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An analysis of the current status of hospital emergency preparedness for infectious disease outbreaks in Beijing, China

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Background: In the event of a large-scale infectious disease outbreak, hospitals will play a critical role. The objective of our study is to understand the current status of hospitals preparedness for infectious disease outbreaks in Beijing and to provide basic information for infectious disease prevention and control in hospitals.

Methods: One hundred fifty-two secondary and tertiary care hospitals in Beijing were surveyed by a standardized questionnaire. Data related to hospital demographic information and their emergency plans, laboratory diagnosis capacity, medical treatment procedures for infectious diseases, stockpiles of drugs and personal protective equipment, and staff training were collected.

Results: Responses were received from 134 (88.2%) of the 152 hospitals surveyed. Overall, hospitals reported that the number of physicians and nurses in infectious disease accounted for only 1.8% of the total physicians and 2.5% of the total nurses, and surgery beds accounted for 8.5% of all the fixed beds. Approximately 93.3% of the hospitals surveyed reported that they had an emergency plan, and none of those reported that their laboratories were able to isolate and identify all 8 kinds of common pathogens of infectious diseases: 22.4% of the hospitals had medical treatment procedures for all these infectious diseases, 23.1% had stored specific drugs for treatment, 2.2% had all personal protective equipment, and 30.6% reported that their health care staff had been trained in hospital emergency preparedness for infectious diseases. In general, emergency preparedness for infectious diseases in tertiary care hospitals was better than that in secondary care hospitals; the preparedness at general hospitals was better than that at specialized hospitals; and that at teaching hospitals was better than that at nonteaching hospitals.

Conclusion: Emergency preparedness for infectious disease at hospitals in Beijing was in an early stage of development during this survey. Comprehensive measures should be developed and implemented to enhance their capacity for infectious disease emergency. (Am J Infect Control 2007;35:62-7.)

Infectious diseases are still a major public health problem worldwide in the 21st Century. Prevention and treatment of infectious diseases not only relate to social development and people's health but also reflect development of health care in a region. In the event of a large scale infectious disease outbreak, hospitals will be on the front line. All hospitals should have emergency plans; prepare beds, drugs, and equipment; and educate and train staff in advance to respond to a large scale infectious disease outbreak or other public health emergency. Severe acute respiratory syndrome (SARS) crisis tested hospitals’ capability in infectious disease emergency response in China and revealed its fragility, and the city of Beijing was no exception.

The SARS crisis dramatically raised public awareness of health and led to national and local initiatives to improve emergency preparedness for infectious diseases. One year after these initiatives, are hospitals now well prepared for infectious disease emergencies in Beijing? What are some important aspects of hospital preparedness that are likely ignored? To understand the current status of hospital preparedness for infectious diseases in Beijing and to provide basic information for infectious disease prevention and control in hospitals, we surveyed all secondary and tertiary care hospitals in Beijing between November 2004 and March 2005.

METHODS

Evaluated hospitals

One hundred fifty-two secondary and tertiary care hospitals in Beijing were evaluated, including general hospitals, hospitals of traditional Chinese medicine, hospitals of integrated traditional and Western medicine, specialized hospitals, medical emergency
centers, and maternal and child health care centers. A complete and up-to-date list of hospitals was provided by the Beijing Health Bureau. Primary care hospitals were excluded from the study for 2 reasons: (1) they played a relatively less significant role in SARS control during the 2003 crisis in Beijing, and (2) they were not designated for managing infectious diseases in Beijing’s health care system.

**Instrument**

A hospital preparedness for public health emergencies questionnaire was developed, based on authors’ direct field experiences in China and literature and government documents of China and the United States, including the Accreditation Standards of Comprehensive Manual for Hospital Evaluation in Beijing Area,10 the Hospital Capability Assessment for Readiness of Hawaii,11 the American Hospital Association Chemical and Bio-terrorism Preparedness Checklist,12 and the Capability Assessment for Readiness (CAR).13

The questionnaire consisted of 18 sections with 192 items. In this article, only findings of the 60 items covering the areas of hospital preparedness for infectious disease emergency were reported, including hospital demographic information and 6 key components of hospital preparedness for infectious diseases: (1) emergency plan (EP), (2) laboratory diagnosis capacity (LDC), (3) medical treatment procedures (MTP), (4) specific drug stockpile (SDS), (5) personal protective equipment stockpile (PPES), and (6) staff training (ST).

