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Risk Factors for SARS-Related Deaths in 2003, Beijing

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Objective To study the potential risk factors for severe acute respiratory syndromes (SARS)-related deaths in Beijing. **Methods** Epidemiological data were collected among the confirmed SARS patients officially reported by Beijing Centers for Disease Control and Prevention (BCDC), and information was also supplemented by a follow-up case survey. Chi-square test and multivariate stepwise logistic regression analysis were performed. **Results** Old age (over 60 years) was found to be significantly associated with SARS-related deaths in the univariate analysis. Also, history of contacting SARS patients within 2 weeks prior to the onset of illness, health occupation, and inferior hospital ranking as well as longer interval of clinic consulting (longer than 1 day) were the risk factors for SARS-related deaths. Multivariate stepwise logistic regression analysis found four risk factors for SARS-related deaths. **Conclusion** Old age (over 60 years) is the major risk factor for SARS-related deaths. Moreover, hospital health workers, the designated hospitals for SARS clinical services and the interval of consulting doctors (less than 1 day) are protective factors for surviving from SARS.

Key words: Severe acute respiratory syndromes; Death; Risk factor

INTRODUCTION

Severe acute respiratory syndrome (SARS), a highly infectious atypical pneumonia, is a new clinical entity caused by a novel coronavirus[1]. The epidemic of SARS struck Beijing in late February 2003. The number of victims surged quickly. The Ministry of Health of China defined the probable and suspected SARS cases according to epidemiologic history (either contact with other SARS patients or exposure to a SARS-affected area), symptoms and signs of fever and respiratory illness, normal or decreased leukocyte count, chest radiograph abnormalities, and absence of substantial improvement through antibiotic treatment[2]. By the end of August 16, 2003, 2521 probable cases occurred, resulting in 193 deaths. A novel coronavirus was identified as the causative agent. But the pathogenesis of SARS is not clearly understood, and at present no effective medicine and vaccine are available. The control and prevention of SARS depend on early detection and timely effective treatment, including the quarantine of confirmed or probable cases, and the disposal of their secretion and the environment they contact. As no effective treatment is available[3], it is of great value to explore the factors predicting the outcome and prognosis of SARS patients.

The outcome of SARS patients is affected by some factors comprehensively. Some descriptive studies have reported the characteristics of dead patients, but till now no multivariate studies are available. It has been reported that some factors are associated with SARS-related deaths, and that old age and high LDH level are associated with the deteriorated clinical condition[4]. Apart from clinical symptoms, the association between SARS and the environment, demographic characteristics, and some factors influencing his/her clinical consultation are scarcely reported. In this study we analyzed the epidemic data obtained from Beijing Centers for Disease Control and Prevention by multivariate regression in order to identify the predictors of death.

MATERIALS AND METHODS

Data Source

Database of notification of infectious diseases in

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Beijing and database for individual SARS cases were linked by name and reported time, and 1649 valid SARS cases were included from the two databases.

Statistical Analysis

Data were input into a dataset file with Microsoft Excel-2000 software using SPSS version 10.0. The data were analyzed by Chi-square test and multivariate unconditional logistic regression. In the analysis of logistic regression, the dependent variable was death. Death was defined as 1 and survival was defined as 0. The independent variables are listed in Table 1.

TABLE 1

Independent Variables in Logistic Regression Model

Independent Variable	Assignment
Gender	Male=1, Female=0
Age (Years)	0~59=1, 60~=0
Tertiary Referral Hospital	Yes=1, No=0
Hospital Designated Specially for SARS Patients	Yes=1, No=0
Health Condition in the Two Months Before Onset of SARS	Have Been Ill=1, Healthy=0
History of Contact With SARS Patients	Yes=1, No=0
Health Care Worker	Yes=1, No=0
Interval Between Onset of SARS and Hospital Visit (Days)	⩽1=1, ＞1=0

RESULTS

A total of 1649 cases (814 males, 835 females) were confirmed to be SARS cases according to the diagnostic criteria set by the Ministry of Health of China. The age of patients ranged from 1 to 93 years, with a mean of 37.6 years. One hundred and sixty-one patients were over 60 years old, accounting for 11.58% of the total cases, and 1458 patients at the age of 60 years and younger accounted for 88.42%. Up to July 7, 2003, 120 cases died. The case fatality rate was 7.28% (120/1649). The distribution of interested variables in the SARS patients is listed in Table 2.

