Experience of resources management on coronavirus disease 2019 epidemic at a tertiary medical center in Northern Taiwan

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Abstract

Background: Coronavirus disease 2019 (COVID-19) is a respiratory infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes infectious symptoms including fever, cough, respiratory and gastrointestinal symptoms, and even loss of smell/taste and to date had caused 489 000 people to be infected with 32 000 deaths. This article aims to develop some strategies in dealing with the COVID-19 epidemic to prevent nosocomial infection and ensure the safety of healthcare workforce and employees.

Methods: This is a prospectively registered and retrospective descriptive study investigating the clinical characteristics, results of diagnostic tests, and patients' disposition from February 1, 2020, to April 30, 2020, at a tertiary medical center in Northern Taiwan.

Results: There is no nosocomial spreading of SARS-CoV-2 in our facility. The following strategies were followed: information transparency; epidemic prevention resources planning by authorities; multidisciplinary cooperation; informative technologies; immigration quarantine policies; travel restrictions; management of diversion/subdivision; self-health monitoring; social distancing; screening of travel, occupation, contact, and cluster (TOCC) history; traffic control bundling (TCB); training of using personal protective equipment; real-name visiting management; and employee care. The patients' basic characteristics and diagnostic results were gathered. Of the 3832 cases, about 25.9% had travel history. Most of them were traveling to Asia (419 people/time, 10.9%) and from China (256 people/time, 6.7%). Meanwhile, healthcare personnel accounted for 316 people/time (8.3%) and cleaning personnel, 6 people/time (0.16%). The 36 cases who care or have contact with confirmed cases have negative results from the COVID-19 test. The most frequent symptoms were fever and upper respiratory infection followed by gastrointestinal symptoms.

Conclusion: The above strategies were followed. Patients were stratified based on the risk of TOCC history assessment to ensure the safety of healthcare personnel and patients' appropriate and timely medical services.

Keywords: COVID-19; Epidemics; SARS-CoV-2

1. INTRODUCTION

Coronavirus disease 2019 (COVID-19) first emerged in December 2019 in Wuhan, China. COVID-19 is a respiratory infection caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that causes infectious symptoms including fever, cough, respiratory and gastrointestinal symptoms, and even loss of smell/taste sensation.[1] World Health Organization (WHO) had declared COVID-19 a global pandemic on March 11, 2020, that had spread to 216 countries[2] and to date had caused 489 000 people to be infected with 32 000 deaths in about 5 months since it had emerged. The top five countries with most confirmed cases and deaths cases are United States, Russia, Brazil, United Kingdom, and Spain, and the United States, United Kingdom, Italy, France, and Spain, respectively.[3] The global mortality rate is 6.54%.[4] The asymptomatic infection of COVID-19 was different from previous novel infectious diseases like SARS and Middle East respiratory syndrome (MERS). It is more difficult to block the COVID-19 infection. Moreover, the survival time of SARS-CoV-2 in the environment lasts for several days. Thus, how to block and mitigate the asymptomatic infection and prevent the spread of invisible environmental mediums become an unignorable issue. This article aims to share our strategies and experiences in dealing with the COVID-19 epidemic to prevent nosocomial infection and ensure the safety of healthcare workforce and employees.

2. METHODS

2.1. Setting and study design

This is a prospectively registered and retrospective analysis descriptive study conducted at a tertiary medical center in Northern Taiwan. The facility has 3000 beds, and the annual emergency department (ED) visits were 85 182 ± 1821 (mean

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± SD) in the past 5 years. This study investigates patients' clinical characteristics (age, source, TOCC history, clinic visit and on what symptoms, and reported infectious disease), results of diagnostic tests (rapid influenza A/B test, influenza A/B polymerase chain reaction [PCR], atypical respiratory panel PCR, SARS-CoV-2 PCR), and patients' disposition (hospital discharge; admission to quarantine intensive care unit [ICU], ICU, quarantine ward, ordinary ward, ED negative pressure area, and ED observation; or death) from February 1, 2020, to April 30, 2020.

