Emergency department response to coronavirus disease 2019 outbreak with a fever screening station and "graded approach" for isolation and testing

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Abstract

Background: Ever since coronavirus disease 2019 (COVID-19) emerged in Wuhan, China, in December 2019, it has had a devastating effect on the world through exponential case growth and death tolls in at least 146 countries. Rapid response and timely modifications in the emergency department (ED) for infection control are paramount to maintaining basic medical services and preventing the spread of COVID-19. This study presents the unique measure of combining a fever screening station (FSS) and graded approach to isolation and testing in a Taiwanese medical center.

Methods: An FSS was immediately set up outside the ED on January 27, 2019. A graded approach was adopted to stratify patients into "high risk," "intermediate risk," and "undetermined risk" for both isolation and testing.

Results: A total of 3755 patients were screened at the FSS, with 80.3% visiting the ED from home, 70.9% having no travel history, 21.4% having traveled to Asia, and 10.0% of TVGH staff. Further, 54.9% had fever, 35.5% had respiratory symptoms, 3.2% had gastrointestinal symptoms, 0.6% experienced loss of smell, and 3.1% had no symptoms; 81.3% were discharged, 18.6% admitted, and 0.1% died. About 1.9% were admitted to the intensive care unit, 10.3% to the general ward, and 6.4% were isolated. Two patients tested positive for COVID-19 (0.1%) and 127 (3.4%) tested positive for atypical infection; 1471 patients were tested for COVID-19; 583 were stratified as high-risk, 781 as intermediate-risk, and 107 as undetermined-risk patients.

Conclusion: Rapid response for infection control is a paramount in the ED to confront the COVID-19 outbreak. The FFS helped divide the flow of high- and intermediate-risk patients; it also decreased the ED workload during a surge of febrile patients. A graded approach to testing uses risk stratification to prevent nosocomial infection of asymptomatic patients. A graded approach to isolation enables efficient allocation of scarce medical resources according to risk stratification.

Keywords: Coronavirus; Emergency service, hospital; Infection control

1. INTRODUCTION

Ever since coronavirus disease 2019 (COVID-19) emerged in Wuhan, China, in December 2019, it has affected more than 60 countries around the world with over 6000 cases and 106 deaths, only 2 months after the virus was discovered.[1] The World Health Organization declared the COVID-19 outbreak a pandemic on March 12, 2020. The outbreak challenges the global health system and specifically impacts the emergency departments (EDs) that serve as the frontline for surveillance, triage, and clinical care functions during a public health emergency.[2] Patients experiencing symptoms, be it severe respiratory distress or mild fever and cough, present to the ED as it is a convenient and accessible port of entry for healthcare services in Taiwan. Therefore, EDs face the tasks of delivering care to patient groups who typically present to the ED, protecting the personnel, and providing medical services to critically ill patients while effectively isolating and preventing walk-in patients from transmitting COVID-19 even before these patients are seen by an emergency physician (EP).

The disease outbreak and transmission in many parts of the world serve as reminders that high vigilance is required as early as at the door of the ED. The stakes of cross-infection in unidentified patients are high, especially when up to 80% of the patients infected with COVID-19 present with mild respiratory tract symptoms or mild pneumonia and 1.2% of the patients have no symptoms.[3–5] Moreover, a nosocomial outbreak in a hospital can cause significant morbidity and mortality among patients and healthcare workers.

The study describes our unique approach of combining a fever screening station (FSS) at the door of ED and a "graded approach" for both isolation and testing for different risks of

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Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

Journal of Chinese Medical Association. (2020) 83: 997-1003.

Received June 4, 2020; accepted June 15, 2020.

doi: 10.1097/JCMA.0000000000000420.

infection within the ED in a tertiary medical center in Taiwan, with the purpose of early triage, isolation, and detection of COVID-19 patients.

