectious diseases having a relatively high mortality. Epidemics of each began in China. By searching through Science Citation Index, this study analyzed the article literature on SARS and H7N9 influenza, particularly papers in the leading journals *The Lancet*, *New England Journal of Medicine (NEJM)*, *Nature* and *Science*. The results show that the quantity and quality of SARS and H7N9 influenza literature from mainland China changed distinctly over the course of 10 years. Researchers from mainland China published 12 article literature in the *The Lancet*, *NEJM*, *Nature* and *Science* about H7N9 influenza, whereas mainland China had only 2 article literature about SARS in the same journals. The literature reflects China's growing strength in the science and technology of emerging infectious disease.

Keywords Emerging infectious disease · Trends · Literature · SARS · H7N9 influenza · China

Introduction

Since 19 February 2013, when the first patient was reported to have been infected with the novel H7N9 influenza virus from an avian source, 571 laboratory-confirmed cases have been reported in China, of which 212 individuals died by 23 February 2015 (WHO 2015). Also in China, severe acute respiratory syndrome (SARS) emerged late in 2002, first in Guangdong Province, subsequently spreading across China and worldwide to 29 countries. Probable SARS cases reached 8096, of which 774 individuals died (WHO 2003).

SARS and H7N9 influenza are emerging infectious diseases sharing some common features. First, they all began in China; the first SARS patient was identified in Guangdong

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Province in 2002, and human H7N9 influenza infection first emerged in Shanghai in 2013. Second, they have a relatively high mortality rate, approximately 9.6 % for SARS (WHO 2003) and approximately 37.1 % for human H7N9 influenza infections (WHO 2015). Third, they all caused worldwide alarm. Meanwhile they also have some differences, one being that SARS spread rapidly outside China and became epidemic in some other countries such as Canada, Singapore and Vietnam, although H7N9 influenza has been mainly confined to China. Another difference is that, unlike H7N9 influenza, SARS is capable of effective person-to-person transmission, although some research shows that the possibility of H7N9 influenza transmission via this route exists (Rudge and Coker 2013).

Journal articles are useful for sharing research results, promoting control and prevention of emerging infectious diseases, and speeding up drug and vaccine development. The quantity and quality of journal articles can reflect the level of research in some countries and institutes as well as the degree of concern. China is a developing country, with the world's highest population, and like other countries it faces the threat of emerging infectious disease. China is now improving its capability to deal speedily with emerging infectious disease. To some degree, literature analysis can reflect this improvement.

Materials and methods

A literature search of Science Citation Index Expanded database (<http://apps.isiknowledge.com>) was conducted on July, 2015. The search formula for SARS was: Title = (“severe acute respiratory syndrome” OR “SARS”), Publication Type = Article; the search formula for H7N9 influenza was: Title = “H7N9”, Publication Type = Article. The affiliation countries and institutes of the author were based on the Reprint Address. Some results were removed that were not about the search target. Literature analysis included article literature distribution by year, country, institute, journal and literature citations. We particularly analyzed article literature in the journals *The Lancet*, *New England Journal of Medicine (NEJM)*, *Nature* and *Science*, which have higher impact factors. For the purposes of analysis, Hong Kong and Taiwan of People's Republic of China were treated separately from mainland China.

Result

SARS literature changed over time

We analyzed changes in published SARS literature by year. SARS article literature that have country information about the reprint author reached a peak of 591 in 2004 and decreased in the following years. Articles from Canada, Hong Kong, Singapore and the United States also increased in 2004 compared with 2003, and decreased in the following years. However, in mainland China the peak did not occur until 2005 (Fig. 1).

Country and region distribution of SARS and H7N9 literature

We retrieved 2628 article literature about SARS that identified the country of the reprint author. Country and region distribution were mainland China (21 %), the United States (20 %), Hong Kong (16 %), Taiwan (10 %), Canada (7 %), Singapore (6 %) and so on

