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Original Article

Is a Mass Prevention and Control Program for Pandemic (H1N1) 2009 Good Value for Money? Evidence from the Chinese Experience

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Abstract

Background: In order to provide guidance on the efficient allocation of health resources when handling public health emergencies in the future, the study evaluated the H1N1 influenza prevention and control program in Hubei Province of China using cost-benefit analysis.

Methods: The costs measured the resources consumed and other expenses incurred in the prevention and control of H1N1. The assumed benefits include resource consumption and economic losses which could be avoided by the measures for the prevention and control of H1N1. The benefit was evaluated by counterfactual thinking, which estimates the resource consumption and economic losses could be happened without any measures for the prevention and control, which have been avoided after measures were taken to prevent and control H1N1 in Hubei Province, these constitutes the benefit of this project.

Results: The total costs of this program were 38.81 million U.S. dollars, while the total benefit was assessed as 203.71 million U.S. dollars. The net benefit was 164.9 million U.S. dollars with a cost-effectiveness ratio of 1:5.25.

Conclusions: The joint prevention and control strategy introduced by Hubei for H1N1 influenza is cost-effective.

Keywords: H1N1 influenza, Prevention and control, Cost-benefit

Introduction

The H1N1 influenza is a type of acute respiratory infection caused by a new mutant of swine influenza virus (SIV). It causes an immune response in humans similar to the influenza pandemic of 1918 which took the lives of some 20 million people (1).The emergence of H1N1 has had a serious impact on human health and economy internationally. From May 12th 2009, the day when the first reported cases of H1N1 influenza were diagnosed in China until, to the end of December 2009, 121843 people in total were diagnosed and 645 people died from H1N1 influenza in 31 provinces of mainland China. The incidence rate and mortality rate were 9.17/100,000 and 0.05/100,000 respectively (2).

Since the outbreak Chinese governments at each level have paid great attention to managing the risks associated with H1N1 influenza. They have devoted a huge amount of human, material and financial resources to implement evidence based policies, effective prevention and uniform standardized treatment. From the perspective of health

economics, to handle public health emergencies or major infectious disease in a more economical way and to allot and use the limited health resource rationally so as to Improve the efficiency in the use of health resources in the future, it was very necessary to conduct a health economic evaluation on the H1N1 influenza prevention and control program, especially the cost-benefit analysis.

Since the outbreak of H1N1 influenza in 2009, the public health implications quickly became a common concern of the world. However, the studies on H1N1 influenza were mainly in these respects like transmission, disease impact, vaccine, virus testing methods and epidemiological analysis. While the related research from the perspective of health economic evaluation of H1N1 influenza prevention and control measures was scarce. The remaining studies were either just a health economic evaluation of vaccination, for example, Professor Zhao Gen-ming conducted a cost-benefit analysis of H1N1 vaccination in Shanghai, and found that the cost-benefit ratio was 1:1.6(3), or a health economic analysis and evaluation of joint prevention and control measures at the initial stages of the outbreak, for example, Professor Zhao Kun in China Health Economics Institute of the Ministry of Health conducted a cost-benefit analysis of joint prevention and control measures for H1N1 from April 25th to June 10th in mainland China, and found that the cost-benefit ratio in this period was 1: 10.08, and illustrated the these measures were cost-effective (4). Up to date, there has been no systematic cost-benefit analysis of H1N1 prevention and control, which would affect the scientific and reasonable evaluation on the effective of H1N1 prevention and control. The objective of this study was to develop a cost-benefit analysis of H1N1 prevention and control from all aspects and the whole process, to give some basis for making wiser decision when faced with other public health emergencies or serious infectious diseases in the future, and to provide a reference for other developing countries.

In order to guarantee the quality of data and the veracity of the cost-benefit estimates of H1N1 prevention and control in China, given China's characteristics of vast territory and population and the difficulty of data collection, Hubei Province was selected as the survey object. It is in central China with its medium level economy development in China.