2. METHODS

2.1. Design

We conducted a retrospective study in the ED of a tertiary medical center. This project was reviewed and approved by Institutional Research Board, which waived the need for patient consent (No. 2020-06-011BC).

2.2. Setting

The Taipei Veterans General Hospital (TVGH) is a 2900-bed university-affiliated leading medical center in Taiwan. It closely follows the updated recommendations for the diagnosis of COVID-19 released by the National Health Command Center (NHCC). The NHCC, with the Taiwan Center of Disease Control (CDC) as its base, was established in 2004 in response to the global epidemic of severe acute respiratory syndrome, which relentlessly tested Taiwan's capability of public health emergency management in 2003. Given the narrow window of opportunity to prepare for a surge in COVID-19 cases, an FSS was immediately set up outside the ED in TVGH on January 27, 2019. FSS serves to screen patients with fever, relevant TOCC, and high potential for COVID-19 infection, who are denied entry into the ED. Fever surveillance is conducted using infrared thermal-imaging cameras and forehead thermometers.

2.3. Participants

The study included patients screened at the FSS from January 27, 2020, to April 30, 2020. Missing or incomplete data were excluded. Questionnaires on TOCC in accordance with the updated diagnostic criteria were printed and distributed to each patient to fill out before ED entry.

2.4. Protocol

A "graded approach" was adapted to stratify patients for both isolation and testing. The reporting criteria of COVID-19 in Taiwan included clinical, epidemiologic, and laboratory criteria.[6] A patient who has one clinical and one epidemiologic/laboratory criteria fulfills the reporting criteria. On the basis of recommendations from the NHCC and Taiwan CDC, hospitals in Taiwan must stratify patients into three categories: (1) high risk (2), intermediate risk, and (3) undetermined risk. [6]

A graded approach for isolation helps identify high-risk patients who are denied entry into the ED and immediately ushered into a negative-pressure isolation area (higher-level isolation) from an exterior route while waiting to be seen by an EP. Patients with intermediate risk are also denied entry into the ED and ushered into a non-negative pressure isolation area (lower-level isolation) from an exterior route. Patients at the undetermined risk without relevant TOCC who do not fit the NHCC case definition are allowed entry into the ED.

Graded approach for testing: high-risk and intermediate-risk patients who fit the NHCC case definition are tested and identified as high-risk and intermediate-risk patients accordingly. High-risk patients require two negative COVID-19 test results before being released from isolation for admission. Intermediate-risk patients require one negative test result. Undetermined-risk patients have low risk of infection but are tested before the admission in order to avoid nosocomial infection; these patients are temporarily isolated in the non-negative pressure isolation area while waiting for their COVID-19 results. If one negative COVID-19 test result is obtained, undetermined-risk patients are transferred to a regular observational unit in the ED.

2.5. Data analysis

Data are expressed as mean ± SD for continuous variables and number (%) for categorical variables. Data distribution was assessed by the Kolmogorov-Smirnov test. Comparisons of numerical variables were performed using an unpaired *t* test (parametric data) or Mann-Whitney *U* test (nonparametric data). One-way analysis of variance followed by Turkey multiple range exact test was performed appropriately for statistical analysis between the groups. A $p < 0.05$ was considered statistically significant.

3. RESULTS

Table 1 shows the demographics of 3755 patients screened at the FSS; the average age was 43.9 ± 21.2 years.

Table 1

Demographics and clinical characteristics of patients screened at fever screening station