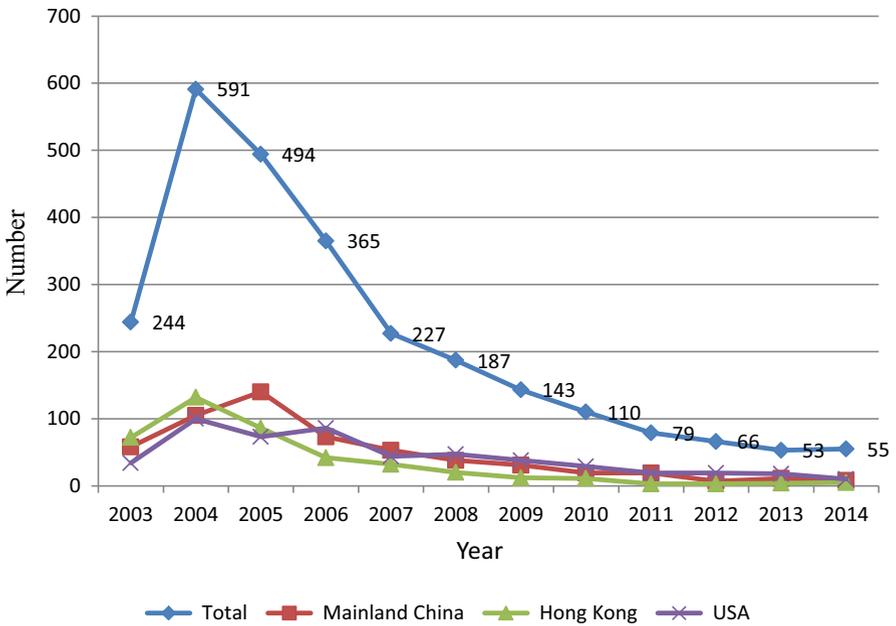


Fig. 1 Overall number of SARS journal articles published annually

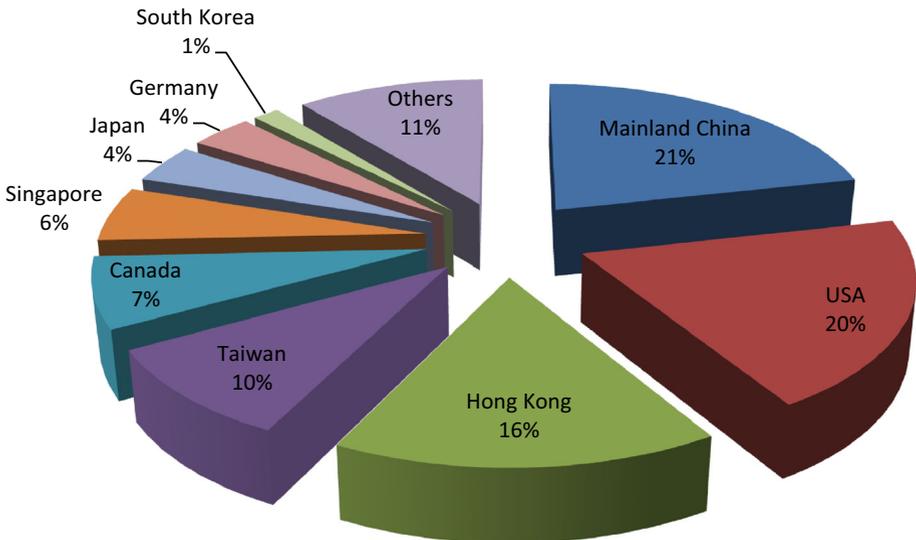


Fig. 2 Distribution of SARS journal articles by country and regions

(Fig. 2). Of the 835 article literature about SARS published in 2003–2004 that have country information about the reprint author, the leading country and regions were Hong Kong (24 %), mainland China (20 %), the United States (16 %), Canada (9 %), Singapore (8 %) and so on (Fig. 3).