Predictors of Mortality

The results of univariate analysis are summarized in Table 3. We evaluated the effect of the following variables on mortality by using univariate analysis. Age over 60 years, admittance to tertiary referral hospitals, special hospitals for SARS patients, health care worker, and interval between onset and hospital visit longer than 1 day were predictors of mortality.

TABLE 2

Distribution of Interested Variables in SARS Patients

	Survivals (*n*=1529)	Deaths (*n*=120)	Total
	n (%)	*n* (%)	*n* (%)
Sex			
Female	781(51.08)	54(45.00)	835(50.64)
Male	748(48.82)	66(55.00)	814(49.36)
Age			
<60	1397(91.37)	61(50.83)	1458(88.42)
⩾60	132(6.63)	59(49.17)	191(11.58)
Contact History			
No	641(41.92)	47(39.17)	688(41.72)
Yes	888(58.08)	73(60.83)	961(58.28)
Admitted to Tertiary Hospital			
Yes	1358(88.80)	95(79.17)	1453(88.11)
No	171(11.18)	25(20.83)	196(11.89)
Admitted to Special Hospital for SARS Patients			
No	42(2.75)	29(24.17)	71(4.31)
Yes	1487(97.25)	91(75.83)	1578(95.69)
Health Status in the Two Months Before SARS Onset			
Healthy	897(90.97)	66 (75.00)	963(89.66)
Not Healthy	89(9.03)	22(25.00)	11(10.34)
Occupation			
NHCWs	1275(83.19)	116(96.67)	1388(84.17)
HCWs	257(16.81)	4(3.33)	261(15.83)
Interval Between Onset and Hospital Visit			
⩽1 day	1003(67.14)	92(78.63)	1095(67.97)
>1 day	491(32.86)	25(21.37)	516(32.03)

Note. Column totals may differ due to missing data.

A multivariate logistic regression model could identify predictors of mortality. The dependent variable was death or not and the independent variables were the 8 variables listed in Table 1. In multivariate logistic regression, age over 60 years, non health care worker, interval between onset of SARS and hospital visit longer than 1 day, and admittance to hospitals not designated specially for SARS patients were independent predictors of mortality (Table 4).

DISCUSSION

WHO has estimated that the case fatality rate of SARS ranges from 0% to 50% depending on the age group affected: less than 1% in persons aged 24 years or younger, 6% in persons aged 25-44 years, 15% in persons aged 45-64 years, and greater than 50% in

TABLE 3

Univariate Analysis of Association Between Variables and Mortality

	Survivals (*n*)	Deaths (*n*)	Total	Case Fatality Rate (%)	OR	95%CI
Sex						
Female	781	54	835	6.47	1	
Male	748	66	814	8.11	1.28	0.879-1.854
Age						
<60	1397	61	1458	4.18	1	
⩾60	132	59	191	30.89	10.24	6.862-15.270
Contact History						
No	641	47	688	6.83	1	
Yes	888	73	961	7.60	1.12	0.766-1.640
Admitted to Tertiary Hospital						
No	171	25	196	12.76	1	
Yes	1358	95	1453	6.54	0.48	0.300-0.764
Admitted to Special Hospital for SARS Patients						
No	42	29	71	40.85	1	
Yes	1487	91	1578	5.77	0.089	0.053-0.149
Health Status in the Two Months Before SARS Onset						
Healthy	897	66	963	6.85	1	
Not Healthy	89	22	11	19.82	3.360	1.979-5.704
Occupation						
NHCW	1275	116	1388	8.36	1	
HCW	257	4	261	1.53	0.171	0.062-0.467
Interval Between Onset and Hospital Visit						
⩽1 day	1003	92	1095	8.40	1	
>1 day	491	25	516	4.84	0.555	0.434-0.875