	All patients, N = 3755 (%)
Age, y	43.9 ± 21.2
Source	
TVGH	492 (13.1)
OPD	383 (10.2)
Ward	69 (1.8)
ED	15 (0.4)
Other departments	25 (0.7)
TVGH branch hospital	5 (0.1)
Other medical clinics	159 (4.2)
Veterans home	8 (0.2)
Government notification (TCDC of MOHW)	56 (1.5)
Self-visit (home, department, school)	3014 (80.3)
Airport	12 (0.3)
Others	9 (0.2)
Travel	
Asia	803 (21.4)
North America	149 (4.0)
Europe	65 (1.7)
Africa	8 (0.2)
Oceania	29 (0.8)
Domestic tourism	39 (1.0)
None	2660 (70.9)
Occupation	
Medical personnel in TVGH	375 (10.0)
Medical personnel in other hospitals	83 (2.2)
Others	2911 (77.5)
None	386 (10.3)
Contact	
None	3346 (89.2)
With suspected cases	378 (10.1)
With confirmed cases	29 (0.8)
Cluster	
None	3520 (93.8)
With suspected cases	216 (5.8)
With confirmed cases	17 (0.5)
Symptom	
Fever	2062 (54.9)
URI	1334 (35.5)
GI symptom	121 (3.2)
Loss of taste or smell	24 (0.6)
Others	99 (2.6)
None	115 (3.1)

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Table 1. (Continued)

	All patients, N = 3755 (%)
Reporting of infectious diseases	
Nonreporting	2284 (60.8)
Reporting as a high risk of infection	583 (15.5)
Reporting as an intermediate risk of infection	781 (20.8)
Hospital screening of undetermined risk of infection	107 (2.8)
2019-nCOV PCR	
Nonscreening	2285 (60.9)
Negative	1468 (39.1)
Positive	2 (0.1)
Atypical respiratory panel	
Nonscreening	1900 (63.2)
Negative	1305 (34.8)
Positive of the following pathogens	127 (3.4)
Human metapneumovirus	54 (42.5)
Enterovirus	50 (39.4)
Coronavirus	27 (21.3)
Parainfluenza	17 (13.4)
Respiratory syncytial virus	7 (5.5)
Adenovirus	7 (5.5)
Influenza A or B	5 (3.9)
Mycoplasma pneumoniae	4 (3.1)
Bordetella pertussis	3 (2.4)
Diagnosis	
Diseases of the respiratory system	2355 (62.7)
Fever of unknown origin	821 (21.9)
Diseases of the digestive system	215 (5.7)
Diseases of the genitourinary system	87 (2.3)
Neoplasms	64 (1.7)
Symptoms, signs, and abnormal clinical and laboratory findings, not elsewhere classified	56 (1.5)
Diseases of the skin and subcutaneous tissue	40 (1.1)
Injury, poisoning, and certain other consequences of external causes	40 (1.1)
Factors influencing health status and contact with health services	31 (0.8)
Diseases of the circulatory system	26 (0.7)
Diseases of the musculoskeletal system and connective tissue	16 (0.4)
Certain infectious and parasitic diseases	12 (0.3)
Diseases of the nervous system	4 (0.1)
Trend	
Discharge	3053 (81.3)
Admission	698 (18.6)
Expired	4 (0.1)
Ward	
ICU	71 (1.9)
General ward	387 (10.3)
Isolation ward	240 (6.4)
Isolation times, h	55.6 ± 46.2

Data were presented as mean ± standard deviation or n (%).

ED = emergency department; GI = gastrointestinal; ICU = intensive care unit; MOHW = Ministry of Health and Welfare; nCOV PCR = PCR for COVID-19; OPD = outpatient department; TCDC = Taiwan Centers for Disease Control; TVGH = Taipei Veterans General Hospital; URI = upper respiratory infection.

3.1. Source

A majority (80.3%) visited the ED from home and 10.3% were referred from outpatient department (OPD).

3.2. Travel

About 70.9% had no travel history, and 21.4% had traveled to Asia.

3.3. Occupations

About 10.0% were medical staff at TVGH, and 77.5% were non-medical personnel.

3.4. Contact/cluster

While a majority had no contact or cluster history (89.2%; 93.8%), 0.8% and 0.5% had contact and cluster history with confirmed cases.

3.5. Symptoms

About 54.9% had symptoms of fever, 35.5% respiratory symptoms, 3.2% gastrointestinal symptoms, 3.1% had no symptoms, and 0.6% complained of loss of smell.

