Analysis of Pulmonary Infection of Hospitalized Patients Injured in the Wenchuan Earthquake in China

Jing Xu[1,2], Zi-Gui Liu[1,2], Xia Zhu[1,2], Xue-Bing Chen[1,2], and Hong Tang[1,2*]

[1] *CENTER OF INFECTIOUS DISEASES, WEST CHINA HOSPITAL, SICHUAN UNIVERSITY, CHENGDU, CHINA;* [2] *DIVISION OF INFECTIOUS DISEASES, STATE KEY LABORATORY OF BIOTHERAPY, SICHUAN UNIVERSITY, CHENGDU, CHINA.*

htang6198@hotmail.com

Abstract-*Background:* On 12 May 2008, a devastating earthquake measuring 8.0 on the Richter scale hit Wenchuan County, Sichuan in China, and resulted in the casualties of thousands of people. Some of the hospitalized earthquake victims can occur pulmonary infection. However, few studies have been conducted on the clinical features of pulmonary infection in hospitalized casualty after Wenchuan Earthquake. *Methods*: To analyze retrospectively the clinical data of 115 pulmonary infection patients among wounded inpatients in West China Hospital of Sichuan University after the Wenchuan earthquake. *Results*: In our report, 76 cases (66.1%) of 115 hospitalized earthquake victims with pulmonary infection were patients with age > 60 years; 74 cases (64.3%) of them with long-term hospitalization(> 20 days); 23 cases (20.0%) of them with traumatic brain injury; 71 cases (61.7%) with torso trauma; 58 cases (50.4%) of them were patients with underlying disease; 25 cases(21.7%) of them were the patients treated with mechanical ventilation. A total of 143 nonduplicate clinical isolates from sputum specimen of 115 pulmonary infection patients were analyzed. Gram-negative bacilli were the most commonly isolated pathogens (73.4%). Only 7.7% of total isolates were gram-positive bacteria; 18.9% of total isolates were fungi. There were high rates of multiple drug resistance in most bacteria isolates. The detection rates and resistance rates of Acinetobacter baumannii were higher than others and 81.8% of all Staphylococcus aureus detected from sputum culture were resistant to antibiotics but vancomycin in this group patients. There were 98 cases of recovery, 17 death cases due to lung infection. *Conclusions*: Most of earthquake inpatients with pulmonary infection were patients with age > 60 years, longer hospital stay or severe trauma. These factors might increase the risk of pulmonary infection in earthquake inpatients. Gram-negative bacilli play the most important role in these pulmonary infection patients. Pandrug-resistant Acinetobacter baumannii and Methicillin resistant S.aureus in this study might increase the risk of nosocomial infection. The prevention and control of pulmonary infection are crucial for earthquake survivors during hospitalization. . [Life Science Journal. 2010; 7(2): 28 – 34] (ISSN: 1097 – 8135).

Key Words: Wenchuan earthquake; Pulmonary infection; Pathogen; Drug sensitivity

INTRODUCTION

On 12 May 2008, an earthquake measuring 8.0 on the Richter scale hit Wenchuan County, Sichuan Province in southwest China. According to the official reports, the earthquake disaster caused more than 374171 injuries and 69185 deaths, and more than ninety-six thousand people were hospitalized after earthquake. Infection is a frequent and severe complication occurring in the earthquake victims with severe trauma in the course of rescue and treatment. Of these, pulmonary infection is common and serious one that affect the prognosis of the earthquake wounded. Therefore, pulmonary infection of the wounded in the follow-up hospitalization can not be neglected in the medical rescue after earthquake. However, few studies have been conducted on the analysis of pulmonary infection in hospitalized casualty after Wenchuan Earthquake. In this study, we retrospectively reviewed the clinical data on 115 hospitalized earthquake victims with pulmonary infection in West China Hospital of Sichuan University.