To ensure face and content validity, the draft questionnaire was evaluated by 16 experts in hospital management and public health emergency preparedness and was revised based on their evaluation. Feasibility of the questionnaire was tested by a pilot study in 2 tertiary care hospitals and 3 secondary care hospitals in Beijing. The survey protocol, field study procedures, and quality control forms were revised based on the pilot study results. Approval of this study was obtained from the Institutional Review Board of the School of Basic Medicine, Peking Union Medical College in Beijing.

The questionnaire was sent to the departments of medical administration of 152 secondary and tertiary care hospitals in Beijing, accompanied by an official document issued from the Beijing Health Bureau, stating the importance of the survey to the construction of a public health preparedness system in the city. The directors of the departments of medical administration in hospitals were requested to be responsible for completing the questionnaire, and each of them organized a group of key persons involved in hospital emergency planning and/or infection control to answer the questions listed in the questionnaire.

**Statistical analysis**

Each returned questionnaire was carefully reviewed for completeness and consistency. For those with incomplete responses, a telephone call was made to ask the reason for the incomplete response. If no answer could be obtained, that questionnaire was considered as “no” response. A score for each of 6 aspects of emergency preparedness was calculated by summing the number of items with “yes” answers to the questionnaire in each aspect. The higher the score, the better the hospital was prepared.

All data were entered into a database with Microsoft Excel (Microsoft Corp, Redmond, WA) software and cleaned, checked, and analyzed using statistical analysis system (SAS) software version 6.12 (SAS Institute, Cary, NC). Descriptive statistics were used to present the data. Comparisons of mean score for each of 6 emergency preparedness aspects among different types of hospitals were performed by independent-sample t test (2-tailed), with \( P \leq .05 \) as statistical significance.

**RESULTS**

One hundred thirty-four of 152 hospitals responded, with a response rate of 88.2%.

**Hospital demographic information**

Of the 134 respondents, 35.8% were tertiary care hospitals and 64.2% secondary care; 58.2% general hospitals and 41.8% nongeneral; and 57.5% teaching hospitals and 42.5% nonteaching.

There was a department of infectious diseases in 40.3% of all the responding hospitals, with 517 physicians and 827 nurses specializing in infectious disease, accounting for 1.8% and 2.5% of the total, respectively. Extra beds were provided in 79.8% of responding hospitals in the event of public health emergency, accounting for 8.5% of the fixed ones. There were isolation beds and intensive care unit (ICU) beds in 35.8% and 53.7% of all the respondents, respectively. Table 1 shows the numbers of health care staff and beds.

**Current status of hospital preparedness**

Six aspects of hospital preparedness are described below.

**Emergency plan.** Of 134 hospitals responding, 125 (93.3%) had EPs during the survey. Among 125 hospitals with EP, 92.8% had a mechanism to initiate its EP, 80.0% had a classification system of emergency level for different infectious disease outbreaks, 83.2% had protocol for use of personal protective equipment, 50.4% had a detailed plan for drug distribution,
52.0% had measures to protect against secondary transmission, and 84.0% reported that their EPs were accessible to all medical staff.

There were plans to enhance communication and cooperation between hospitals and hospitals and between hospitals and local centers for disease control and prevention in 83.6% and 64.9% of all the respondents, respectively. Within the past 12 months, 59.7% of respondents had revised their EP at least once, and 52.2% participated in response exercises for a large-scale infectious disease outbreak.