Hubei Province has a population about 61,418,800 and an area of 185,900 square kilometers, accounting for 1.95% of China's area, ranking 14th. Since the first case of H1N1 influenza was confirmed on June 2nd in 2009, to the end of December 31st in 2009, 5542 cases in total had been reported, including six deaths. Among these cases, 2907 cases were laboratory-confirmed, 2635 cases were clinically diagnosed.

The purpose of the study was to conduct a health economic evaluation on the influenza A H1N1 prevention and control program in China with the example of Hubei Province.

Materials & Methods

Fundamental Lines

From all aspects in society related to the disease, the study investigated the cost-benefit of the measures to prevent and control H1N1 in Hubei Province in 2009. The costs measured the resources consumed and other expenses incurred in the prevention and control of H1N1, including direct and indirect cost of the treatment of diagnosed patients, medical observation of clinically diagnosed patients at home, isolated observation of close contacts, disinfection of reservoirs, the technician time and materials used in laboratories, vaccine costs, community health education and logistics. The assumed benefits include resource consumption and economic losses which could be avoided by the measures for the prevention and control of H1N1, including the medical resource, the work delays, the economic losses caused by death and the loss of hospital income.

The study evaluates the benefit by counterfactual thinking, the method used by Professor Zhao Kun in China Health Economics Institute of the Ministry of Health when doing the cost-benefit analysis of the prevention and control of H1N1 all around China at the initial stages of the outbreak, which estimates the resource consumption and economic losses could be happened without

any measures for the prevention and control.4 The counterfactual scenarios like this: In the trend that H1N1 may spread around the world, if no measures were taken to prevent and control H1N1 in Hubei province, it would natural sporadic even the outbreak around the province. This would cause death case, therefore cause lots of direct and indirect cost for treatment; Meanwhile, people would be out of work due to disease, worse more, some work force would be lost, which could result in social work force reduction and GDP decline. In fact, all the counterfactual resource consumption and economic losses have been avoided after measures were taken to prevent and control H1N1 in Hubei province, these constitutes the benefit of this project.

The period of the survey

The survey lasted from April 25th, 2009 to December 31st, 2009. The evaluations for cost and benefit are also during the same period. Meanwhile, April 25th, 2009 is the day when joint prevention and control measures were started in China.

The place of the survey

Among the 17 districts in Hubei Province, three areas were selected as the areas typically investigated, based on typical investigation methods and considering factors such as economic, traffic and geography, namely Hongshan Area in Wuhan District, Fancheng Area in Xiangyang District and Enshi City in Enshi District. Another three areas were respectively selected based on stratified random sampling methods with the incidence as stratification factor (high, medium, low), namely Huangzhou Area in Huanggang District, Wujiagang Area in Yichang District and Xiaonan Area in Xiaogan District.

The object and method of the survey

Field survey mainly included giving out questionnaire and interviewing indirect personnel, the object contains three parts, the first one is the survey of health-related sector, including local public health bureaus, emergency aid centers, CDCs, designated hospitals, medical observation station, those hospitals which have fever clinics; the second is the interview to sectors other than health, including finance bureau, education bureau, immigration and quarantine bureau, railway administration, transportation authority, civil aviation authority and tourism bureau; the third is telephone interview to the individuals directly affected, including patients, household and close contacts. In order to better realize the research object, the research group did a pre-survey among some sectors such as the department of health, and Centers for Disease Control (CDC) in Hubei Province, and then improved the questionnaire and interview plan on the basis of pre-survey.

Data sources

Epidemiological data

The number of confirmed cases of H1N1 influenza at latest on December 31th 2009 came from Hubei CDC statistics, while the treatment cycle of diagnosed patients came from < Analysis and report about H1N1 influenza prevention and control in Hubei in 2009>, and the data of urban and rural area population came from <2010 Hubei Statistical Yearbook >. The data about confirmed cases, deaths and others came from the official website of U.S. government (url: http://www.flu.gov/individualfamily/about/h1n1/estimates_2009_h1n1.html). The data of U.S. population comes from statistical data in official website of WHO.