2.2. Patient stratification

Patients who visited our ED with a risk of suspected COVID-19 infection (have TOCC history, fever, upper respiratory symptoms, loss of taste/smell sensation, diarrhea, and so on) met the inclusion criteria for the study period. They are classified according to three different areas to receive medical services. Patients with high risk of COVID-19 infection and were assessed by physicians and nurses at an outdoor screening station were guided directly into the ED negative pressure area and received chest film and nasopharyngeal swab examination (rapid influenza A/B test or influenza A/B PCR, atypical respiratory panel PCR, SARS-CoV-2 PCR). Blood testing was also performed in patients with critical illness. Patients with medium to low risk of COVID-19 infection without critical illness received chest film and nasopharyngeal swab examination at an outdoor screening area. Patients from the community who did not meet any criteria for suspected COVID-19 infection but had fever from unknown origin received SARS-CoV-2 PCR and relevant laboratory examinations at ED single room area.

2.3. Data collection and statistical analysis

Data were collected and recorded on a medical chart, and laboratory reports were reviewed by ED physicians and triage nurses. Afterward, result of continuous variable such as age is expressed as mean ± SD, and categorical variables are expressed as n (%). The statistical method of the chi-square test with Fisher's exact test was used for categorical variables. p values of <0.05 were considered to be significant. Statistical analysis was performed using R statistical version 3.4.1.

3. RESULTS

3.1. Basic characteristics and diagnostic results of patients

According to risk management of diversion and subdivision, 3832 patients visited the ED at a tertiary medical center in Northern Taiwan from February 1, 2020 to April 30, 2020 and were analyzed (Table). Of the 3832 cases, about 25.9% had travel history. Most of them were traveling to Asia (419 people/time, 10.9%) and from China (256 people/time, 6.7%). Meanwhile, healthcare personnel accounted for 316 people/time (8.3%) and cleaning personnel, 6 people/time (0.16%). The 36 cases who care or have contact with confirmed cases have negative results of COVID-19 test. The most frequent symptoms were fever and upper respiratory infection followed by gastrointestinal symptoms.

3.2. Basic characteristics and diagnostic results of stratified patients

Patients were stratified into three groups according to different medical care delivery areas, namely, ED negative pressure quarantine area, outdoor screening area, and extended community screening area. Patients' age (mean ± SD) of the three groups were 40.89 ± 23.71, 45.75 ± 19.73, and 70.07 ± 20.88, respectively (p < 0.001). Other variables included sources, TOCC history, symptoms, kinds of report, rapid influenza diagnostic test, SARS-CoV-2 PCR, and atypical respiratory panel (PCR). Dispositions between three groups revealed significant difference (p < 0.001). For the extended community screening cases, the most common symptoms were fever and pneumonia; however, respiratory-associated symptoms were less common. Results of rapid influenza test and atypical respiratory panel did not reveal a trend of influenza epidemic.

4. DISCUSSION

First, Taiwan is located near Mainland China. It becomes the country with the highest risk of COVID-19 epidemic. Our government's epidemic prevention command center used the core concept of the previously published model as well as the attitude of information transparency, epidemic prevention resources planning by authorities, multidisciplinary departments collaboration, informative technologies, immigration quarantine policies, travel restrictions, management of diversion/subdivision, education on self-health monitoring, and social distancing to ensure safety of people and hospital workforce.[5–8] According to the structure of hospital incident command system (HICS), a tertiary medical center in Northern Taiwan established SARS-CoV-2 epidemic prevention command center in January 2020. Under the lead of the hospital president and through the use of the model of team resources management, the TOCC/fever screening station, negative pressure quarantine area in ED, and the wards that were set up within 5 days took responsibility of COVID-19 epidemic. In addition, we established the distribution mechanism for the overall management of epidemic prevention materials, planned the employee and patients' routes in hospital using the concept of diversion/subdivision and visiting management, and resolved ED overcrowding at the same time. The important concept of epidemic prevention is to balance transparency of information without causing panic; thus, the SARS-CoV-2 epidemic prevention command center in the hospital will transmit the epidemic prevention information to relevant personnel by e-mail daily and in a timely manner. Simultaneously, the director of every department communicates important information and policies by bulletin. This enabled decision makers to seamlessly connect with executors, creating a situation of peace of mind and trust toward epidemic prevention.