3.6. Risk stratification

Among the COVID-19–tested patients, 15.5% were high risk, 20.8% intermediate risk, and 2.8% undetermined risk

3.7. 2019-PCR for COVID-19

While 60.9% of patients at FFS were not tested, 39.1% tested negative and 0.1% tested positive.

3.8. Atypical respiratory panel

While 68.2% were not tested, 34.8% tested negative and 3.4% positive.

3.9. Diagnosis

While 62.7% had a respiratory system diagnosis, 21.9% had fever of unknown origin (FUO), 5.7% had digestive system disorders, and 2.3% had genitourinary system disorders.

3.10. Disposition

Over 81.3% were discharged, 18.6% were admitted, and 0.1% died. About 1.9% were admitted to the intensive care unit (ICU), 10.3% to the general ward, and 6.4% were placed under isolation.

Table 2 shows characteristics of 1471 patients who were risk stratified and tested for COVID-19. The mean ages of high-risk, intermediate-risk, and undetermined-risk patients are 46.7 ± 23.7, 40.3 ± 19.3, and 55.2 ± 26.3, respectively.

3.11. Source

Approximately 77.9% of high-risk, 76.6% of intermediate-risk, and 59.8% of undetermined-risk patients came to the ED on their own without referral. Approximately 4.1% of high-risk, 12.2% of intermediate-risk, and 20.6% of undetermined-risk patients were referred from the TVGH outpatient clinic. Approximately 7.2% of high-risk, 0.8% of intermediate-risk, and 0.9% of undetermined-risk patients were referred to the ED by the CDC.

3.12. Travel history

About 55.6% of high-risk, 14.6% of intermediate-risk, and 8.41% of undetermined-risk patients had a travel history. About 38.4% of high-risk, 6% of intermediate-risk, and 6.5% of undetermined-risk patients had traveled to Asia.

3.13. Occupation

About 4.6% of high-risk, 23.8% of intermediate-risk, and 19.6% of undetermined-risk patients were TVGH hospital staff.

3.14. Contact

Only 2.1% of high-risk, 1.7% of intermediate-risk, and none of the undetermined-risk patients had contact history.

3.15. Cluster

Only 1.7% of high-risk, 0.8% of intermediate-risk, and none of undetermined-risk patients had cluster history.

Table 2

Comparison of clinical characteristics among patients with high risk of, intermediate risk of, and undetermined risk of coronavirus disease 2019 test

