

Impact of the Coronavirus Disease 2019 Pandemic on an Emergency Department Service: Experience at the Largest Tertiary Center in Taiwan

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Purpose: Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2) is an emerging contagious pathogen that has caused community and nosocomial infections in many countries. This study aimed to evaluate the impact of Coronavirus disease 2019 (COVID-19) on emergency services of the largest medical center in Taiwan by comparing emergency department (ED) usage, turnover, and admission rates before the COVID-19 outbreak with those during the outbreak.

Materials and Methods: A retrospective cohort study was conducted in the ED of the largest tertiary medical center in Taiwan. Trends of adult, non-trauma patients who visited the ED during February–April 2019 were compared with those during February–April 2020. The number of visits, their dispositions, crowding parameters, and turnover rates were analyzed. The primary outcome was the change in ED attendance between the two periods. The secondary outcomes were changes in hospital admission rates, crowding parameters, and turnover rates.

Results: During the outbreak, there were decreased non-trauma ED visits by 33.45% ($p < 0.001$) and proportion of Taiwan Triage and Acuity Scale (TTAS) 3 patients ($p=0.02$), with increased admission rates by 4.7% ($p < 0.001$). Crowding parameters and turnover rate showed significant improvements.

Conclusion: Comparison of periods before and during the COVID-19 outbreak showed an obvious decline in adult, non-trauma ED visits. The reduction in TTAS 3 patient visits and the increased hospital admission rates provide references for future public-health policy-making to optimise emergency medical resource allocations globally.

Keywords: emergency department, Coronavirus disease 2019, Taiwan Triage and Acuity Scale, Stratification to Prevent Overcrowding Taskforce, SPOT

Introduction

In recent decades, emergency department (ED) overcrowding and overuse has become a major healthcare problem in many countries. In Taiwan, the total number of ED visits per year increased from 10.2 million in 1997 (approximately 46.9 visits per 100 persons) to 11.8 million in 2018 (approximately 50.1 visits per 100 persons).¹ Coronavirus disease 2019 (COVID-19) was first detected in late 2019, and the World Health Organization stated that there were 3,090,445 cases worldwide by April 30, 2020.² Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2) is a new, emerging virus that is thought to be transmissible through respiratory droplets and

direct contact,³ and community and nosocomial infections have been reported in many countries. ED staff, as frontline healthcare workers, have a high possibility of exposure to this contagious virus.

The first COVID-19 case in Taiwan was confirmed on January 21, 2020,⁴ and the first episode of nosocomial infection (involving eight people, including nursing staff, the hospitalized patient, the patient's family members, and healthcare workers) was reported on February 28, 2020.¹ Following this incident, the Ministry of Health and Welfare (MOHW) of Taiwan implemented several measures to inhibit the spread of the virus, including banning the entry of foreigners into the country and suggesting that the public avoid unnecessary hospital visits, maintain social distancing of more than one meter, use surgical masks in public areas, and frequently wash their hands; these recommendations were promoted through television, radio broadcasts, and the Internet.⁵ Taiwan Linkou Chang Gung Memorial Hospital (LCGMH), one of the largest hospitals in the world, immediately made its ED available to help manage the virus response during the outbreak period.⁶

This study aimed to evaluate the impact of COVID-19 on emergency services by comparing the usage, turnover, and admission rates of an ED before the COVID-19 outbreak with the equivalent data during the outbreak. Such an investigation could help to differentiate actual ED demand from non-essential ED demand, which could, in turn, inform quality-improvement policies.