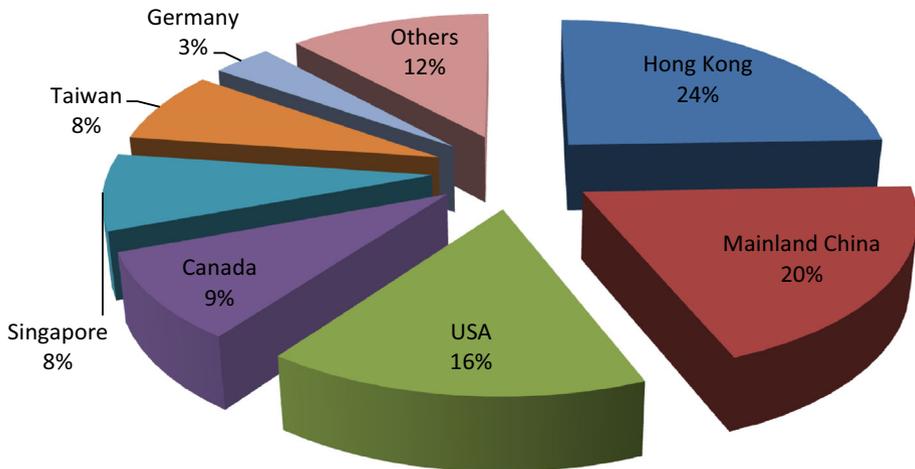


Fig. 3 Distribution of SARS journal articles by country and regions from year 2003 to 2004

Of the 385 article literature about H7N9 influenza that have country information about the reprint author, most were from Mainland China (57 %), followed by the United States (18 %), Hong Kong (6 %), Japan (3 %), Taiwan (2 %) and so on (Fig. 4).

SARS and H7N9 literature in leading scientific journals

Of the 47 article literature about SARS that were published in the leading scientific journals *The Lancet*, *NEJM*, *Nature* and *Science* and that have country information about the reprint author, most came from Hong Kong (16), the United States (11), Canada (5) and so on (Table 1).

Of the 20 article literature about H7N9 influenza that were published in these journals and that have country information about the reprint author, most were from mainland China (12), followed by Hong Kong (3), United States (2) and so on (Table 2).

Distribution of SARS and H7N9 journal articles citations by country and regions

We total retrieved 76,632 citations of SARS articles. Country and region distribution were the United States (28 %), Hong Kong (19 %), Mainland China (14 %), Canada (9 %), and so on (Fig. 5).

We retrieved 4633 citations of H7N9 articles. Country and region distribution were mainland China (65 %), the United States (13 %), Hong Kong (7 %), Japan (6 %), and so on (Fig. 6).

The main journals of published SARS and H7N9 literature

The main journals of published SARS article literature are *J VIROL* (207), *EMERG INFECT DIS* (128), *BIOCHEM BIOPH RES CO* (73), *VIROLOGY* (67) and so on (Table 3). The main journals of published H7N9 literature are *PLOS ONE* (39), *J VIROL* (28), *EMERG INFECT DIS* (25), *EUROSURVEILLANCE* (19) and so on (Table 4).

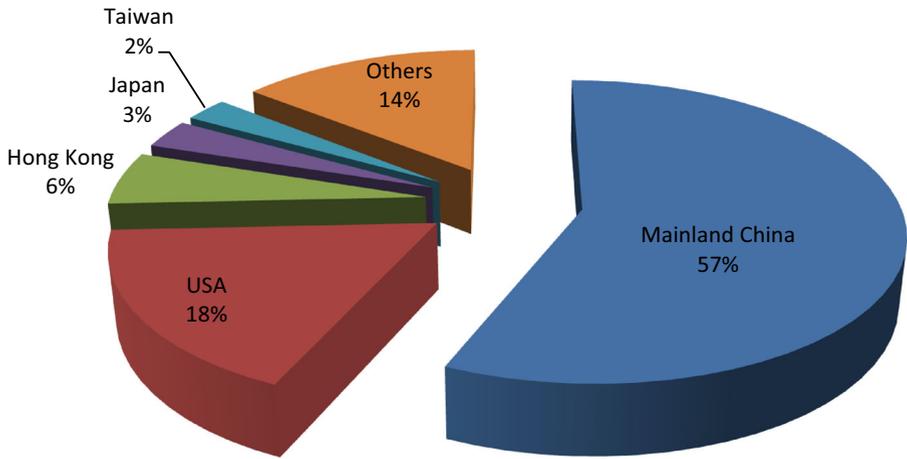


Fig. 4 Distribution of H7N9 journal articles by country and regions

Table 1 Countries and regions distribution of SARS literature in the journals The Lancet, New England Journal of Medicine (NEJM), Nature and Science

Country and regions	Lancet	New Engl J Med	Nature	Science
Canada	1	3		1
Mainland China				2
England	1			1
Germany	2	1		1
Hong Kong	12	3		1
Netherlands	2		2	
Singapore	1	1		
USA	3	2	3	3
WHO	1			

Table 2 Countries and regions distribution of H7N9 literature in the journals The Lancet, New England Journal of Medicine (NEJM), Nature and Science

Country and regions	Lancet	New Engl J Med	Nature	Science
Mainland China	3	3	3	3
England			1	
Hong Kong	3			
Japan			1	
Netherlands			1	
USA			1	1

The main institutes of published SARS and H7N9 literature

The main institutes from which published SARS article literature include Univ Hong Kong (165), Chinese Univ Hong Kong (140), Chinese Acad Sci (118), Peking Univ (55) and so on (Table 5).