	High risk N = 583 (%)	Intermediate risk N = 781 (%)	Undetermined risk N = 107 (%)	*p*
Age, y	46.7 ± 24.7	40.3 ± 19.3[a]	55.2 ± 26.3[a,b]	<0.001
Source				
TVGH	32 (5.5)	130 (16.6)[a]	29 (27.1)[a,b]	<0.001
OPD	24 (4.1)	95 (12.2)[a]	22 (20.6)[a,b]	
Ward	4 (0.7)	22 (2.8)[a]	6 (5.6)[a]	
ED	2 (0.3)	5 (0.6)	1 (0.9)	
Other departments	2 (0.3)	8 (1)	0 (0)	
TVGH branch	3 (0.5)	1 (0.1)	0 (0)	
Other medical clinics	45 (7.7)	43 (5.5)	13 (12.1)[b]	
Veterans home	2 (0.3)	1 (0.1)	0 (0)	
Government notify (TCDC of MOHW)	42 (7.2)	6 (0.8)[a]	1 (0.9)[a]	
Self-visit (home, department, school)	454 (77.9)	598 (76.6)	64 (59.8)[a,b]	
Airport	4 (0.7)	1 (0.1)	0 (0)	
Others	1 (0.2)	1 (0.1)	0 (0)	
Travel				<0.001
Asia	223 (38.3)	47 (6.0)[a]	7 (6.5)[a]	
America	64 (11.0)	35 (4.5)[a]	0 (0)[a]	
Europe	30 (5.2)	19 (2.4)[a]	2 (1.9)	
Africa	1 (0.2)	3 (0.4)	0 (0)	
Oceania	6 (1.0)	10 (1.3)	0 (0)	
Domestic tourism	1 (0.2)	20 (2.6)[a]	0 (0)	
None	256 (44.1)	647 (82.8)[a]	98 (91.6)[a]	
Occupation				<0.001
Medical personnel in TVGH	27 (4.6)	186 (23.8)[a]	21 (19.6)[a]	
Medical personnel in other hospital	12 (2.1)	42 (5.4)[a]	1 (0.9)	
Others	477 (81.8)	440 (56.3)[a]	75 (70.1)[a,b]	
None	67 (11.5)	113 (14.5)	10 (9.3)	
Contact				0.214
None	506 (87.1)	661 (84.6)	97 (90.7)	
With suspected cases	63 (10.8)	107 (13.7)	10 (9.3)	
With confirmed cases	12 (2.1)	13 (1.7)	0 (0)	
Cluster				0.133
None	545 (93.8)	725 (92.8)	103 (96.3)	
With suspected cases	26 (4.5)	50 (6.4)	4 (3.7)	
With confirmed cases	10 (1.7)	6 (0.8)	0 (0)	
Symptom				<0.001
Fever	237 (40.7)	480 (61.5)[a]	87 (81.3)[a,b]	
URI	281 (48.2)	221 (28.3)[a]	16 (15)[a,b]	
GI symptom	11 (1.9)	30 (3.8)	1 (0.9)	
Loss of taste or smell	4 (0.7)	13 (1.7)	0 (0)	
Others	33 (5.7)	27 (3.5)	3 (2.8)	
None	17 (2.9)	10 (1.3)	0 (0)	
2019-nCOV PCR				0.008
Nonscreening	10 (1.7)	7 (0.9)	6 (5.6)[a,b]	
Negative	572 (98.1)	773 (99.0)	101 (94.4)[b]	
Positive	1 (0.2)	1 (0.1)	0	
Atypical respiratory panel				0.427
Nonscreening	67 (11.5)	112 (14.3)	16 (15)	
Negative	467 (80.1)	611 (78.2)	85 (79.4)	
Positive	49 (8.4)	58 (7.4)	6 (5.6)	
Human metapneumovirus	19	32	0	
Enterovirus	18	30	0	
Coronavirus	10	11	2	
Parainfluenza	5	7	2	
Respiratory syncytial virus	2	1	1	
Adenovirus	3	3	1	
Influenza A or B	3	0	0	
Mycoplasma pneumoniae	3	1	0	
Bordetella pertussis	2	1	0	

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Table 2. (Continued)

	High risk N = 583 (%)	Intermediate risk N = 781 (%)	Undetermined risk N = 107 (%)	*p*
Diagnose				<0.001
Diseases of the respiratory system	457 (78.4)	428 (54.8)[a]	49 (45.8)[a]	
Fever of unknown origin	69 (11.8)	257 (32.9)[a]	42 (39.3)[a]	
Diseases of the digestive system	19 (3.3)	43 (5.5)	4 (3.7)	
Diseases of the genitourinary system	4 (0.7)	16 (2.0)	1 (0.9)	
Neoplasms	4 (0.7)	10 (1.3)	7 (6.5)[a,b]	
Symptoms, signs, and abnormal clinical and laboratory findings, not elsewhere classified	4 (0.7)	5 (0.6)	2 (1.9)	
Diseases of the skin and subcutaneous tissue	0 (0)	1 (0.1)	1 (0.9%)	
Injury, poisoning, and certain other consequences of external causes	5 (0.9)	7 (0.9)	1 (0.9%)	
Factors influencing health status and contact with health services	11 (1.9)	1 (0.1)	0 (0)	
Diseases of the circulatory system	4 (0.7)	3 (0.4)	0 (0)	
Diseases of the musculoskeletal system and connective tissue	1 (0.2)	3 (0.4)	0 (0)	
Diseases of the nervous system	2 (0.3)	0 (0)	0 (0)	
Certain infectious and parasitic diseases	3 (0.5)	0 (0)	7 (0.9)	
Disposition				<0.001
Discharge	324 (55.6)	673 (86.2)[a]	41 (38.3)[a,b]	
Admission	256 (43.9)	108 (13.8)[a]	66 (61.7)[a,b]	
Expired	3 (0.5)	0 (0)	0 (0)	
Admission to hospital				<0.001
ICU	49 (8.4)	3 (0.4)[a]	8 (7.5)[b]	
General ward	10 (1.7)	89 (11.4)[a]	51 (47.7)[a,b]	
Isolation ward	197 (33.8)	16 (2.0)[a]	7 (6.5)[a,b]	