MATERIALS AND METHODS

General data and diagnosis

A retrospective analysis was performed on the collected data on 115 pulmonary infection patients in hospitalized earthquake victims admitted to our hospital from 14 May to 22 June 2008. Data sources include death certificates and medical records. The following data were collected: age, gender, type of injury, length of stay, mechanical ventilation, underlying disease and the pathogen data on culture of sputum specimens.

Pulmonary infection was confirmed by the hospital final diagnosis and were defined according to the Guidelines of Pneumonia Diagnosis and Treatment (draft) issued by Chinese Society of Respiratory Diseases in 1999 and the diagnostic criteria of nosocomial infection issued by Minist ry of Health of the People's Republic of China.[1,2]

Treatment

Pulmonary infection should always prompt antimicrobial therapy. De-escalation of antibiotic therapy could be performed in infection cases of the pathogen remains elusive. All pulmonary infection patients after admission took deep sputum for germiculture. Sputum samples should be consecutively taken to determine the types of infections. According to the results of sputum culture, antimicrobial therapy should be adequate (i.e. cover the causative pathogen) and effective (i.e. adequately administered and dosed).

Bacterial identification and antimicrobial susceptibility testing

The pathogen data were collected by department of laboratory medicine in West China Hospital of Sichuan University. The identification of microorganisms and susceptibility testing were followed the performance standards for antimicrobial susceptibility testing as defined by the Clinical and Laboratory Standards Institute (CLSI).[3] Duplicate isolates of the same organism from the same patient were eliminated, and calculation of resistance rates were performed on all isolates.

RESULTS

General information

In our report, the mean age of 115 hospitalized earthquake victims with pulmonary infection (53 males, 62 females) was 67 years. 76 cases (66.1%) of 115 pulmonary infection patients were patients with age > 60 years; 74 cases (64.3%) of them were patients with long-term hospitalization(> 20 days). Categorization of the earthquake injury was based on the final diagnosis of 115 pulmonary infection patients from hospitalized earthquake casualty: 23 cases (20.0%) of them were patients with traumatic brain injury; 71 cases (61.7%) with torso trauma and 21 cases(18.3%) with others trauma. Fifty eight cases (50.4%) were patients with underlying disease. (Table 1) Of these, 23 cases were patients with chronic obstructive pulmonary disease, 15 of hypertension, 10 of diabetes, 9 of brain infarction, 2 of lung cancer and 13 cases were patients who suffered from more than two kinds of diseases.

Clinical manifestation

The onset of occult, atypical symptoms and no specific pulmonary signs were the features of most pulmonary infection patients from the earthquake. In this report, the main symptoms of these patients were cough, fever, chest tightness and shortness of breath; Chest pain and chills were rare. Of these, cough (33 cases) was one of common respiratory symptoms; stethocatharsis weakness, dry cough or less sputum were frequent. Twenty eight cases were patients with Chest tightness and shortness of breath; 29 cases were patients with dyspneic respiration. There were 21 cases in fever, including 16 cases of low or moderate fever, and only 5 cases of high fever. Twenty five cases were patients treated with mechanical ventilation, accounting for 21.7%.

The lung auscultation were mostly low breath sounds of two lungs, and moist rales could be heard in some parts of lungs but dry rales were rare. All the patients took chest photography or CT and the results showed pulmonary infections. Of them, pleural effusion (32 cases) was more common pulmonary sign, 11 cases had pulmonary atelectasis.

Table 1

The Information of 115 Hospitalized Earthquake Victims with Pulmonary Infection in West China Hospital (case, %) Pathogen characteris

Factors	Infection cases	Proportion (%)
Age（years）		
≤60	39	33.9
>60	76	66.1
Gender		
male	53	46.1
female	62	53.9
Length of stay（days）		
≤20	41	35.7
>20	74	64.3
Mechanical ventilation		
Yes	25	21.7
No	90	78.3
Underlying disease		
Yes	58	50.4
No	57	49.6
Torso trauma		
Yes	71	61.7
No	44	38.3
Traumatic brain injury		
Yes	23	20.0
No	92	80.0