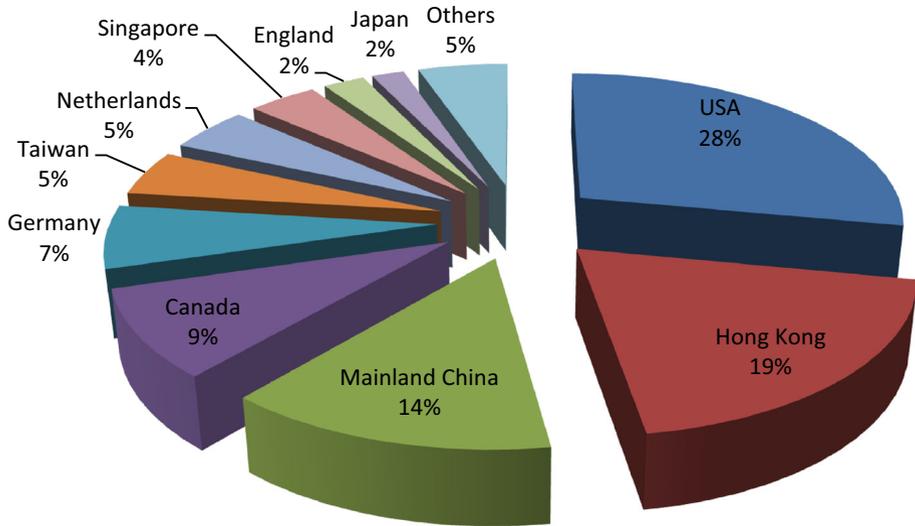


Fig. 5 Distribution of SARS journal articles citations by country and regions

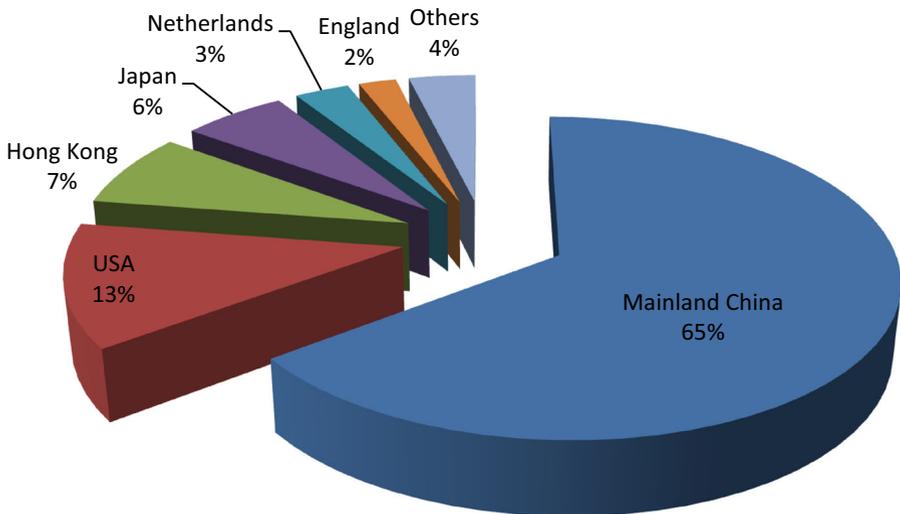


Fig. 6 Distribution of H7N9 journal articles citations by country and regions

The main institutes for published H7N9 influenza article literature include Chinese Ctr Dis Control and Prevent (20), Fudan Univ (20), Zhejiang Univ (19), Univ Hong Kong (19), Zhejiang Prov Ctr Dis Control & Prevent (15), Chinese Acad Sci (14) and so on (Table 6).