Data were presented as mean ± standard deviation or n (%). One-way ANOVA followed by Turkey post-hoc test.

ED = emergency department; GI = gastrointestinal; ICU = intensive care unit; MOHW = Ministry of Health and Welfare; OPD = outpatient department; TCDC = Taiwan Centers for Disease Control; TVGH = Taipei Veterans General Hospital; URI = upper respiratory infection.

[a]$p < 0.05$ vs reported as a high risk of infection group.

[b]$p < 0.05$ vs reported as an intermediate risk of infection group.

3.16. Symptoms

About 2.9% of high-risk and 1.3% of intermediate-risk patients had no symptoms. About 40.7% of high-risk, 61.5% of intermediate-risk, and 81.3% of undetermined-risk patients had fever. About 48.2% of high-risk, 28.3% of intermediate-risk, and 15% of undetermined-risk patients had respiratory symptoms. About 0.7% of high-risk, 1.7% of intermediate-risk, and none of the undetermined-risk patients had loss of smell and taste. About 1.9% of high-risk, 3.8% of intermediate-risk, and 0.9% of undetermined-risk patients had GI symptoms.

3.17. 2019-PCR for COVID-19

About 0.2% of high-risk, 0.1% of intermediate-risk, and none of the undetermined-risk patients tested positive for COVID-19.

3.18. Atypical respiratory panel

About 8.4% of high-risk, 7.4% of intermediate-risk, and 5.6% of undetermined-risk patients were positive for atypical viral infection.

3.19. Diagnosis

About 78.4% of high-risk, 54.8% of intermediate-risk, and 45.8% of undetermined-risk patients had a final diagnosis of the respiratory system. About 11.8% of high-risk, 32.9% of intermediate-risk, and 39.3% of undetermined-risk patients were diagnosed with FUO.

3.20. Disposition

About 55.6% of high-risk, 86.2% of intermediate-risk, and 38.3% of undetermined-risk patients were discharged. About 43.9% of high-risk, 13.8% of intermediate-risk, and 61.7% of undetermined-risk patients were admitted. About 0.5% of high-risk, none of the intermediate-risk and undetermined-risk patients died. About 8.4% of high-risk, 0.4% of intermediate-risk, and 7.5% of undetermined-risk patients were admitted to the ICU. About 33.8% of high-risk, 2.0% of intermediate-risk, and 6.5% of undetermined-risk patients were admitted to the general ward. About 1.7% of high-risk, 11.4% of intermediate-risk, and 47.7% of undetermined-risk patients were admitted to the isolation ward.