**Laboratory diagnosis capacity.** We selected 8 kinds of infectious diseases (plague, cholera, SARS, anthrax, influenza, meningococcal meningitis, Japanese encephalitis B, and brucellosis) to assess the laboratory diagnosis capacity, medical treatment procedures, and specific drug stockpile for infectious diseases control, based on the following criteria: (1) class A infectious diseases, according to the Law on Communicable Disease Prevention and Control of China (plague and cholera); (2) infectious diseases caused by pathogen can potentially be used as a bioterrorist weapon (anthrax and brucellosis); (3) infectious diseases with significant threat to life and health of the citizens of Beijing based on surveillance data (SARS, influenza, meningococcal meningitis, Japanese encephalitis B). The results are listed in Table 2.

At the time of this survey, approximately half of the respondent hospitals reported that they could isolate and identify *Vibrio cholerae*; approximately one fourth of the respondent hospitals could isolate and identify *Neisseria meningitidis*, and less than 10% of surveyed hospitals reported that they could isolate and identify pathogen of plague, SARS, anthrax, influenza, Japanese encephalitis B, and brucellosis. None of the respondents’ laboratories reported they could isolate and identify all 8 kinds of infectious diseases pathogen.

**Medical treatment procedures.** Our results revealed that 22.4% of respondents had medical treatment procedures for all 8 kinds of infectious diseases. As shown in Table 2, 69.4% of the respondent hospitals had special medical treatment procedures for treating SARS or influenza patients; 43.3% for cholera; 40.3% for meningococcal meningitis; 39.6% for Japanese encephalitis B; and less than 30% for plague, anthrax, and brucellosis.

**Special drug stockpile.** Special drug stockpile is defined as storage of certain drugs for treating 30 patients with each of 8 kinds of infectious diseases for at least 7 days. Of all respondents, 23.1% had enough drugs stockpiled for all 8 kinds of infectious diseases. A majority of respondent hospitals reported that they had an adequate stockpile of drugs for influenza and SARS; more than half of respondents had an adequate stockpile of drugs for meningococcal meningitis and Japanese encephalitis B; and less than half of respondents had an adequate stockpile of drugs for plague, cholera, anthrax, and brucellosis.

**Personal protective equipment stockpile.** Of all respondent hospitals, 50.0% had biohazard protective suits, 89.6% had safety glasses, 73.1% had ventilators, 56.0% had N95 masks, and 5.2% had powered air-purifying respirators available for health care personnel and other employees. However, only 2.2% of the respondent hospitals reported that they had all of the above-mentioned 5 types of personal protective equipment.

**Staff training.** Among all the respondents, 94.0% of respondent hospitals reported that they had a staff training program, with varied contents, including awareness of EP (79.9%), medical treatment procedures (94.0%), infectious diseases prevention and control (66.4%), routes of transmission of infectious diseases (71.6%), disinfection and sterilization (57.5%), and principles of quarantine and isolation (56.7%). Overall, 30.6% of respondents reported that their training curriculum included all above-mentioned 6 aspects contents.

### Table 1. The numbers of health care staff and beds in 134 respondent hospitals, 2004

|                          | Mean ± SD | Minimum | Maximum | Total  |
|--------------------------|-----------|---------|---------|--------|
| Physicians               | 209.1 ± 186.6 | 6       | 1147    | 28,014 |
| Nurses                   | 247.5 ± 248.5 | 5       | 1416    | 33,163 |
| Infectious disease physicians | 3.9 ± 19.2 | 0       | 182     | 517    |
| Infectious disease nurses | 6.2 ± 29.4 | 0       | 286     | 827    |
| Licensed beds            | 414.4 ± 345.7 | 0       | 1800    | 55,524 |
| Isolation beds           | 8.0 ± 44.6  | 0       | 500     | 1064   |
| Intensive care unit beds | 6.3 ± 10.9  | 0       | 90      | 839    |
| Extra beds               | 38.2 ± 95.3 | 0       | 842     | 4700   |

SD, Standard deviation.