Cost data

The cost of treatment per capita took the mean of the valid data in field survey as reference; the financial investment of 14 inter-monitoring laboratories was collected by field survey; the data of the cost of materials like H1N1 vaccine and drugs came from Hubei Health Department; the data of financial investment at all levels for Office expenses in H1N1 prevention and control was collected by field survey. The data of the number of hospitals in urban and rural area were collected from <2010 Hubei Health Statistics Yearbook>, the entry and exit ports population were calculated according to the daily immigration in local inspection and quarantine bureau.

Benefit data

The data of treatment cost saved per capita in direct benefit calculation was the same with those for diagnosed patient in cost data. The average daily wage of diagnosed patients and patients who died in the indirect benefit calculation came from <2010 Hubei Statistical Yearbook >. The data of the economic losses of designated hospitals and those hospitals which have fever clinics took the data of field research in sample cities as reference.

Calculation Method

Calculation basis

Cost and benefit was calculated by currency value in cost-benefit analysis. The calculation of the benefit of H1N1 influenza prevention and control in this paper refer the circumstances of prevention and control and incidence in USA during the same period. Learnt from experts, America adopted loose border quarantine policy against H1N1 influenza. The report set up a disease model in natural state in Hubei Province, based on the incidence in America and with consideration of H1N1 influenza's pathogenicity and transmissibility and outbreak in other countries. The natural state means the disease state in Hubei without taking any measures. The disease model includes sporadic and the outbreak. The sporadic took the incidence in USA as reference, while the outbreak was calculated on the base of incidence multiplier. The incidence multiplier was Quoted from <the cost-benefit analysis of joint prevention and control measures for H1N1 influenza in China> written by Professor Zhaokun in Institute of Health Economics in China Health Ministry. The life value like work-delay and death in indirect benefit part in the model took the present value of individual's future income as reference, estimated by human capital approach.

Calculation assumptions

To calculate the cost and benefit of joint prevention and control measures for H1N1 influenza, on the basis above, some parameters hypothesis as follows: the sporadic incidence of H1N1 influenza in natural state was 812.3 per million, the incidence multiplier is 1.8; the average reduction in life expectancy is 12 years(according to <the cost-benefit analysis of joint prevention and control measures for H1N1 influenza in China> written by Professor Zhaokun in Institute of Health Economics in China Health Ministry); 30 percent of urban residents and 10 percent rural residents can obtain promotional materials about H1N1 influenza; The average length of stay of the diagnosed patients is 8.9 day. The average wage income per capita in 2009 is 3,472 U.S. dollars.

Results

The cost of prevention and control

The direct and indirect cost of treatment for diagnosed patients

There were 2907 confirmed cases in total, 760 of them were inpatients, 2147 were outpatients. The direct cost for inpatients included the costs of beds, medicine, inspection, remedy, nursing care, diagnosis, injection, materials, surgery, laboratory tests, oxygen, medical waste disposal and others. The indirect cost for inpatients included costs of transportation, nutrition, the reduction of wage income due to work-delay of patients or their family members accompanying, the additional costs of transportation, registration, remedy, and accompanying persons' transportation and accommodation costs in referral. While the direct cost for outpatients included the costs of radiology, laboratory, material, disinfection, remedy, intensive care, bed, meals, diagnosis, medicine and medicine. And the indirect costs for outpatients mainly refer to outpatients' transportation costs.

Based on the mean of the valid data of field survey in 6 sampling cities, the direct and indirect treatment costs for diagnosed patients were as the Table 1 shows.

The costs of 428 inpatient cases were gotten in the field survey in 6 sampling cities, account for 56.32 percent of inpatient cases in Hubei. Among them, 385 were mild cases, 43 were severe cases, accounting for 58.1% of severe inpatient cases in Hubei, and 2 death cases, accounting for 33.3 percent death cases in Hubei.