4. DISCUSSION

Given that an outbreak such as the COVID-19 is likely to disrupt the usual ED functioning and lead to clinical challenges, modifications in the ED such as restricting hospital visitors[7] were immediately implemented at the TVGH. The FSS functions as an independent outpatient clinic with the capacity to carry out blood work, radiographic tests, and discharge febrile patients without ED entry. The FSS screens febrile patients with TOCC. Patients with high and intermediate risks of infection are denied ED entry and are redirected to isolation areas. Physicians at the FSS, donned in PPE, communicate and work closely with the EPs within the ED. When patients screened at the FSS require admission, physicians at the FSS telephone the EPs, who then decide, according to the stratified risks, whether to allow entry to the ED or isolation ward. FSS helps divide patient flow, enables early isolation of infected patients, promotes the sharing and reduction in ED workload, and acts as a buffer, especially when there is a surge in the number of febrile patients. Although a decrease in ED volume and modification in use of medical service were initially expected in an outbreak,[8,9] a surge in febrile patients is inevitable. In fact, if all the 3755 patients screened at FSS were treated at the ED, this would most definitely collapse the normal functioning of the ED. Hence, FSS is paramount in helping the ED to maintain its clinical function and capacity

in treating acute critical patients and emergency cases without compromise. FSS is also effective in preventing nosocomial infection by dividing the flow of walk-in patients at the ED door.

A graded approach to isolation directs high-risk patients to negative-pressure isolation area (high level) and intermediate-risk patients to the non-negative pressure area (low level), to ensure efficient allocation of medical resources. The arrangement of isolation areas (red zone) and clean area (green zone) should be individualized according to each hospital's volume and capacity. The demarcation and distribution of these zones should be dynamically adjusted and expanded accordingly.[10] The capacity of the negative-pressure isolation area at TVGH allows only a maximum of three high-risk patients, while the non-negative-pressure isolation area allows six intermediate-risk and undetermined-risk patients. In preparation for a massive increase in patient volume from a community or nosocomial infection, TVGH is prepared to set up make-shift tents outside the ED, serving as new isolation areas. Hence, the objective of a graded approach to isolation, during the early phase of the outbreak, is to reserve high-level facility (negative-pressure) only for high-risk patients and low-level facility (non-negative-pressure) for low-risk patients to efficiently align scarce resources.

A graded approach to testing allows physicians to test not only patients at high or intermediate risk but also patients at low risk or undetermined risk who, not fitting the CDC case definition, would not otherwise be tested. A majority of COVID-19 patients present with mild respiratory tract symptoms and some may have no symptoms at all.[3–5] The common fear of EPs during an outbreak is to forgo testing of patients awaiting admission or surgery who turn out to be positive for COVID-19 only after admission, for which EPs would have a strong sense of professional responsibility. Not to mention, a nosocomial infection would potentially collapse the healthcare service within the hospital. Hence, the allowance to test patients at the underdetermined risk enables EPs to test questionable patients in order to detect community infection at an early stage.

The number of patients at the FSS directly from the airport was low (9, 0.3%). This is because the Taiwan CDC established fever screening and testing sites at the airports. Passengers landing in Taiwan with fever or respiratory symptoms must undergo COVID-19 testing and are subject to home quarantine for 14 days. As a result, very few required testing at the medical center. Testing is arranged for individuals who develop symptoms while in quarantine. To avoid patients with infection risk presenting to the ED as walk-in patients, the government set up a CDC hotline (1922) for medical assistance. The CDC would arrange transport and alert the hospital of patient arrival. However, our study showed that 80.3% of the patients screened at the FSS presented to the ED as walk-in and 1.5% were referred by CDC (1922). This underscores the importance of FSS in screening and dividing the flow of walk-in patients with stratified risks. Not only does FSS share the ED workload but also the OPD workload. About 10.2% (383/3755) of FSS patients were referred from the OPD.

A majority, 55.6% (324/583), of high-risk patients had a travel history and 38.4% travelled to Asia. The Taiwanese government takes a step further to integrate immigration and customs database with the National Health Insurance (NHI) database; with a simple insertion NHI smart card, medical staff are immediately alerted on the screen of travel history, border entry, and home quarantine or isolation status.