There were 48 cases of with positive pathogens from sputum culture in 115 pulmonary infection patients. The positive rate of sputum culture was 41.7%. Pulmonary infection was mostly due to various bacteria(43 cases), 15 cases of one single bacteria, 11 cases of complex bacteria and 17 cases of complex fungi; 5 cases only by fungus. A total of 143 nonduplicate clinical isolates from sputa of 115 pulmonary infection patients were analyzed. Gram-negative bacilli (G-bacillus) were the most commonly isolated pathogens (105 isolates,73.4%). Only 11 isolates (7.7%) of total isolates were gram-positive bacteria (G+ cocci); 27 isolates (18.9%) of total isolates were fungus (Table 2).

Table 2

Microorganisms Isolated from 115 Hospitalized Earthquake Victims with Pulmonary Infection

Organism	Isolates number	Proportion（%）
Kinds of bacterium		
Pseudomonas aeruginosa	24	16.8
Klebsiella oxytoca	3	2.1
Enterobacter cloacae	4	2.8
Haemophilus influenzae	1	0.7
Acinetobacter baumannii	34	23.8
Klebsiella pneumoniae	14	9.8
Escherichia coli	6	4.2
Stenotrophomonas maltophilia	6	4.2
Burkholderia cepacia	3	2.1
Enterobacter aerogenes	2	1.4
Proteus mirabilis	3	2.1
Other gram-negative bacilli	3	2.1
Bacillus prodigiosus	2	1.4
Staphylococcus aureus	11	7.7
Kinds of fungi		
Candida albicans	11	7.7
Yeast-like fungus	4	2.8
Aspergillus	5	3.5
Candida tropicalis	4	2.8
Candida glabrata	3	2.1
Total	143	100.0

Drug sensitive test results of some common pathogenic bacteria to antibiotics in sputum culture of 115 pulmonary infection patients from hospitalized earthquake victims are shown in Table 3.

Treatment and Outcome

The third generation cephalosporin antibiotics, carbapenems and/or quinolones were applied to treat bacteria infections; Fluconazole and Itraconazole were applied to treat fungal infections; Combination therapy were applied to treat mixed infections. Tuberculosis infection should be performed in standard anti-tuberculosis program. Among 115 pulmonary infection patients from hospitalized earthquake casualty, 98 were discharge after recovery (85.2%), 17 died (14.8%). One was diagnosed as subacute hematogenous pulmonary tuberculosis by CT and etc, and was recovered by normal ntituberculotic treatment. Four patients were developed for acute respiratory distress syndrome (ARDS), three of them were recovered and one died. Eight of death cases were patients with multiple organ failure(MOF) and one died of cerebrovascular accident.

Table 3. Drug Sensitive Test Results of Some Common Pathogenic Bacteria in 48 Sputum Cultures of 115 Pulmonary Infection Patients in Hospitalized Earthquake Victims. [a] (sensitivity, %)

Antibiotics	Strains						
	Acinetobacter baumannii (n=34)	Pseudomonas aeruginosa (n=24)	Klebiella pneumoniae (n=14)	Escherichia coli (n=6)	Enterobacter cloacae (n=4)	Staphylococcus aureus (n=11)	Stenotrophomonas maltophilia (n=6)
Gentamycin	20.6	37.5	42.9	66.7	25.0	0.0	16.7
Ampicillin	2.9	—	14.3	0.0	0.0	0.0	—
Cefazolin	—	—	14.3	0.0	0.0	18.2	—
Cefoxitin	—	—	64.3	66.7	0.0	—	—
Cefotaxime	17.6	12.5	28.6	0.0	25.0	—	0.0
Ceftazidime	20.6	33.3	28.6	0.0	50.0	—	83.3
Ceftriaxone	17.6	16.7	28.6	0.0	25.0	—	0.0
Cefepime	26.5	41.7	28.6	0.0	50.0	—	0.0
Levofloxacin	50.0	25.0	64.3	16.7	75.0	0.0	100.0
Vancomycin	—	—	—	—	—	100.0	—
Imipenem	32.4	45.8	92.9	66.7	100.0	0.0	0.0
Amikacin	32.4	87.5	78.6	83.3	75.0	—	16.7
Aztreonam	23.5	20.8	28.6	0.0	25.0	—	0.0
Gatifloxacin	11.8	—	57.1	16.7	75.0	—	16.7
Tobramycin	29.4	37.5	64.3	66.7	50.0	—	0.0