Materials and Methods

Study Design and Setting

We conducted a retrospective cohort study through reviewing electronic medical charts from LCGMH. LCGMH, the largest tertiary care hospital located in northern Taiwan, has a capacity of 3406 beds; its ED contains 190 beds and two negative-pressure isolation rooms, and receives approximately 150,000 visits annually.^{6,7}

Participant Selection

We analyzed data for visits to the medical center's ED before (February–April 2019; hereafter 'T1') and during (February–April 2020; hereafter 'T2') the COVID-19 outbreak. Adult, non-trauma ED patients aged over 18 years were selected for the research (Figure 1). Trauma patients were excluded as, based on our experiences during the

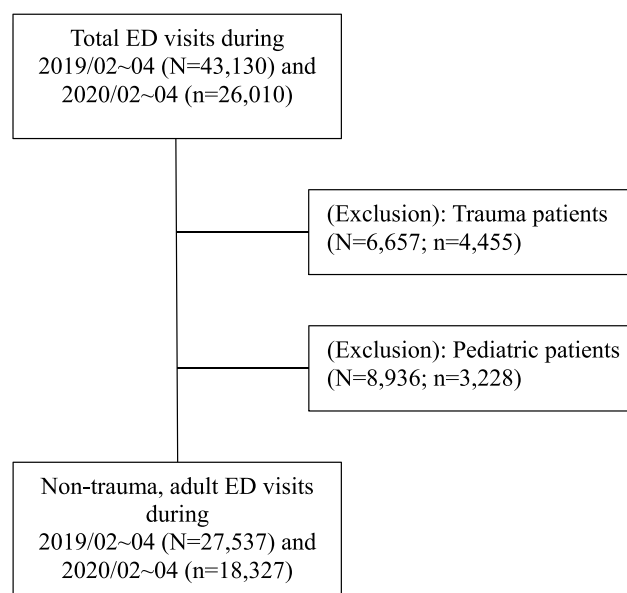


Figure 1 Study algorithm.

2003 SARS pandemic, emergency services for trauma were not expected to be disrupted by the outbreak.

Taiwan Triage and Acuity Scale (TTAS)

The TTAS levels^{8–10} are defined as follows – level 1: patient requiring immediate treatment, level 2: patient requiring treatment within 10 minutes, level 3: patient requiring management within 30 minutes, level 4: patient requiring management within one hour, level 5: patient requiring management within two hours. The full criteria for triaging can be found in Table 1. In general, TTAS levels 1–3 are categorized as emergency conditions.

Data Collection

A blinded, trained study assistant reviewed the de-identified computer-based registry records and conducted data extraction using a standard reporting template that contained clear definitions and codes. Data were collected from electronic charts, medical records, and nurses' records, in particular each patient's age and sex, primary reason for visiting the ED, ED diagnosis, time of visit, level of triage (according to TTAS), vital signs, and disposition. The number of ED patients awaiting general ward or intensive care unit (ICU) admission, the number of patients who stayed in the ED (at the scene or in an observation room), and the average waiting time for admission was also determined.

Patients who stayed at the scene (PSAS) were defined as patients whose disposition remained unresolved two

Table I Taiwan Triage and Acuity Scale (TTAS)

TTAS Level	Criteria	Examples
1	Respiratory failure, RR < 10/min, SpO ₂ : < 90% suspect upper airway obstruction	Acute respiratory distress syndrome, foreign body obstruction
	SBP < 70 mmHg or SBP < 90 mmHg with shock	
	HR < 50 bpm or >140 bpm with shock	
	GCS: 3~8	
	T > 41°C or < 32°C	
2	Respiratory distress, SpO ₂ < 92%	Acute exacerbation of chronic obstructive pulmonary disease
	SBP < 90 mmHg without shock sign or MAP < 65 mmHg SBP ≥ 220 mmHg or DBP > 130 mmHg with symptoms	
	HR < 50 bpm or >140 bpm without shock sign	
	GCS: 9~13	
	BT: 32°C ~35°C, immunocompromised, SIRS criteria ≥ 3	
	Pain severity: 8–10 (central)	Acute coronary syndrome
3	Mild respiratory distress, SpO ₂ : 92~94%	Asthma attack
	Abnormal BP or HR without meeting criteria of level 1 or 2 SBP: 200~220 mmHg or DBP: 110~130 mmHg with symptoms of hypertensive crisis such as headache, chest pain, breathlessness SBP ≥ 220 mmHg or DBP ≥ 130 mmHg without symptoms of hypertensive crisis	Cardiac arrhythmia
	T ≥ 38°C with ill looking	
	Pain severity: 8–10 (extremities), 4–7 (central)	Urolithiasis
4	SBP: 200~220 mmHg or DBP: 110~130 mmHg without symptoms of hypertensive crisis	
	BT ≥ 38°C without ill looking	
	Pain severity: 4–7 (peripheral), <4 (central)	Acute gout attack
5	Vital signs without meeting criteria of level 1–4	
	Pain severity <4 (peripheral)	

