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Characteristics of Infectious Diseases in Hospitalized Patients During the Early Phase After the 2011 Great East Japan Earthquake

Pneumonia as a Significant Reason for Hospital Care

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Background: **Natural catastrophes increase infectious disease morbidity rates. On March 11, 2011, a 9.0-magnitude earthquake and associated Pacific coast tsunami struck East Japan. The aim of this study was to investigate the characteristics of patients with infectious diseases who needed hospitalization after this disaster.**

Methods: **We searched the medical records of 1,577 patients admitted to Tohoku University Hospital in the Sendai area within 1 month (March 11, 2011-April 11, 2011) after the disaster. We examined (1) changes in the rates of hospitalizations for infectious diseases over time and (2) the variety of infectious diseases.**

Results: **The number of hospitalized patients with infectious diseases increased after the first week to double that during the same period in 2010. Pneumonia comprised 43% of cases, and 12% consisted of skin and subcutaneous tissue infection, including tetanus. Pneumonia was prevalent in elderly patients (median age, 78 years) with low levels of serum albumin and comorbid conditions, including brain and nervous system disorders. Sputum cultures contained *Streptococcus pneumoniae*, *Moraxella catarrhalis*, and *Haemophilus influenzae*, known pathogens of community-acquired pneumonia in Japan. In addition, 20.5% of patients had positive results for urinary pneumococcal antigen.**

Conclusions: **Among hospitalized patients, infectious diseases were significantly increased after the disaster compared with the same period in 2010, with pneumonia being prominent. The analyses suggest that taking appropriate measures for infectious diseases, including pneumonia, may be useful for disaster preparedness and medical response in the future.**

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Abbreviations: CAP = community-acquired pneumonia; ICD-10 = *International Statistical Classification of Diseases and Related Health Problems, 10th Revision*

On March 11, 2011, a 9.0-magnitude earthquake struck East Japan, and a tsunami washed away entire communities in the Pacific coastal area of Iwate, Miyagi, and Fukushima prefectures of the Tohoku district. This catastrophe killed 15,782 people, with >4,000 still missing 6 months after the disaster and seriously damaged health-care services and facilities. In the Pacific coastal region of Ishinomaki, Kesennuma, and part of the Sendai area, many hospitals collapsed or were flooded by the tsunami, and many health-care professionals were victims of the disaster. Thus, problems with the health-care system, including how to treat victims efficiently with limited resources, became critical issues in the aftermath.

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Several previous studies described the variety of illnesses that occur after natural disasters, including mega-earthquakes and tsunamis. After the 1995 Hanshin-Awaji earthquake, which struck southern Hyogo prefecture, Japan, the initial rash of illnesses was due to trauma and infectious diseases. Pneumonia was prominent, with the number of cases increasing within 1 month.[1,2] In the aftermath of the 2004 Indian Ocean tsunami in Thailand, acute diarrhea was predominant, followed by wound infection and respiratory illness.[3] Melioidosis, atypical mycobacterial, and polymicrobial bacterial infections were also reported in Thailand and Sri Lanka.[4,5] These reports indicate that infectious diseases are an important health issue after a natural disaster and that endemic background may influence infectious disease development in affected areas.

The aim of this study was to survey infectious disease trends in patients admitted to Tohoku University Hospital after the disaster. To our knowledge, it is the first to report changes in hospitalized patients with infectious diseases over a time course. We further identified the varieties of infectious diseases and conducted an analysis of pulmonary infection in the aftermath.

Materials and Methods

Background Medical Service Area and Population Before and After the Earthquake and Tsunami

Miyagi prefecture contains seven medical service areas. Tohoku University Hospital, one of the largest university hospitals in Japan with 1,300 beds for inpatient services, mainly served the Sendai area before the disaster. The coastal regions of Ishinomaki, Kesennuma, and Sendai were affected by the tsunami (Fig 1), with massive damage in Ishinomaki and Kesennuma. Ishinomaki contained seven secondary-care services and one tertiary-care service, and Kesennuma contained three secondary-care services. However, only one secondary-care service (Kesennuma City Hospital) and one tertiary-care service (Ishinomaki Red Cross Hospital) were available for inpatient services after the tsunami as designated disaster base hospitals, which play a central role in providing medical care during and after major disasters. Lack of essential utilities, food, and medicine limited inpatient service at these facilities. By contrast, the Sendai area had 30 secondary-care services and three tertiary-care services, including seven disaster base hospitals. The earthquake damaged these seven hospitals, including Tohoku University Hospital, but all except one were still available for inpatient care after the disaster. Among these six, Tohoku University Hospital sustained less damage and had much higher medical staffing and bed capacity than the other five. Thus, Tohoku University Hospital proactively received patients from Ishinomaki and Kesennuma in addition to those from Sendai.

We defined the background area of Tohoku University Hospital in the month after the 2011 disaster as Sendai, Ishinomaki, and Kesennuma, where an estimated 1,795,557 people lived. The background area during the same period in 2010 was Sendai, where an estimated 1,478,314 people lived (Fig 1).

Data Collection

We retrospectively reviewed medical charts and radiologic and laboratory findings for all available Tohoku University Hospital inpatient records during the first month after the earthquake and tsunami (March 11, 2011-April 11, 2011) and the same period of 2010. Including patients from the Ishinomaki and Kesennuma areas who were triaged once at Ishinomaki Red Cross Hospital or Kesennuma City Hospital, a total of 1,577 patients were admitted to our hospital during the month after the disaster. We classified the diseases of all hospitalized patients according to the *International Statistical Classification of Diseases and Related Health Problems, 10th Revision* (ICD-10) and calculated the rate for each disease group based on background medical service population (e-Table 1). We extracted the patients with infectious diseases and new injuries after the disaster who required immediate medical treatment by specialists.

The physicians in charge of the patients conducted all clinical procedures and tests. Pneumonia was diagnosed through clinical evaluation, radiologic evaluation, and microbial testing according to community-acquired pneumonia (CAP) guidelines.[6,7] Pneumonia severity was evaluated by CURB-65 (confusion, urea >7 mmol/L, respiratory rate ≥ 30/min, low systolic [<90 mm Hg] or diastolic [≤ 60 mm Hg] BP, age ≥ 65 years).[8] This study was determined to be exempt from the requirement of institutional review board review because it was conducted as part of a public health investigation into retrospective data.

Microbiologic Tests

Pathogens in samples obtained from respiratory tracts were investigated. These samples were cultured semiquantitatively in sheep blood agar, chocolate agar, and potato dextrose agar. The Vitek 2 (bioMérieux sa) system was used to identify pathogens from blood, skin and wounds, and respiratory tracts. Upon positive identification of potentially drug-resistant pathogens, such as *Staphylococcus aureus*, *Streptococcus pneumoniae*, and extended-spectrum β-lactamase-producing Enterobacteriaceae, drug resistance was defined according to Clinical and Laboratory Standards Institute guidelines.[9,10]

The BinaxNOW *S pneumoniae* test (Alere) and Check *Legionella* Urinary Antigen EIA (Alfresa Holdings Corp) were used for qualitative detection of *S pneumoniae* antigen and *Legionella pneumophila* serogroup 1 antigen, respectively, in human urine. The ESPLINE Influenza A&B-N (FUJIREBIO Inc) was used for

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