### Comparison of emergency preparedness among different types of hospitals

Mean scores for 6 aspects of emergency preparedness were compared among different types of hospitals.
As shown in Table 3, the mean scores in all 6 aspects of preparedness were higher in tertiary care hospitals than those in secondary care ones, but only the difference in score of specific drug stockpile between tertiary and secondary care hospitals had statistical significance. The mean scores in all 6 aspects of preparedness were higher in general hospitals than those in nongeneral ones, but only the difference in mean scores of 3 aspects (medical treatment procedures, specific drug stockpile, and staff training) had statistical significance. The mean scores in all 6 aspects of preparedness were higher in teaching hospitals than those in nonteaching ones, but only the difference in mean scores of 4 aspects (EP, medical treatment procedures, specific drug stockpile, and staff training) had statistical significance.

**DISCUSSION**

There are 3 levels of government (central, provincial, and local) that play roles in funding health care services in China. After the SARS crisis, the Chinese government has invested 5.7 billion RMB to local governments, including 15 million to Beijing, to assist in developing regional response plans in 2004. One of the major efforts is to enhance hospitals’ infectious disease emergency response capabilities. The Beijing government has developed a citywide response plan and invested 53.25 million RMB to implement and enhance the response capabilities. This study examined the current status of hospitals preparedness for infectious diseases in Beijing.

Emergency preparedness means the planning and actions that ensure an organization’s, or a community’s, readiness to respond to an emergency in a coordinated, timely, and effective manner. Lack of emergency response capability to infectious diseases is a worldwide question. Even in America, hospitals may not have the capacity to deal with a sudden, large increase in the number of patients, as might be seen in a bioterrorist attack. Because precautions avert perils, hospitals should formulate an EP; store staff, beds, and equipment; and educate and train their staff in advance to respond to a large-scale infectious disease outbreak or other public health emergency.

Sufficient emergency response personnel and equipment are necessary to respond effectively to a large-scale infectious disease incident. Loutfy et al reported that hospitals’ biggest challenge was insufficient personnel in Toronto in the event of SARS. Our study indicates that, during the SARS epidemic, hospitals were short of infectious disease physicians, nurses, and equipment in Beijing.

Following public health emergencies, a substantial number of patients may present to hospitals within a relatively short period of time. Higgins et al reported hospitals had the ability to surge 4881 beds or 27% of all licensed beds in Kentucky. Our study shows that different hospitals could provide different numbers of extra beds. Most hospitals admitted that their extra beds were not enough to meet the demands. One hundred thirty-four respondent hospitals can provide 4700 extra beds, accounting for 8.5% of all fixed beds in Beijing. Xiaotangshan hospital, Beijing Chest hospital, Beijing Ditan hospital, and Beijing You’nan hospital were the top 4 hospitals reported that could provide surge beds; the total number was 1582. These 4 hospitals were designated hospitals for SARS patients in Beijing. Therefore, it has been estimated that around 4000 extra beds at tertiary and secondary hospitals in Beijing could be used as emergency. Among all extra beds, at least 1582 beds could accept patients with infectious disease.

During a sudden, large-scale infectious disease outbreak, hospitals will have to convert quickly from their current care capacity to surge capacity. Therefore, the infectious disease emergency plan is needed before, during, and immediately after the infectious disease outbreak. In addition, reviewing and updating the emergency plan and have exercises periodically are

| Laboratory diagnosis capacity | Medical treatment procedures | Specific drug stockpile |
|------------------------------|------------------------------|-------------------------|
| No. "yes" | % | No. "yes" | % | No. "yes" | % |
| Plague | 7 | 5.2 | 36 | 26.9 | 43 | 32.1 |
| Cholera | 64 | 47.8 | 58 | 43.3 | 57 | 42.5 |
| SARS | 3 | 2.2 | 93 | 69.4 | 94 | 70.1 |
| Anthrax | 10 | 7.5 | 32 | 23.9 | 42 | 31.3 |
| Influenza | 12 | 9.0 | 93 | 69.4 | 112 | 83.6 |
| Meningococcal meningitis | 33 | 24.6 | 54 | 40.3 | 78 | 58.2 |
| Japanese encephalitis B | 6 | 4.5 | 53 | 39.6 | 77 | 57.5 |
| Brucellosis | 12 | 9.0 | 32 | 23.9 | 43 | 32.1 |
pertaining to the increasing trend of globalization, an infectious disease of immediate importance, but also infectious diseases of public health significance. However, the Beijing Health Bureau has established the Laboratory Response Networks to help hospitals that have inadequate laboratory diagnostic capabilities for infectious diseases.