The institutes that had SARS literature in *The Lancet*, *NEJM*, *Nature* and *Science* include the Erasmus Med Ctr of Netherland (*Lancet* 1, *Nature* 2), Harvard Univ of the United States (*Nature* 1, *Science* 2), Univ Hong Kong (*Lancet* 6, *NEJM* 1, *Science* 1), Ctr Dis Control and Prevent of the United States (*Science* 1, *NEJM* 2) and so on.

Table 3 Journals distribution of SARS literature

Journals	Amount
J Virol	207
Emerg Infect Dis	128
Biochem Bioph Res Co	73
Virology	67
Adv Exp Med Biol	46
Chinese Med J-Peking	45
Vaccine	38
P Natl Acad Sci USA	37
Plos One	35
J Biol Chem	34
J Clin Microbiol	32
J Infect Dis	32
Virus Res	32
Febs Lett	29
J Gen Virol	29
Antivir Res	27
J Med Virol	25
J Virol Methods	25
Clin Infect Dis	23
Lancet	23
Biochemistry-US	22
Plos Pathog	21
Others	1598

Table 4 Journals distribution of H7N9 literature

Journals	Amount
Plos One	39
J Virol	28
Emerg Infect Dis	25
Eurosurveillance	19
Vaccine	15
BMC Infect Dis	13
Sci Rep-UK	11
J Infect Dis	10
Clin Infect Dis	7
Emerg Microbes Infec	7
Nat Commun	7
Nature	7
Int J Infect Dis	6
J Clin Virol	6
Lancet	6
Virol J	6
Others	173

Table 5 Main institutes distribution of SARS literature

Country and regions	Institutes	Amount
Hong Kong	Univ Hong Kong	165
Mainland China	Chinese Univ Hong Kong	140
Mainland China	Chinese Acad Sci	118
Mainland China	Peking Univ	55
Singapore	Natl Univ Singapore	48
Japan	Natl Inst Infect Dis	38
Mainland China	Wuhan Univ	34
Canada	Univ Toronto	29

Table 6 Main institutes distribution of H7N9 literature

Country and regions	Institutes	Amount
Mainland China	Chinese Ctr Dis Control and Prevent	20
Mainland China	Fudan Univ	20
Mainland China	Zhejiang Univ	19
Hong Kong	Univ Hong Kong	19
Mainland China	Zhejiang Prov Ctr Dis Control & Prevent	15
Mainland China	Chinese Acad Sci	14
USA	St Jude Childrens Res Hosp	10
Mainland China	Chinese Acad Med Sci	10

Mainland China had 12 article literature about H7N9 influenza in *The Lancet*, *NEJM*, *Nature* and *Science*, more than half of the total. The Chinese articles mainly originated from seven institutes, including China CDC (*Nature* 1, *NEJM* 2), Chinese Acad Agr Sci (*Science* 1), Chinese Acad Sci (*Lancet* 1, *Science* 1), Fudan Univ (*Lancet* 1), Shantou Univ (*Nature* 1, *Science* 1), Zhejiang Univ (*Lancet* 1, *NEJM* 1), Shenzhen Third Peoples Hosp (*Nature* 1). The institutes of other countries and regions that had H7N9 influenza literature in those journal include Univ Hong Kong (*Lancet* 3) and so on.

Discussion

Threat of emerging infectious disease

Emerging infectious disease poses an enormous threat to humankind. It can be associated with tragic consequences due to lack of immunity or inexperience in public health response, and the lack of effective medical treatment. One terrifying example is the 1918 H1N1 influenza pandemic, which killed 50 million people (Taubenberger and Morens 2006). There have been many emerging infectious diseases beside SARS and avian influenza, such as *E. coli* O157:H7, Nipah virus, Enterovirus 71, Hendra virus (Morens et al. 2004). Also including Ebola virus disease and Middle East Respiratory Syndrome (MERS) epidemic in year 2014 and 2015. Furthermore, because of the possibility of gene reassortment and potential cross-species transmission, the influenza virus is very threatening to humankind. New types of influenza are endlessly emerging. The potential H5N1

influenza pandemic and the 2009 H1N1 influenza world epidemic have had significant effects on human health, economic development and social stability.