Table 1: The direct and indirect treatment costs for diagnosed patients

Type of costs	Per capita costs(RMB)	Total costs(RMB)
The direct treatment costs	—	8,423,400
Inpatient cases	6416.16	4,876,300
Outpatient cases	1652.11	3,547,100
Indirect treatment costs	—	3,910,200
Inpatient cases	4790.80	3,641,000
Outpatient cases	125.40	269,200
Total	—	12,333,600

The average direct and indirect costs for each inpatient were 11206.96 RMB among them the direct costs were 6416.16 RMB while the indirect costs were 4790.8 RMB. The per capita indirect treatment costs contained 125.4 RMB for traffic, 890 RMB for nutrition, 2600 RMB for the income reduction of patients or their families accompanying; 1125.4 RMB for the accompanying persons' traffic and accommodation and 50 RMB for the additional traffic fees, registration fees, clinic fees in referral.

Meanwhile, the costs of 306 outpatient cases were gotten in the field survey in 6 sampling cities, account for 14.3 percent of outpatient cases in Hubei. The average direct costs for each were 1652.11 RMB, while the indirect costs were 125.4 RMB (traffic costs mainly).

Finally, based on 2906 diagnosed cases in Hubei in 2009, the treatment costs for inpatients and outpatients were calculated, they were 8.51 million RMB and 3.82 million RMB respectively, the total costs were 12.33 million RMB.

The costs of medical observation for patients clinically diagnosed at home

Up to December 31st in 2009, the total case of clinically diagnosed patients were 2635, the total costs of medical observation for them were 1,233,200 RMB (Table 2).

Table 2: The costs of medical observation for patients clinically diagnosed at home

Type of costs	Per capita costs(RMB)	Total costs(RMB)
Inspection	152	400,500
Drugs	58	152,800
Disinfectants	108	284,600
Others	150	395,300
Total	468	1,233,200

Costs of isolated observation for close contacts

Since the first case of H1N1 influenza was reported on June 2nd 2009, many close contacts in different groups had been isolated for observation in hotels, hospitals or at home. Based on means of valid data of the field survey in 6 sampling cities, the total costs of isolated observation for close contacts were estimated to be 9,030,000 RMB (Table 3).

Table 3: Costs of isolated observation for close contacts

Ways of isolation	Number of people	Per capita costs(RMB)	Total costs (RMB)
Isolation in hotel	528	5,477.42	2,890,000
Isolation in hospital	1623	3,737.84	6,067,800
Isolation at home	344	210.00	72,200
Total	—	—	9,030,000

The costs of detection for influenza cases

In the year of 2009, 9702 specimens were collected in 19 sentinel hospitals in Hubei, virus isolation and identification were done for 3956 specimens and 659 types of virus (isolation-positive- rate was 16.7%) were found, including 591 plants of seasonal influenza virus and 68 plants of H1N1 influenza virus. Nucleic acid detection was done for 7982 specimens from sentinel hospitals and 3679 positive cases were found (positive- rate was 46.1%), the popular plant of virus was H1N1 influenza virus (accounting for 52.5%). Rapid serological survey was carried out in Hubei in December 2009, and 422 specimens were detected.

The mean positive rate was 8.53%. The costs distribution was shown in Table 4.

Table 4: The costs of detection for H1N1 influenza cases

Project	Number of specimens	Mean costs (RMB)	Total costs (RMB)
Specimen collection	9,702	20	194,000
Virus isolation and identification	3,956	180	712,100
Nucleic acid detection	7,982	400	3,192,800
Serology tests	422	50	21,100
Total	—	—	4,120,000

The operating costs for influenza surveillance network laboratories

There were 14 influenza surveillance network laboratories in Hubei up to the end of 2009, including 8 new laboratories set up for H1N1 influenza prevention and control from June in 2009. In the process of H1N1 influenza prevention and control, the total operating costs for 14 influenza surveillance network laboratories invested by every level government were approximately 14.8 million RMB, the investment were mainly used for consumption of reagents, equipment maintenance or supplement, related technical staff training.