Note: a: Drug sensitivity (%) = sensitive isolates / n (isolates number)

DISCUSSION

The magnitude 8.0 earthquake that struck Wenchuan County of Sichuan Province on 12 May, 2008, was the strongest earthquake China has experienced in over 50 years. Earthquakes are among the most devastating disasters that cause mass casualties. Because of gathering of a large number of the wounded and lower population immunity caused by stress and malnutrition in the earthquakes, respiratory infection became a major infection after earthquake; Some statistics showed that 6.4 percent of hospitalized earthquake victims developed pulmonary infection and most of them were hospital-acquired infections(HAI).[4,5] In this study, we retrospectively reviewed the clinical data on 115 hospitalized earthquake victims with pulmonary infection in West China Hospital. Previous study revealed that infection was the second most common reason which caused death in hospitalized earthquake casualty and pulmonary infection was frequent and serious one. [4-6] More consistently, pneumonia is known to increase medical consumption in terms of antibiotic use and length of hospital stay. [7,8]Therefore, correct understanding and effective control of pulmonary infection of earthquake inpatients are of great significance to minimize the disability and death of earthquake victims.

It is well known that trauma patients are at high risk of developing infections and the mortality which is associated with HAI is increased in the presence of trauma. [9-11] In this study(Table 1), we observed that the earthquake inpatients with age > 60 years, long-term hospitalization(> 20 days) or torso trauma were very prone to the development of pulmonary infection. The patients with torso trauma or traumatic brain injury were accounted for 61.7% and 20.0%, respectively. These patients were suffered from severe injury which affected breathing and expectoration, or the old as well as organ dysfunction, which caused immunocompromised; Furthermore, longer hospital stay increased the probability of pulmonary infection, thus, many earthquake inpatients suffered from lung infection and most of them might be nosocomial infection. Recently, Magnotti observed that pulmonary infection was an independent factor for death in trauma patients. [12] Our data showed that the case fatality of pulmonary infection was as high as 14.8% and was similar with the report of Tanaka about Hanshin-Awaji earthquake; [13]The

pulmonary infection patients easily led to MOF(7.0%,8/115) in the clinical late-phase. Catania analyzed that immunological changes following trauma cause an increase in the HAI rate which then results in higher morbidity and mortality.[14]The mechanisms such as auto-oxidative receptor injury or changes in natural killer activity associated with stress might be responsible for these changes.[15,16]

After earthquakes, the pathogens of pulmonary infection assume multiplicity. Bacterium is mostly responsible and fungus are also involved. However, mixed infections are in the majority.[17] Yorsaengrat[18] found that the respiratory tract infection was mostly due to non-fermentation and ESBL-producing G-bacillus after earthquake and tsunami. In our study, G-bacillus was the mainly responsible for pulmonary infections of hospitalized earthquake victims, accounting for 73.4%, G+ cocci accounted for 7.7%, fungal accounted for 18.9% mainly due to Candida albicans. The results were roughly consistent with the reports of Yorsaengrat[18] and Weihua Wang et al.[19] Moreover, Acinetobacter baumannii (A. baumannii) in this report was the most frequently pathogen of lung infections, accounting for 23.8%, followed by Pseudomonas aeruginosa and Klebsiella pneumoniae, accounting for 16.8% and 9.8%, respectively. Similar findings were published in Oncul 's study. [20] Their results showed that most nosocomial infections were caused by A. baumannii, Staphylococcus aureus (S.aureus) and Klebsiella pneumoniae after earthquake. Also, Oncul reported that 4.7 percent of hospitalized earthquake casualty suffered from nosocomial pneumonia after the Marmara earthquake. Thus, we considered that some patients with pulmonary infection in this study might be nosocomial infection cases. Several possible factors could be responsible for A. baumannii infection. In trauma patients, injured and ischaemic tissues make it easier for colonization of A. baumannii. A. baumannii is an increasingly important opportunistic pathogen and a relatively common cause of nosocomial infections in areas of natural disaster. [21,22]