TABLE 4

Independent Predictors of Mortality by Multivariate Logistic Regression

Variable	β	$S_{\bar{x}}$	Wald	*P*	OR	95%CI
Age Over 60 Years	2.089	0.266	61.711	0.000	8.075	4.795-13.598
Non Health Care Worker	-1.632	0.731	4.984	0.026	0.195	0.047-0.819
Interval Between Onset and Hospital Visit Shorter Than 1 Day	-0.757	0.327	5.365	0.021	0.469	0.247-0.890
Admittance to Special Hospitals for SARS Patients	-2.036	0.352	33.435	0.000	0.130	0.065-0.260

persons aged 65 years or over[5]. The case fatality rates reported from all regions are different, which might be due to a nonuniform case definition of SARS disease. In July 11, 2003 (no new case was reported to occur since this day) there were 8437 cases all over the world, and 813 of them died of SARS, the case fatality rate was 9.64%. There were 5327 SARS cases in China and 348 of which died, the case fatality rate was 6.53%[6]. In this study, 120 of the 1649 SARS cases died, the case fatality rate was 7.28%.

The univariate analysis showed that age over 60 years, and disease occurred two months before onset of SARS were risk factors for SARS-related deaths, but such factors as admittance to tertiary referral hospitals and special hospitals for SARS patients, health care worker, and interval between onset of SARS and hospital visit shorter than 1 day decreased the risk of SARS-related deaths.

Multivariate logistic stepwise regression showed that four variables (age, occupation, interval between onset of SARS and hospital visit, and category of

hospital admittance) influenced the deaths significantly. Age over 60 years significantly increased the risk of SARS-related deaths, while health care worker, admittance to special hospitals for SARS patients, and interval between onset of SARS and hospital visit shorter than 1 day significantly decreased the risk of SARS-related deaths.

Age over 60 years was the main risk factor for SARS-related deaths. The patients over 60 years old had a 8.71-fold risk of death, as compared with those under 60 years of age, which is consistent with the results in other studies[7-8]. This may be explained by the fact that old aged patients generally have chronic diseases before the onset of SARS, and when they suffer from SARS, their health is easily deteriorated. This is an important characteristic of SARS, indicating that the Centers for Disease Control and Prevention and medical authorities should strengthen the tertiary preventive and clinical care of old aged patients to decrease the deaths.

Health care workers are the main force in preventing SARS and treating SARS patients. They are at the high risk of being infected with SARS-CoV when SARS occurs. Therefore, effective measures must be taken to protect health care workers against the infection. The results of multivariate analysis indicate that the case fatality rate of health care workers is lower than that of other people. This may be explained by the following two factors. The measures taken in Beijing effectively protected the health care workers from being infected with SARS, and most of the health care workers were young with high immunity.

The multivariate analysis showed that the interval between the onset of SARS and hospital visit strongly influenced the prognosis of SARS patients. The cases who visited hospitals for consultation within a day of the onset of SARS had a lower risk of death than those who visited hospitals one day after onset. The authority responsible for preventing and controlling SARS encouraged the timely hospital visit during SARS epidemic, aiming at reducing the further spread in the public and the risk of deteriorated clinical status.

The multivariate logistic regression analysis showed that the patients admitted to special hospitals for SARS had a lower risk of death than those admitted to other hospitals, suggesting that the strategy to rebuild special hospitals for admitting and treating SARS patients can decrease the deaths effectively.

The two variables, admittance to tertiary referral hospitals and health condition before onset of SARS, significantly influence the prognosis, which might be due to the admittance to hospital and health condition before onset of SARS that have the same influence on the prognosis as special hospitals for SARS and age.

The limit of the study is that all the clinical and environmental factors could not be considered comprehensively. Further studies are needed to elucidate the risk factors for SARS.

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