Before the 2003 SARS crisis, there had not been a large-scale infectious disease outbreak for a long period; therefore, hospitals' capability to identify and manage infectious diseases declined. Education and training are the key measures to enhance medical staff's capability to respond to infectious diseases. Our study shows that Beijing hospitals realized the importance of training medical staff for infectious diseases, and that the majority of respondent hospitals reported that different types of training programs were offered to their staffs. However, the quality of training needs to be evaluated.

The results from this study suggest that tertiary care hospitals emergency preparedness for infectious diseases is better than that of secondary care hospitals, general hospitals preparedness is better than that of nongeneral hospitals, and teaching hospitals preparedness is better than that of nonteaching hospitals. These results may reflect the fact that different types of hospitals have different functions and missions.

It would be unreasonable or inappropriate to expect all hospitals in Beijing to have the same level of preparedness for infectious diseases. However, the accompanied Beijing Health Bureau's official document partially assures that a team approach at each hospital be applied to complete the survey as accurately as possible. The removal of a

### Table 3. Comparison of mean scores for 6 aspects of emergency preparedness among different types of hospitals, 2004

| EP          | LDC      | MTP      | SDS       | PPES      | ST        |
|-------------|----------|----------|-----------|-----------|-----------|
| Hospitals overall | 7.90 ± 2.42 | 1.10 ± 1.51 | 3.40 ± 2.98 | 4.14 ± 2.82 | 3.68 ± 1.11 | 4.26 ± 1.89 |
| Tertiary care   | 8.25 ± 2.21 | 1.31 ± 1.83 | 3.77 ± 3.09 | 4.93 ± 2.90 | 3.71 ± 1.20 | 4.56 ± 1.90 |
| Secondary care  | 7.71 ± 2.52 | 0.98 ± 1.28 | 3.19 ± 2.91 | 3.72 ± 2.70 | 3.66 ± 1.06 | 4.09 ± 1.88 |
| General         | 8.18 ± 2.22 | 1.20 ± 1.61 | 4.05 ± 2.91 | 4.99 ± 2.60 | 3.69 ± 1.21 | 4.58 ± 1.80 |
| Nongeneral      | 7.52 ± 2.63 | 1.02 ± 1.43 | 2.50 ± 2.85 | 3.02 ± 2.73 | 3.66 ± 0.96 | 3.82 ± 1.94 |
| Teaching        | 8.31 ± 2.21 | 1.22 ± 1.71 | 4.12 ± 2.92 | 5.01 ± 2.61 | 3.82 ± 1.07 | 4.54 ± 1.82 |
| Nonteaching     | 7.35 ± 2.58 | 0.93 ± 1.18 | 2.41 ± 2.78 | 2.98 ± 2.69 | 3.49 ± 1.14 | 3.88 ± 1.94 |

**Note:**
- EP: emergency plan; LDC: laboratory diagnosis capacity; MTP: medical treatment procedures; SDS: specific drug stockpile; PPES: personal protective equipment stockpile; ST: staff training.
- Mean ± standard deviation.
- \( P < .05 \) t test.
- \( P < .01 \) t test.

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important to enhance emergency response capability. At the time of this survey, virtually all respondents (93.3%) had an EP. However, only 59.7% of hospitals that had an EP reported that their facilities reviewed and updated their EP at least once, and only 56.0% had participated in a disaster exercise for a large-scale infectious disease outbreak within the past 12 months.