H1N1 vaccine purchase costs and vaccination subsidies

Vaccination had successively begun all around Hubei since November 1st 2009. In total, 4,500,000 doses were purchased in Hubei. Each dose of vaccine cost 23 RMB, with a total cost of vaccine purchase being 103.5 million RMB. In addition, government provided subsidies for vaccination amounting to 14.6 million RMB. The total costs of vaccine purchase and vaccination subsidies were 118 million RMB and the per capita cost of vaccination was 26.25 RMB.

Other costs allocated by Hubei Finance

Other costs besides vaccine allocated by Hubei Finance were 15.6 million RMB in total. Among them, 7.5 million RMB was for working expenses, 2.6 million RMB was for Tamiflu reservation (176 RMB per copy, 15,000 copies), 5 million RMB was for ventilators purchase(250 thousand RMB per ventilator, 20 ventilators), 500 thousand RMB was for ambulance purchase (250 thousand RMB for each, 2 ambulances).

Other costs allocated by local Finance

Based on field survey, besides the costs for the construction of influenza network laboratories, the local governments had located more than 70 million RMB as special funds, mainly used for official business of headquarters, immigrants tracking, disposal for sites of outbreak, purchase of medical equipment, reserves of emergency supplies, health education and so on.

Costs of other units in joint prevention and control for H1N1 influenza

Many units were involved in the prevention and control for H1N1 influenza, besides the governments in all levels, local health authorities and medical institutions, departments like education, transportation, tourism, port, police and their subordinate units had input lots of human, material and financial resources. Estimated on the basis of field survey and incomplete statistics, the direct costs for these units were 19.7 million RMB in total.

In summary, from April 25th 2009 to December 31st 2009, the total costs for H1N1 influenza prevention and control in Hubei were 265 million RMB approximately. Among them, the costs of H1N1 vaccine purchase and vaccination subsidies account the highest proportion (44.57%). The second was the costs allocated by local Finance for official business of headquarters, immigrants tracking, disposal for sites of outbreak, purchase of medical equipment, reserves of emergency supplies, health education and so on (26.41%). Other costs and details were shown in Table 5.

Table 5: The total costs for H1N1 influenza prevention and control in Hubei

Measures	Mean costs(RMB)	Total costs(thousand RMB)	Percentage (%)
Direct and indirect cost of treatment for diagnosed patients	_	12,334	4.65
Medical observation for clinically diagnosed patients at home	468.00	1,233	0.47
Isolated observation for close contacts	_	9,030	3.41
Detection for influenza cases	_	4,120	1.55
Influenza surveillance network laboratories	106.29	14,880	5.61
Vaccine purchase and vaccination	26.25	118,140	44.57
Other costs besides vaccine allocated by Hubei Finance	_	15,630	5.90
Other costs allocated by local Finance	_	70,000	26.41
Costs of other associated units	_	19,720	7.44
Total	_	265,087	100

The effect of prevention and control

Analysis of the epidemic of H1N1 influenza in USA

Up to December 16th 2009, 246 thousand people In USA were infected by H1N1 influenza, with 11,160 death cases. The population of USA was 302,841 thousand, therefore, the incidence rate of H1N1 influenza was 8.123/10000 (246000/302841000×10000/10000= 8.123/10000), the mortality rate was 3.69/100000 (11160/302841000×100000/100000=3.69/100000), the case fatality rate was 4.54% (11160/246000×100%=4.54%)

The prediction of H1N1 influenza in counterfactual state in Hubei: The population of Hubei Province is 61,418,800, if the spread multiplier is 1.8, then 139,693 cases would be infected by H1N1 in natural state in Hubei.{61,418,800×8.123/10000×(1+1.8)=139,693}, and 2,266 cases would die. (61,418,800×3.69/100000=2,266).