Oncul [20] analyzed the information about disaster-associated infection after the Marmara earthquake, it indicated that all strains of S.aureus were methicillin-resistant and multiresistant strains of A. baumannii and Pseudomonas aeruginosa emerged. Our data showed that there were high rates of multiple drug resistance in most bacteria isolates, but there were different drug resistance rates to different antibiotics. According to Table 3, the resistance rates of A. baumannii and Pseudomonas aeruginosa were higher than others. It is worth noting that 81.8% of all S.aureus detected from sputum culture were resistant to antibiotics but vancomycin in this group patients. This indicated that the S.aureus infections were mostly due to Methicillin resistant S.aureus (MRSA). The above analysis showed that most of pathogens of pulmonary infection in this study were serious drug resistance and pandrug-resistant A. baumannii and Methicillin resistant S.aureus might increase the risk of nosocomial infection. This was not only because of many transferred patients admitted to our hospital as a referral center of medical rescue for severely injured patients after earthquake, but also because of many focused hospitalized patients. Thus, multi-drug resistant microorganisms could be transferred by patients from other hospitals. Moreover, inappropriate empiric antibacterial therapy has been found to cause the spread of highly virulent microorganisms such as Pseudomonas spp and Acinetobacter spp.[23-25]

In summary, most of hospitalized earthquake victims with pulmonary infection were patients with age > 60 years, longer hospital stay or severe trauma. These factors might increase the risk of pulmonary infection in earthquake inpatients. The pathogen distribution isolated from these patients was wide; Gram-negative bacilli play the most important role in these pulmonary infection patients and the resistance of antibiotics was serious. Further expansion of case studies are also needed to address the relationship between earthquake victims and pulmonary infection. We believe that the prevention and control of pulmonary infection are crucial after earthquake survivors were rescued, especially during hospitalization. Inspecting pathogens and using antibiotics reasonably according to susceptibility testing result are very important in reducing pathogenic bacteria resistant and improving the prognosis of pulmonary infection patients after earthquake. Acknowledgements

Correspondence to

Professor Hong Tang

Center of Infectious Diseases, West China Hospital, Sichuan University, Chengdu, China; Division of Infectious Diseases, State Key Laboratory of Biotherapy, Sichuan University, Chengdu, China.

Abbreviations

CLSI: the Clinical and Laboratory Standards Institute

G-bacillus: Gram-negative bacilli

G+ cocci: gram-positive bacteria

ARDS: acute respiratory distress syndrome.

MOF: multiple organ failure

HAI: hospital-acquired infections

baumannii: Acinetobacter baumannii

S.aureus: Staphylococcus aureus

MRSA: Methicillin resistant S.aureus

REFERENCES

1. Chinese society of respiratory diseases. Guidelines of acquired pneumonia diagnosis and treatment (Draft). Modern Practical Medicine, 2002; 14: 158-61.

2. Ministry of Health of the People's Republic of China. Diagnostic criteria of nosocomial infection. Natl Med J China, 2001; 81: 314-320.

3. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing, 17th informational supplement. Wayne, PA: CLSI, 2007.

4. Lai SW, Liu CS, Li CI, et al. Post-earthquake illness and disease after the Chi-Chi earthquake. Eur J Intern Med, 2000;11: 353-354.

5. Keven K, Ates K, Sever MS, et al. Infectious complications after mass disasters : the Marmara earquake experience. Scand J Infect Dis, 2003;

35: 110-113 .