Second, TOCC screening, assessment, and TCB are the most effective methods to prevent the spread of epidemic and avoid the risk of cross-infection. At the start of COVID-19 epidemic, the first priority was to plan for emergency TOCC screening station, outdoor epidemic/fever screening station, and emergency negative pressure epidemic quarantine area. As the international epidemic became more severe and cooperation with the extended screening policy had been made, the ED divided the traffic route into high-risk area and added low- to medium-risk area to respond to change in medical needs. Initially, the SARS-CoV-2 infection was seen as closely related to Wuhan, China. To prevent the ED from becoming an epidemic area, emergency TOCC screening station and infrared temperature monitor/forehead thermometer were set up at the entrance of the ED. Furthermore, body temperature is checked and monitored on each person (including patients, visitors, and staff) before entering the ED. Also, the contents of questionnaire for TOCC history are adjusted according to the trend of international epidemic and a virtual private network (VPN) system established by national health insurance to shorten the waiting time for TOCC history assessment. In addition, security guards assist in safety maintenance, and nursing staffs take charge of the infection risk assessment and diversion. People with high risk of COVID-19 infection will be guided to negative pressure quarantine area accompanied by specially assigned staffs. Those with low to medium risk will receive the chest film and nasopharyngeal swab screen test at the outdoor epidemic/fever screening station. Those without symptoms and risks of

Table

Result for Patient Analysis of Diversion/Subdivision

N = 3832	ED negative pressure quarantine area (n = 1245)		Outdoor screening area (n = 2298)		Extended community screening (n = 289)		*p*
Age(mean ± SD)	40.89 ± 23.71		45.75 ± 19.73		70.07 ± 20.88		<0.001
Source							<0.001
1922 (CDC)	44	(3.5%)	6	(0.3%)	0	(0.0%)	
OPD	43	(3.5%)	301	(13.1%)	9	(3.1%)	
Our hospital	54	(4.3%)	81	(3.5%)	0	(0.0%)	
Workplace	19	(1.5%)	41	(1.8%)	0	(0.0%)	
School	4	(0.3%)	18	(0.8%)	0	(0.0%)	
Other countries	12	(1.0%)	10	(0.4%)	0	(0.0%)	
Home	971	(78.0%)	1757	(76.4%)	187	(64.7%)	
Healthcare facilities	27	(2.2%)	21	(0.9%)	28	(9.7%)	
Other hospitals	65	(5.2%)	61	(2.7%)	60	(20.8%)	
Travel							<0.001
None	847	(68.0%)	1708	(74.3%)	286	(99.0%)	
China	81	(6.5%)	175	(7.6%)	0	(0.0%)	
USA	45	(3.6%)	86	(3.7%)	1	(0.4%)	
Canada	6	(0.5%)	9	(0.4%)	0	(0.0%)	
Europe	35	(2.8%)	34	(1.5%)	0	(0.0%)	
Asia	196	(15.7%)	222	(9.7%)	1	(0.4%)	
Africa	6	(0.5%)	13	(0.6%)	0	(0.0%)	
Oceania	7	(0.6%)	19	(0.8%)	0	(0.0%)	
Warship/Cruise ship	0	(0.0%)	2	(0.1%)	0	(0.0%)	
Attractions	22	(1.8%)	30	(1.3%)	1	(0.4%)	
Occupation							<0.001
Doctor	38	(3.1%)	37	(1.6%)	0	(0.0%)	
Nurse	97	(7.8%)	86	(3.7%)	5	(1.7%)	
Other medical staffs	16	(1.3%)	37	(1.6%)	0	(0.0%)	
Cleaning staff	1	(0.1%)	5	(0.2%)	0	(0.0%)	
Others	1093	(87.8%)	2133	(92.8%)	284	(98.3%)	
Contact							<0.001
None	942	(75.7%)	1800	(78.3%)	283	(97.9%)	
Contact the case from epidemic area or suspected case	279	(22.4%)	486	(21.2%)	6	(2.1%)	
Contact the confirmed case	14	(1.1%)	12	(0.5%)	0	(0.0%)	
Has cared the confirmed cases	10	(0.8%)	0	(0.0%)	0	(0.0%)	
Cluster							<0.001
None	1205	(96.8%)	2163	(94.1%)	289	(100%)	
Yes	40	(3.2%)	135	(5.9%)	0	(0.0%)	
Symptom							<0.001
None	16	(1.3%)	33	(1.4%)	0	(0.0%)	
Fever	361	(29.0%)	526	(22.9%)	60	(20.8%)	
URI	464	(37.3%)	1242	(54.1%)	26	(9.0%)	
Pneumonia	185	(14.9%)	103	(4.5%)	50	(17.3%)	
Age	66	(5.3%)	99	(4.3%)	14	(4.8%)	
Others	152	(12.2%)	295	(12.8%)	137	(47.4%)	
Cardiac arrest (OHCA)	1	(0.1%)	0	(0.0%)	2	(0.7%)	
Reporting							<0.001
None	499	(40.1%)	1579	(68.7%)	0	(0.0%)	
Severe pneumonia with novel pathogens	254	(20.4%)	110	(4.8%)	0	(0.0%)	
Suspected SARS-CoV-2	437	(35.1%)	556	(24.2%)	156	(54.0%)	
Self-tested in hospital	54	(4.3%)	53	(2.3%)	133	(46.0%)	
Others (VZV)	1	(0.1%)	0	(0.0%)	0	(0.0%)	
Rapid influenza diagnostic test							<0.001
None	1062	(85.3%)	1744	(75.9%)	285	(98.6%)	
Negative	179	(14.4%)	543	(23.6%)	4	(1.4%)	
Influenza A	2	(0.2%)	8	(0.4%)	0	(0.0%)	
Influenza B	1	(0.1%)	3	(0.1%)	0	(0.0%)	
Influenza A/B	1	(0.1%)	0	(0.0%)	0	(0.0%)	
SARS-CoV-2 PCR							<0.001
None	504	(40.5%)	1585	(69.0%)	0	(0.0%)	
Negative	740	(59.4%)	710	(30.9%)	289	(100%)	
Positive	1	(0.1%)	3	(0.1%)	0	(0.0%)	