The effect of H1N1 prevention and control in Hubei: From April 25th 2009 to the end of December 31st 2009, the total number of incidence was 5,542 (including 2,907 diagnosed cases and 2,635 clinically diagnosed cases) while 6 cases died. Compared with the prediction in counterfactual state, the cases infected had been greatly reduced due to the measures of prevention and control for H1N1. The reduction of incidence was 134,151 cases (139,693-5542=134,151), while the reduction of death was 2,260 cases (2266-6=2260). The virtual incidence rate of H1N1 in Hubei was 9.02/100000, the mortality rate was 0.01/100000, and the case fatality rate was 0.11%, all these indicators were lower than the means in China. (In China, the incidence rate of H1N1 was 9.17/100000, the mortality rate was 0.05/100000, and the case fatality rate was 0.54%).

Effectiveness analysis of H1N1 prevention and control

The analysis above demonstrated that in counterfactual thinking model, 2266 cases would die of H1N1, but the virtual death cases were 6, therefore 2260 cases had avoid death because of the H1N1 prevention and control measures. On the supposition that the mean years of life lost was 12 years, then the total increased person-years of life was 27,120 person-years (2260 persons×12 years = 27120 person-years)

Benefit analysis of H1N1 prevention and control

Outcome of direct benefit

In counterfactual thinking model, under the trend that H1N1 may spread around the world, if no measures were taken to prevent and control H1N1 in Hubei Province, it would outbreak around the province and 139693 people would be infected. However, the virtual number of cases was 5542, which means 134151 people had avoid be infected due to the measures of prevention and control for H1N1. According to the virtual

rates of diagnosed cases and clinically diagnosed cases and their costs in Hubei in 2009, the direct benefit could be estimated to be 328350100 RMB Yuan (Table 6).

Table 6: The direct benefit of H1N1 prevention and control in Hubei in 2009

Types	Percentage in total (%)	Cases	Per capita costs(RMB)	Total costs saved (total direct benefit, thousand RMB)
Laboratory-confirmed cases	52.45	70,362	—	298,496.9
including：inpatients	13.71	18,392	11,206.96	206,119.6
outpatients	38.74	51,970	1,777.51	92,377.4
Clinically diagnosed cases	47.55	63,789	468.00	29,853.2
Total	100	134151	—	328,350.1

Outcome of indirect benefit

The indirect benefits contain the avoided economic burden of death, the avoided losses due to work-delay for patients and their families, the avoided loss of hospitals' income, other avoided losses and so on. On the basis that the per capita yearly wage-income was 23709 RMB in Hubei in 2009, the avoided economic burden of death was 642988100 RMB (23709 RMB /person/year×27120 person/year=642988100 RMB). In general, H1N1 patients cannot work normally for about 20 days (for diagnosis, treatments and convalescences), on the supposition that each patient would have a family accompanied, therefore, the avoided losses due to work-delay for patients and their families were 348792600 RMB {(139693-5542)×2×65 RMB /day×20days=348792600 RMB }. The calculation of the avoided loss of hospitals' income was based on the field survey in Hubei, on the supposition that the average loss of hospitals' income was 1810200RMB, the total loss of 34 designated hospitals' income was about 61546800 RMB; Other avoided losses mainly refer to the subsidies for security & cleaning personnel in designated hospitals and fees for communications in work. Suppose there were 10 security & cleaning personnel in 34 designated hospitals on average, and their daily wage was 65 RMB /day, and they had been hired for 7 months, the estimated fees for communications were 500000 RMB, so the total other avoided costs were 9782000 RMB (Table 7). The table above shows that the indirect benefit of H1N1 prevention and control was 1,063 million RMB. Among them, the avoided economic burden of death accounted for the largest portion (60.48%), while the avoided loss due to work-delay for patients and families accounted for 32.81%, the avoided loss of hospitals' income due to ward voidance for H1N1 patients accounted for 5.79%, other avoided losses accounted for 0.92%.

Outcome of total benefit

The total benefit of measures of prevention and control for H1N1 was 1,391 million RMB, among which the direct benefit accounted for 23.60%, while the indirect benefit accounted for 76.40%. It was demonstrated that most of the benefit were savings of indirect costs (Table 8).