6. Watson J, Gayer M, Connolly MA. Epidemics after natural disasters. Emerg Infect Dis, 2007; 13 : 1-5 .

7. Rosenthal VD, Guzman S, Migone O, et al. The attributable cost and length of hospital stay because of nosocomial pneumonia in intensive care units in 3 hospitals in Argentina: A prospective, matched analysis. Am J Infect Control, 2005; 33: 157-161.

8. Warren DK, Shukla SJ, Olsen MA, et al. Outcome and attributable cost of ventilator-associated pneumonia among intensive care unit patients in a suburban medical center. Crit Care Med, 2003; 31:1312-7.

9. Chevret S, Hemmer M, Carlet J, Langer M. Incidence and risk factors of pneumonia acquired in intensive care units. Results from a multicenter prospective study on 996 patients. European Cooperative Group on Nosocomial Pneumonia. Intensive Care Med, 1993;19: 256-264.

10. Dinkel RH, Lebok UJ. A survey of nosocomial infections and their influence on hospital mortality rates. J Hosp Infect ,1994; 28: 297-304.

11. Bochiccio GV, Joshi M, Knorr KM, et al. Impact of nosocomial infections in trauma: does age make a difference? J Trauma. 2001; 50: 612-7.

12. Magnotti LJ, Croce MA, Fabian TC. Is ventilator-associated pneumonia in trauma patients an epiphenomenon or a cause of death? Surg Infect. 2004; 5:237–242

13. Tanaka H, Oda J, Iwai A, et al. Morbidity and mortality of hospitalized patients after the 1995 Hanshin-Awaji earthquake. Am J Emerg Med. 1999; 17:186-91.

14. Catania RA, Chaudry IH. Immunological consequences of trauma and shock . Ann Acad Med Singapore. 1999; 28: 120-132.

15. Inoue-Sakurai C, Maruyama S, Morimoto K. Posttraumatic stress and lifestyles are associated with natural killer cell activity in victims of the Hanshin-Awaji earthquake in Japan. Prev Med. 2000; 31: 467-473.

16. Simms HH, D'Amico R. Posttraumatic auto-oxidative polymorphonuclear neutrophil receptor injury predicts the development of nosocomial infection. Arch Surg. 1997; 132: 171-177.

17. Uçkay I, Sax H, Harbarth S, et al. Multi-resistant infections in repatriated patients after natural disasters:

lessons learned from the 2004 tsunami for hospital infection control. J Hosp Infect. 2008; 68: 1-8.

18. Yorsaengrat W, Chungpaibulpatana J, Tunki B, et al. Respiratory complication of tsunami disaster victims in Vachira Phuket Hospital. J Med Assoc Thai. 2006; 89: 518-520.

19. Wei-hua W, Yi-hua Z. Drug Resistance and Pathogens in Critically Ill Patients with Pulmonary Infection. Chin J Nosocomiol Vol . 2007; 17: 227-229.

20. Oncul O，Keskin O，Acar HV，et al. Hospital-acquired infections following the 1999 Marmara earthquake. J Hosp Infect, 2002; 51: 47-51.

23. Mulin B, Talon D, Viel JF, et al. Risk factors for nosocomial colonization with multiresistant Acinetobacter baumannii. Eur J ClinMicrobiol Infect Dis. 1995;14: 569-576.

24. Scerpella EG, Wanger AR, Armitige L, et al. Nosocomial outbreak caused by a multiresistant clone ofAcinetobacter baumannii: results of the case-control and molecular epidemiologic investigations. Infect Control Hosp Epidemiol. 1995; 16: 92-97.

25. Bowton PL. Nosocomial pneumonia in the ICU-year 2000 and beyond. Chest. 1999; 115: 28S-33S.

21. Caricato A, Montini L, Bello G, et al. Risk factors and outcome of Acinetobacter baumanii infection in severe trauma patients. Intensive Care Med. 2009; 8:1582-1585.

22. Joly GM. Clinical impact and pathogenicity of Acinetobacter. Clin Microbiol Infect. 2005; 11: 868–73.