(*Continued*)

Table (Continued)

N = 3832	ED negative pressure quarantine area (n = 1245)		Outdoor screening area (n = 2298)		Extended community screening (n = 289)		p
Atypical respiratory panel							<0.001
None	535	(43.0%)	1593	(69.3%)	38	(13.2%)	
Negative	631	(50.7%)	629	(27.4%)	243	(84.1%)	
Influenza A	18	(1.5%)	20	(0.9%)	0	(0.0%)	
Influenza B	1	(0.1%)	1	(0.0%)	0	(0.0%)	
Coronavirus	11	(0.9%)	15	(0.7%)	0	(0.0%)	
Parainfluenza virus	10	(0.8%)	5	(0.2%)	2	(0.7%)	
Mycoplasma pneumoniae	3	(0.2%)	1	(0.0%)	0	(0.0%)	
Human rhinovirus/enterovirus	24	(1.9%)	23	(1.0%)	5	(1.7%)	
Human rhinovirus A	0	(0.0%)	1	(0.0%)	0	(0.0%)	
Enterovirus	3	(0.2%)	0	(0.0%)	0	(0.0%)	
Adenoviruses	0	(0.0%)	0	(0.0%)	1	(0.4%)	
Bordetella pertussis	5	(0.4%)	5	(0.2%)	0	(0.0%)	
Respiratory syncytial virus, (RSV)	0	(0.0%)	3	(0.1%)	0	(0.0%)	
Human metapneumovirus	4	(0.3%)	2	(0.1%)	0	(0.0%)	
Disposition							<0.001
Discharge	900	(72.3%)	1939	(84.4%)	19	(6.6%)	
Quarantine ICU	45	(3.6%)	8	(0.4%)	36	(12.5%)	
ICU	5	(0.4%)	9	(0.4%)	51	(17.7%)	
Quarantine ward	136	(10.9%)	59	(2.6%)	17	(5.9%)	
Ordinary ward	88	(7.1%)	182	(7.9%)	164	(56.8%)	
Death	3	(0.2%)	1	(0.0%)	2	(0.7%)	
ED observation	43	(3.5%)	61	(2.7%)	0	(0.0%)	
ED negative pressure area	25	(2.0%)	39	(1.7%)	0	(0.0%)	

CDC = Centers for Disease Control; ED = emergency department; ICU = intensive care unit; OHCA = out-of-hospital cardiac arrest; OPD = obstructive pulmonary disease; PCR = polymerase chain reaction; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2; VZV = varicella zoster virus.