No hospital or medical system can manage a public health emergency by itself. Therefore, hospitals need to communicate and cooperate with other hospitals and public health agencies. Our survey reveals that 85.6% respondents had a plan to enhance communication and cooperation with other hospitals, and 64.9% of respondents had a plan to enhance communication and cooperation with local centers for disease control and prevention.

The survey also shows that large a proportion of hospitals in Beijing have specific drugs and medical treatment procedures for SARS and influenza. Only a small proportion of hospitals have specific drugs and medical treatment procedures for the other 6 infectious diseases of public health significance. This may reflect the prioritization in infectious disease prevention and control strategies in Beijing, partially based on the recent SARS crisis and avian flu event. With the increasing trend of globalization, an infectious disease occurring in one region is prone to spreading to other regions. Considering the coming 2008 summer Olympics in Beijing, the prioritization of Beijing's infectious disease preparedness should be reconsidered. Hospitals should prepare for responding to not only the infectious disease of immediate importance, but also those occurring rarely and emerging suddenly.

Detecting, isolating, and identifying an unknown pathogen accurately and timely are essential for selecting appropriate prevention and treatment measures. Our results indicate that many hospitals do not have adequate laboratory diagnostic capability for the 8 kinds of infectious disease of public health significance. However, the Beijing Health Bureau has established the Laboratory Response Networks to help hospitals that have inadequate laboratory diagnostic capabilities for infectious diseases.

Before the 2003 SARS crisis, there had not been a large-scale infectious disease outbreak for a long period; therefore, hospitals' capability to identify and manage infectious diseases declined. Education and training are the key measures to enhance medical staff's capability to respond to infectious diseases. Our study shows that Beijing hospitals realized the importance of training medical staff for infectious diseases, and that the majority of respondent hospitals reported that different types of training programs were offered to their staffs. However, the quality of training needs to be evaluated.

The results from this study suggest that tertiary care hospitals emergency preparedness for infectious diseases is better than that of secondary care hospitals, general hospitals preparedness is better than that of nongeneral hospitals, and teaching hospitals preparedness is better than that of nonteaching hospitals. These results may reflect the fact that different types of hospitals have different functions and missions.

It would be unreasonable or inappropriate to expect all hospitals in Beijing to have the same level of preparedness for infectious diseases. However, the accompanied Beijing Health Bureau’s official document partially assures that a team approach at each hospital be applied to complete the survey as accurately as possible. The removal of a
high-ranking official who hid or distorted information during the SARS crisis has created an environment that encourages hospitals to report information accurately. With a pilot study, return questionnaire review, and follow-up investigation, we do not believe that the respondent reporting bias will have a significant impact on the survey results. Second, our study only included secondary and tertiary care hospitals. Primary care hospitals were not included in this study. Although secondary and tertiary care hospitals are the mainstay for Beijing’s infectious diseases prevention and control, primary care hospitals roles in prevention and control infectious diseases should not be ignored. However, based on Beijing’s SARS control experience, secondary and tertiary care hospitals’ emergency response capacity reflects Beijing’s emergency response capacity for infectious diseases. Third, only qualitative data were collected for certain questions such as the status of personal protective equipment and specific drugs stockpiles. The answers to these questions are “Yes,” “No,” or “Don’t know,” which limited our ability to quantify hospitals personal protective equipment and specific drugs stockpiles preparedness.

Overall, our survey revealed that hospitals emergency preparedness efforts for infectious diseases were in an early stage of development at the time of this survey in Beijing. To enhance preparation for dealing with infectious diseases of public health significance, hospitals should revise/update their EP timely, ie. planning is an ongoing process; hospitals should also have regular staff training and disaster exercises, enhance laboratory diagnostic capability, store appropriate antidotes and antibiotics, have sufficient personal protective equipments and related supplies, and pay close attention to communication and cooperation with other hospitals and public health agencies. In addition, more comprehensive instruments should be used periodically to assess the progress of hospital emergency preparedness.

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