hours after registration; meanwhile, patients who were placed in an observation room had a clear disposition: awaiting admission.

Outcome Measures

The primary outcome of this study was the difference between T1 and T2 regarding the composition of ED visits. The secondary outcomes included the differences between T1 and T2 regarding the hospital admission rates and variations in crowding and turnover parameters.

Statistical Analysis

Categorical data were reported as numerical values with percentages, and were compared across groups using chi-square tests. Meanwhile, continuous variables with normal distributions were reported as means and standard deviations, and were compared using Student's *t*-test. Statistical analyses were performed using SPSS Statistics for Windows, Version 20.0 IBM Corp. P-values of less than 0.05 were considered to indicate statistical significance.

Table 2 Characteristics of the Adult, Non-Trauma ED Patients

	2019/02–2019/04	2020/02–2020/04	Change in Percentage	P-value
ED visit				
Non-trauma	27,537	18,327	–33.45	<0.001*
Age	55.3±19.6	53.87±19.59		<0.001*
Male (%)	14,102 (51.21)	9,654 (52.68)	1.47	0.33
Ambulance (%)	3477 (12.63)	3282 (17.91)	5.28	<0.001*
Unaccompanied visit (%)	24,060 (87.37)	15,045 (82.09)	–5.28	<0.001*
TTAS(%)				
1	1098 (3.99)	747 (4.08)	0.09	0.87
2	3669 (13.32)	2592 (14.14)	0.82	0.44
3	20,474 (74.35)	13,038 (71.14)	–3.21	0.02*
4	2122 (7.71)	1753 (9.57)	1.86	0.03*
5	174 (0.63)	197 (1.07)	0.44	0.08
OHCA (%)	93 (0.34)	93 (0.51)	0.17	0.38
IHCA (%)	106 (0.38)	103 (0.56)	0.18	0.36
MV (%)	461 (1.67)	336 (1.83)	0.16	0.74

Note: *Denotes significant difference.

Abbreviations: ED, emergency department; IHCA, in-hospital cardiac arrest; MV, mechanical ventilator; OHCA, out-of-hospital cardiac arrest; TTAS, Taiwan Triage and Acuity Scale.

Ethical Approval

This study was approved by the Chang Gung Medical Foundation's Hospital Ethics Committee on Human Research (IRB: 202000941B1). The study protocol was reviewed, and the study was exempted from the requirement of obtaining informed consent.

Results

Compared to T1, LCGMH saw a significant decrease in adult non-trauma ED visits ($p<0.001$) and unaccompanied ED visits ($p<0.001$) with a significant increase in number of patients brought in by emergency medical services ($p<0.001$) in T2. The number of patients triaged as TTAS 3 decreased significantly ($p=0.02$) during the pandemic, with a concurrent significant rise in TTAS 4 cases ($p=0.03$). Parameters of disease severity, in terms of cardiac arrests and use of mechanical ventilators, showed no significant difference between the two study periods (Table 2).

Regarding admission rates, T2 saw a significant rise in overall hospital admissions ($p<0.001$) with similar proportions of ward and ICU admissions, despite a significant and dramatic fall in ED visits by approximately a third ($p<0.001$). At the same time, the proportion of patients

discharged from the ED significantly decreased in T2 ($p<0.001$) (Table 3).