Factors impact on literature related to emerging disease

Factors affecting the quantity and quality of literature related to emerging disease include the overall strength of the national research effort, the number of institutions and scientists engaged in such research, the amount of funding, the epidemiology of the disease, the level of scientific investigations in the field and so on.

The literature relating to SARS has decreased since 2004, mainly because SARS cases vanished after 2004. Acquired immunodeficiency syndrome (AIDS) was once considered an emerging infectious disease, but the quantity of literature on AIDS is persistently high because of the continuation of the global pandemic of AIDS (Tian et al. 2012). Also the quantity of H1N1 influenza literature sharply increased in 2009 because of the world epidemic of the H1N1 influenza.

The quantity and quality of emerging disease literature is also related to the science and technology capability. The United States had only 27 SARS case and no deaths, but the quantity of its SARS article literature is more. By contrast, some countries, such as Vietnam, had 63 SARS cases (WHO 2003), but the quantity of SARS article literature is far behind that of the United States. Another example is that the United States and the Japan have no human H7N9 influenza cases, but they have relatively more H7N9 literature.

The quantity and quality of SARS and H7N9 literature in mainland China changed distinctly

In this study, there were 565 article literature from mainland China about SARS, which account for 21 % of all the article literature about SARS. There were 218 article literature from mainland China about H7N9, accounting for 57 % of all the journal articles on H7N9 influenza. Although the Chinese SARS Molecular Epidemiology Consortium published a journal article in *Science* in 2004 (Chinese SARS Molecular Epidemiology Consortium 2004), the Institute of Zoology, Chinese Academy of Sciences published an article in *Science* in 2005 (Li et al. 2005), most higher impact factor journal articles on SARS were published by institutes outside mainland China, such as British Columbia Cancer Agency Genome Sciences Centre (Canada), Frankfurt University Medical School (Germany), University of Hong Kong (Hong Kong), Erasmus Medical Centre (Netherlands) and Univ London Imperial Coll Sci Technol & Med (UK). However, in the case of H7N9, this distribution changed distinctly. Mainland China have published 12 journal articles about H7N9 influenza in *The Lancet*, *NEJM*, *Nature* and *Science* since April 2013, taking up more than half of the total. Moreover, in the distribution of SARS article literature Citations by country and regions, mainland China is 14 %, compare with the H7N9 article literature is 65 %.

Breadth of research in H7N9 journal article from mainland China

Through analysis of the H7N9 journal articles from mainland China, it was found that these articles covered different fields, including epidemiology, clinical, virology, phylogenetics and so on. The *NEJM* article from the China CDC in April 2013 and February 2014 analyzed data obtained from field investigations and characterize the epidemiologic

characteristics of H7N9 cases in China (Liu et al. 2013; Li et al. 2014). The *NEJM* journal article from Zhejiang University in June 2013 analyzed the clinical findings in 111 cases of influenza H7N9 virus infection (Gao et al. 2013). The *Lancet* article from Chinese Academy of Sciences in June 2013 did phylogenetic analyses to extrapolate the potential origins of the virus and possible routes of reassortment events (Liu et al. 2013). The *Nature* article from the China CDC in July 2013 analyzed the biological features of the H7N9 influenza virus (Zhou et al. 2013). The *Science* article from Harbin Veterinary Research Institute in July 2013 found that one virus isolated from humans was highly transmissible in ferrets by respiratory droplets (Shi et al. 2013).

Improving Chinese capability to respond to emerging infectious diseases

Ten years ago, in the SARS response, the science and technology support capability of China was inadequate. For example, the SARS biological agent first appeared in China, but the gene sequence was first published by another country (Marra et al. 2003). Due to lack of experience, some health practitioners were infected and even died. Ten years later, the environment had changed notably. The overall capacity of the national disease prevention and control system has been greatly improved. A Web-based infectious disease reporting system has been built during the past decade, and it played a vital role in the response to H7N9 (Wang 2013). In 2008, China initiated major national science and technology projects including “Prevention and Control of Major Infectious Diseases Including HIV/AIDS and Viral Hepatitis”, together with the “973” project, “863” project and the National Natural Science Foundation, which promoted basic and applied research into emerging infectious disease. All of those have improved the science and technology support capability in response to emerging infectious diseases in China and the world.

Acknowledgments We thank Elixigen Corporation (Huntington Beach, California, USA) for helping in proofreading and editing the English of final manuscript.

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