COVID-19 infection were allowed to go to the ED to receive medical services. To avoid outbreak of COVID-19 epidemic at the ED, those with suspected cases of COVID-19 infection were screened by emergency TOCC screening station, diverted to the outdoor epidemic/fever screening station, and received physical assessment like chest film and virus test using the usual outdoor ED lounge. This open and independent space will have the advantage to divert staffs and patients into different routes to avoid cross-infection. People with high risk of COVID-19 infection assessed by emergency TOCC screening station will be reported with severe pneumonia with novel pathogens to Taiwan Centers for Disease Control and admitted to emergency negative pressure epidemic quarantine area. The expansion of community screening and people coming back from other countries resulted in limited space for enormous number of patients. Thus, the epidemic observation area where patients with minor symptoms and have negative result of first COVID-19 test were admitted was set up. Overall, it is an excellent strategy on a daily basis to attend to the outbreak of information from the epidemic prevention command center that is instantly in a rolling response to ensure safety of the hospital workforce.

Third, the vital element about the spread of virus is through interpersonal contact. As the transmission route became clearer, we learned that the virus could survive several days in the environment. Besides, it is more difficult to deal with the virus that can spread from asymptomatic people we are not in contact with. The focus on epidemic prevention includes environment cleaning, personal protection, handwashing, and social distancing. These reduce the chance of spreading the virus through interpersonal contact. To ensure that the supply of epidemic prevention resources is secured, healthcare personnel were provided different levels of personal protective equipment according to the area of risk. The full protective equipment included waterproof cloth, N95 mask, surgical mask, goggles, face shield, surgical grooves,[9] and headset microphone for effective communication in high-risk areas. With the gradual volume of supplies and changes in the epidemic, personal protective equipment was also gradually revised to allow frontline staff to obtain the most suitable equipment. On the aspect of employee, the model of diversion/subdivision was applied. We recruited individuals who are willing to attend to high-risk patients and selected seed personnel to participate in the planning and training of relevant personnel. Except for medical relevant personnel, we also provided education to contractors, cleaners, and support staffs to ensure the safety of the employees.

Fourth, visitors may be the weakest point in epidemic prevention. In the implementation of visiting policies, visiting of family is taken into consideration, as it is an indispensable culture of Taiwanese during this epidemic prevention period. The initial source of SARS-CoV-2/COVID-19 infection may have come from relevant travel history. Thus, immigration management becomes the focus of epidemic prevention in various countries.[10] Our healthcare authorities, together with the relevant departments, authorized hospitals to use the national health insurance information network service through VPN system to query patients and visitors' travel history to screen high-risk group faster and improve the efficiency of TOCC assessment. According to the above policy, ED nursing staffs performed patients/visitors' body temperature measurement using infrared temperature monitor/forehead thermometer and the national health insurance information network service through VPN system to query travel history. Also, the visitor health declaration card should be filled out with security personnel present to assist safety maintenance at TOCC screening station. Under the visiting policies, the needs of patients and families were also taken into account; thus, our hospital implemented online videos for patient visitation. For emergency visitation, our hospital also provided planned hospital visitation through real-name visitor/guest app system under the agreement

of patient's right to autonomy. Visitors can fill out the personal information, TOCC history, and health declaration in the app and get a QR code that authorizes the access to pass through hospital gates and wards. Considerably, every ward regularly provides masks to reduce the risk of cross-infection.

Finally, to face the challenge of COVID-19 epidemic, high pressure is placed on employees. Support system is even more important.[5,9] The key to the success of epidemic prevention is closely related to employees; however, employees face the harsh tests of epidemic prevention. Support of program leaders, therefore, is required. The core value of our hospital is to create a happy workplace for employees through an employee-centered support system. For example, this support system provides personnel (1) enough epidemic prevention materials, employee self-health monitoring,[9] employee care phone line, and epidemic prevention leave by personnel office; (2) guardian angel and nursing angel as emotional support platform by the nursing department; (3) nutritious meals, enhanced immune drinks, carry-on bottles of dry hand sanitizer, and incentives for frontline personnel by the president; and (4) e-mail about the epidemic prevention and LINE® social media group to make real-time communication and solve problems in a timely manner by the ED.

However, this study has some limitations. First, as this is a retrospective medical chart reviewed study, it would be affected by missing or incomplete data collection. Second, this is a single center study, and the result of this study might not be fully applied to other facilities.

Overall, the previously published model of epidemic prevention policies by Taiwan epidemic prevention command center and the above strategies developed by HICS are effective in stopping the spread of COVID-19 epidemic in the hospital.

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