The number of PSAS was significantly lower during this period ($p<0.001$), as was the number of patients in observation rooms ($p<0.001$) and who stayed in the ED for >48 hours ($p<0.001$). Average waiting time for ward admission was significantly shorter during the outbreak ($p<0.001$) but average time to ICU admission was significantly longer ($p<0.001$) (Table 4).

Discussion

This study showed that, during the COVID-19 outbreak, there was a clear reduction in daily ED visits (33.45%) when compared to the pre-epidemic period (Table 2). We attribute this decline in ED visits solely to the impact of the COVID-19 pandemic and corresponding containment measures by the Taiwanese MOHW, with no other obvious confounding systemic changes in our healthcare setting during this period. This trend resembles that which was observed during the 2003 SARS outbreak,¹¹ as well as the initial trends in other countries such as Italy during this current COVID-19 pandemic.¹²

Furthermore, a significant 5.28% reduction in patients visiting EDs unaccompanied was noted. These results show that the public-health policies that were implemented in

Table 3 Comparison of Admission Rate Among Adult, Non-Trauma ED Patients

	2019/02–2019/04	2020/02–2020/04	Change in percentage	P-value
ED visit	27,537	18,327	–33.45	<0.001*
Admission (%)	8147 (29.59)	6285 (34.29)	4.7	<0.001*
Male	4589 (56.33)	3636 (57.85)	1.52	0.067
Age	63.69 ± 17.66	62.67 ± 17.53		0.001*
Ward (%)	7174 (88.06)	5469 (87.02)	–1.04	0.06
ICU (%)	973 (11.94)	816 (12.98)	1.04	0.06
TTAS (%)				
1	917 (11.26)	594 (9.45)	–1.81	0.24
2	2426 (29.78)	1834 (29.18)	–0.6	0.77
3	4704 (57.74)	3766 (59.92)	2.18	0.39
4	98 (1.20)	84 (1.34)	0.14	0.94
5	2 (0.02)	7 (0.11)	0.09	0.85
Discharge	17,703 (64.29)	10,997 (60.00)	–4.29	0.003*
Expired in the ED	106 (0.38)	97 (0.53)	0.15	0.47
Critical AAD	40 (0.15)	26 (0.14)	–0.01	<0.001*

Note: *Denotes significant difference.

Abbreviations: AAD, advise against discharge; ED, emergency department; ICU, intensive care unit; TTAS, Taiwan triage and acuity scale.

Table 4 Crowding Parameters and Turnover Rates for the ED

	2019/02–2019/04	2020/02–2020/04	P-value
Number of patients in the ED			
Scene	26.53 ± 11.49	15.13 ± 5.06	<0.001*
Observation room	156.08 ± 28.5	97.21 ± 22.4	<0.001*
Patients in ED > 48 hrs	101.76 ± 40.48	62.1 ± 28.8	<0.001*
Patients awaiting admission			
Ward	124.08 ± 26.95	78.85 ± 20.24	<0.001*
ICU	2.67 ± 2.21	2.35 ± 4.76	0.57
Time waiting for admission			
Ward (mins)	2120.21 ± 1997.2	1933.75 ± 1976.48	<0.001*
ICU(mins)	480.39 ± 721.15	1461.04 ± 1670.18	<0.001*

Note: *Denotes significant difference.

Abbreviations: ED, emergency department; ICU, intensive care unit.

Taiwan, which were informed by previous SARS experience, successfully reduced the number of unnecessary ED visits.¹³ In other words, a combination of public-health-policy promotion and people's fear of visiting hospitals during the COVID-19 outbreak effectively reduced ED visits, thereby giving front-line ED staff more flexibility and capacity to respond to unpredictable situations and to screen uncertain

cases.¹⁴ Nevertheless, those patients who indeed were more ill and required urgent medical attention presented themselves to the ED all the same, as evidenced by similar proportions of TTAS 1 and 2 patients across both periods.