Medical staff with symptoms of viral infection are referred to the FSS for COVID-19 testing. Due to a travel ban for healthcare workers issued by the Taiwanese government on February 23, 2020, few medical staff had a travel history. Only 4.6% of the staff tested fell under high risk. Medical staff tested for COVID-19 require two negative test results 24 hours apart and 24-hour symptom-free status before return to work.

Symptoms, along with TOCC, serve as important components of CDC case definition.[6] A study of 321 imported COVID-19 cases to Taiwan revealed only 44.9% had fever, three-quarters of had respiratory symptoms, 13.1% had loss of smell or taste, and 7.2% had diarrhea.[11] This signifies that body temperature screening at the ED door does not ensure detection of all cases and can miss those without obvious symptoms. A graded approach in testing allows testing of even low-risk patients, who may not have been eligible for testing. Among the high-risk patients tested in TVGH, 48.2% had respiratory symptoms and 40.7% had fever. Among intermediate-risk patients, 61.5% had fever and 28.3% respiratory symptoms. Among the undetermined-risk patients, 81.3% had fever and 15% had respiratory symptoms. This extra caution in testing low-risk patients stems from that fact that many COVID-19 patients have mild or asymptomatic disease and would have been difficult to identify if their travel and contact history had not been available.[12] A long transmissibility period and the fact that asymptomatic or paucisymptomatic patients can transmit this disease make disease control challenging.[13–15]

During the outbreak, to minimize the risk of exposure to respiratory droplets facing EPs and medical staff, rapid influenza diagnostic testing was suspended. Only swabbing was restricted for patients tested for COVID-19 in an isolation area with proper PPE. This is because symptoms of influenza-like illness (ILI) or COVID-19 are often indistinguishable. Furthermore, in response to the outbreak, Taiwan's CDC announced an extension for government-funded free anti-influenza (oseltamivir) prescription drugs for patients with ILI. In TVGH, 86.4% patients swabbed for COVID-19 were also tested for atypical respiratory panel with 7.1% positive for atypical pathogens. The small number of patients testing positive for influenza A or B may be the result of the use of oseltamivir by patients with ILI during the outbreak.

A majority (76.4%) of high-risk patients were diagnosed with a disease of the respiratory system. It is not surprising as patients with the combination of TOCC and pneumonia fit the CDC case definition. On the other hand, 54.8% of intermediate-risk and 45.8% of undetermined-risk patients were diagnosed with a disease of the respiratory system. These patients had pneumonia, did not have pertinent TOCC, and did not fit the CDC case definition before admission. On the other hand, 32.9% of intermediate-risk and 39.3% of undetermined-risk patients had a final diagnosis of FUO. Patients with FUO usually require extensive workup during admission, but before admission, febrile patients without obvious focus at the ED were tested for COVID-19 per request by subspecialty. This explains why FUO was observed in 39.3% of undetermined-risk patients.

A majority of the patients tested for COVID-19 were young (mean 43.9), robust, and mobile. Hence, 55.6% of high-risk and 86.2% of intermediate-risk patients, after swabbing, were discharged to their homes for quarantine. High-risk patients often show a combination of pneumonia and TOCC, which justifies the 43.9% admission rate. Patients at undetermined risk required admission but were tested by the request of subspecialty, with 61.7% admission rate.

The measures implemented in TVGH during the COVID-19 outbreak may not be universally applicable to every hospital. Nevertheless, these measures can be referenced and modified accordingly to each hospital's unique condition.

In conclusion, given the narrow window of opportunity to prepare for a surge in the COVID-19 pandemic, there is an immediate need to respond and modify the ED setup accordingly. The significance of maintaining a functional ED and healthcare system during a pandemic cannot be overemphasized. EDs are the frontlines for delivering lifesaving treatment when confronted with a serious and unpredictable emerging infectious disease.

Rapid response and implementation of infection-control measures are critical steps in managing and containing an outbreak such as COVID-19.

ACKNOWLEDGMENTS

This study was supported by research grant from 109VACS-002 from Taipei Veterans General Hospital, Taiwan, Republic of China.

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