Table 7: Outcome of indirect benefit

Types of indirect benefit	Amount of indirect benefit (thousand RMB)	Percentage (%)
The avoided economic burden of death	642,988.1	60.48
The avoided work-delay for patients and families	348,792.6	32.81
The avoided loss of hospitals' income	61,546.8	5.79
Other avoided losses	9,782.0	0.92
Total	1,063,109.5	100

Table 8: Outcome of total benefit

Types of benefit	Benefit(thousand RMB)	(%)
Direct benefit	328,350.1	23.60
Indirect benefit	1,063,109.5	76.40
Total	1,391,459.6	100

Cost-effectiveness ratio

During the period from April 25th in 2009 to December 31st in 2009, the total costs of H1N1 influenza prevention and control were 265 million RMB while the total benefit were 1,391 million RMB, its net benefit was 1,126 million RMB, the cost-effectiveness ratio was 1 ： 5.25.

Discussion

China is big country with a population of 1.3 billion. The expenditure for healthcare increased rapidly in these years (5). Since the breakout of Influenza A H1N1 in 2009, vigorous responses to influenza A H1N1 were taken by the China government, which included aggressive case finding, vaccine development, and mass vaccination at a speed and scale unparalleled elsewhere(6). In the research, the benefit was evaluated by counterfactual thinking. In natural state, where would be 139693 infected cases and 2266 death cases. However, these numbers were controlled to be 5542 and 6 after taking vigorous measures. It demonstrates that the measures for Influenza A H1N1 prevention and control were effective.

From the perspective of health economy, lots of human, material and financial resources were put into the prevention and control for influenza A H1N1. According to the research, the total cost were 265 million RMB, while the benefit were 1391 million RMB, the net benefit were 1126 million RMB, the cost-effectiveness ratio were 1 ： 5.25. These figures fully demonstrated that measures for Influenza A H1N1 prevention and control in Hubei were cost-effective, which means that 1 RMB input would result in 5.25 RMB output. This economic information showed that prevention and control measures for preventable infectious diseases were cost-effective (7).

From the constitution and their percentage of costs, the most part of the costs is Vaccine purchase and vaccination subsidy (118 million), accounting for nearly half of the total costs. The reason why so much money was input in Vaccine is that vaccination is commonly acknowledged as the best way to prevent and control influenza A H1N1(8). Vaccination can protect healthy people from infection and reduce the spread of the virus in the population. In the cost benefit analysis of a mass influenza A vaccination program in Ontario, Canada, Beate Sander and Chris T. Bauch(9) drew the conclusion that vaccination is not only effective and cost-beneficial, and also more effective if it was carried out earlier. As to the reason why it cost so much in influenza A H1N1 vaccination, the study thought that influenza A H1N1 is a new pandemic virus, therefore the cost of research and produce was more expensive.

Meanwhile, due to the masses' lack of knowledge about influenza A H1N1 and the hype of some media, the fear was easily arouse among the masses and the danger was overestimated. Therefore, severe isolation measures were taken in Hubei in early period. Though the over-tight measures would reduce the transmission probability in theory, however, it would increase the cost which resulted in a waste of health resource.

One thing that worth mentioning is that the purpose of the cost-benefit analysis of prevention and control measures for influenza A H1N1 prevention and control in Hubei Province is to assess the effectiveness of current control efforts from a health economics point of view, and to provide basis for decision making when handling future public health emergencies or disease prevention control program. However, it does not mean that the economic principle is the only factor to be considered when developing prevention and control measures, because in addition to economic factors, ethics (concerned about fairness, justice and other issues) is also need to consider in the decision-making process for allocation of health resources (10).

Conclusion

In conclusion, when humans face similar infectious diseases such as influenza A H1N1, it is an effective way to control the spread of infectious diseases by devoting the necessary human, material and financial resources and taking strict measures against infectious disease prevention and control in the first time. Not only it meets the needs of human physical and mental health, but also it is cost-effective.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

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