The TTAS levels used in Taiwan are based on the patient's chief complaint, vital signs, consciousness level, pain scale, and prehospital oxygen-dependent status, all of which indicate

the urgency level.⁹ During T2, the decline in adult, non-trauma ED visits was mainly related to TTAS 3 patients (representing 3.21% of the decline in the total number of patients); the number of TTAS 3 patients reduced significantly by 7436 (36.32%) between T1 and T2. This suggests that during the pandemic, these patients chose to stay at home or seek alternatives, such as taking over-the-counter medications and visiting other local hospitals, before visiting the ED of a tertiary medical center. Despite that, there was no significant reduction in the visits of patients with TTAS 1 and 2 (18.22%) indicating sicker patients who indeed required emergency services still came to ED and admitted (38.63%). The percentage of TTAS 4 and 5 ED patients increased during the pandemic; a possible explanation for this result is that many patients with mild symptoms of upper respiratory infections feared that they had contracted COVID-19 and visited EDs to undergo screening.

The admission rates increased during T2 from 29.59% to 34.29%. This demonstrates that many of the ED visits during T2 were from patients with a higher need for inpatient care. The percentage of admissions accounted for by TTAS 1–3 patients was similar – 98.78% in T1 vs 98.55% in T2, suggesting that the association between TTAS level and likelihood of admission to hospital remained almost the same between the two periods. The percentage of patients discharged from the ED in T1 was higher (64.29% in T1; 60% in T2, $p = 0.003$), which may be due to a higher percentage of patients with non-critical illness visiting the ED during this earlier period.

Comparison of the crowding parameters¹⁵ in T1 and T2 showed that the total number of PSAS, those admitted to observation rooms, and patients who stayed in the ED over 48 hours all decreased significantly in T2 (Table 4). This may reflect patients' and families' fear of staying in the hospital, and resulted in more ward vacancies and a higher turnover rate.¹⁶ This is evidenced by the decrease in the number of patients awaiting admission and in the average time to admission. Previous studies have shown that crowding in ED environments can contribute to poor outcomes for ED patients.¹⁷ Improvement in crowding parameters and turnover rate during T2 allowed emergency staff to provide better patient care and optimise patient flow.

The decline in ED visits during the COVID-19 outbreak afforded an opportunity to monitor and evaluate the actual level of demand for emergency care in a tertiary medical center in Taiwan. Public-health policy, which advocates referral and a hierarchy of medical care, has long explored means of optimising emergency medical resource allocation in Taiwan; however, positive outcomes have remained elusive.¹⁸ Taiwan's medical environment has changed in recent years, and now

emphasises maximising tertiary care hospital development while gradually reducing the focus on community and local hospitals. This situation contributed to the phenomenon of patients immediately visiting medical centers with relatively minor or chronic illnesses. During the COVID-19 outbreak, the obvious decline in the amount of total adult, non-trauma ED visits, of which the majority were TTAS 3, could provide a profile for evaluating the actual demand for emergency medical resources, and could influence future policy-making regarding national health insurance payments.

Limitations

This study should be interpreted in the context of the following limitations.

First, the study was conducted at a single medical center in northern Taiwan within a limited time period, which may restrict the generalisability of our findings. More validation studies conducted in different regions and ED settings would be of interest. Second, no analysis of survival outcomes was conducted. Although the decline in adult, non-trauma ED visits was obvious, further studies investigating ED usage and efficiency could provide additional interesting results.

Conclusions

Comparison of periods before and during the COVID-19 outbreak showed a drastic decline in adult, non-trauma ED visits. The findings regarding the relative urgency of the ED visits (TTAS > 3) and the admission rates during this period could help inform future public-health policy-making to optimise emergency medical resource allocations worldwide.

Abbreviations

ED, emergency department; COVID-19, coronavirus disease 2019; SARS, severe acute respiratory syndrome; MOHW, Ministry of Health and Welfare; LCGMH, Linkou Chang Gung Memorial Hospital; TTAS, Taiwan Triage and Acuity Scale; ICU, intensive care unit; PSAS, patients who stayed at the scene.

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Disclosure

The authors declare that they have no conflicts of interest.

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