

The effect of COVID-19 pandemic on the length of stay and outcomes in the emergency department

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Objective This study aimed to evaluate the change in length of stay (LOS) in the emergency department (ED) and outcomes during the coronavirus disease 2019 (COVID-19) pandemic.

Methods This is a single-center, retrospective observational study. We compared ED LOS and outcomes in patients aged ≥ 19 years who presented to the ED of Soonchunhyang University Bucheon Hospital, a single tertiary university hospital, between January and December in 2018, 2019, and 2020. We included patients who were diagnosed with fever, pneumonia, and sepsis in the ED, based on the International Statistical Classification of Diseases and Related Health Problems 10th Revision. We also compared the LOS and outcomes of overall ED patients in 2019 (before COVID-19) and in 2020 (after COVID-19).

Results A total of 5,061 patients with fever, pneumonia, and sepsis were analyzed. The LOS in the ED in 2020 significantly increased compared with 2018 and 2019 (177.0 ± 115.0 minutes in 2018, 154.0 ± 85.0 minutes in 2019, and 208.0 ± 239.0 minutes in 2020). The proportion of patients who were transferred to other hospitals in 2020 (2.1%) increased compared with 2018 (0.8%) and 2019 (0.7%). Intensive care unit admission significantly increased in 2020 (13.7%) compared with 2019 (10.3%). Among all ED patients, ED LOS in 2020 was longer than in 2019, particularly in patients who were admitted and then transferred to another hospital. Intensive care unit admission (4.4% vs. 5.0%), transfer rate (0.7% vs. 0.9%), and ED mortality (0.6% vs. 0.7%) also significantly increased.

Conclusion The ED LOS, time to intensive care unit admissions, time to transfer to other hospitals, and ED mortality significantly increased during the COVID-19 pandemic.

Keywords COVID-19; Emergencies; Crowding; Length of stay

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Capsule Summary

What is already known

The coronavirus disease 2019 (COVID-19) pandemic is a global crisis that may adversely affect the emergency department (ED) process for patient care.

What is new in the current study

This study showed that the length of stay in the ED, time to intensive care unit admission, and time to transfer to other hospitals significantly increased during the COVID-19 pandemic compared with the prior years among patients with fever, pneumonia, and sepsis according to the diagnosis code. The mortality in the ED also increased along with the length of stay, transfer, and intensive care unit admission in the total ED patients during the COVID-19 pandemic.

INTRODUCTION

In December 2019, cases of pneumonia with an unknown cause were first reported in Wuhan, Hubei Province, China, which had by then spread globally. The World Health Organization termed the condition as coronavirus disease 2019 (COVID-19), which is caused by severe acute respiratory syndrome coronavirus 2. COVID-19 involves nonspecific symptoms, including fever, dry cough, and discomfort. COVID-19 pneumonia causes severe dyspnea, and patients have high rates of transition to intensive care and mortality.¹⁻⁵

As the safety net of the healthcare system, the emergency department (ED) is responsible for managing the large influx of patients affected by the pandemic. With the spread of COVID-19, the work routine in the ED has changed remarkably.⁶⁻¹⁴ The COVID-19 pandemic affected not only quality of care, safety, patient-centeredness, timeliness, efficiency, effectiveness, and equity, but also objective clinical endpoints such as mortality in the ED. The ED process for patients with fever or suspected infection that need to be differentiated from COVID-19 or quarantined may be further affected. Information on ED admission patterns, length of stay (LOS), and mortality is important to determine ED policies and allocate medical resources in an effective way during a pandemic of an infectious disease like COVID-19.

The aim of the study was to evaluate the change in ED LOS and outcomes including ED disposition and ED mortality during the COVID-19 pandemic compared with the prior years. We compared the outcomes in patients with fever, pneumonia, and sepsis, and investigated all ED patients.

METHODS

This study was a retrospective cross-sectional study. Ethical approval was obtained from the institutional review board of Soonchunhyang University Bucheon Hospital (No. 2020-11-023-001). Informed consent was waived due to the retrospective nature of the study. The patients included in this study were admitted to the ED of a single tertiary university between January 1st and December 31st in 2018, 2019, and 2020. We included patients who were diagnosed with fever, pneumonia, and sepsis in the ED during the corresponding period from 2018 to 2020. Fever, pneumonia, and sepsis were defined based on the International Statistical Classification of Diseases and Related Health Problems 10th Revision, Clinical Modification (ICD-10 CM) codes R50.9, R50.99, R57.2, J12.9, J15.9, J18.9, and A41.9. In addition, we compared the LOS and disposition of all ED patients between 2019 (before the COVID-19 period) and 2020 (after the COVID-19 period). We excluded patients aged < 19 years.

From the electronic medical records, data on demographics, chief complaints, disposition of the patients, and LOS in the ED were collected. We also investigated ED mortality, admission, in-hospital arrest in the ED, and the rate of intensive care unit (ICU) admission. The primary outcome was the ED LOS, and secondary outcomes were time to ICU admission, time to transfer to another hospital, and ED mortality.

All statistical analyses were performed using the R ver. 4.0.2 (R Foundation for Statistical Computing, Vienna, Austria). We conducted frequency analysis to identify the subjects' characteristics. Nominal variables are presented as counts and percentages of

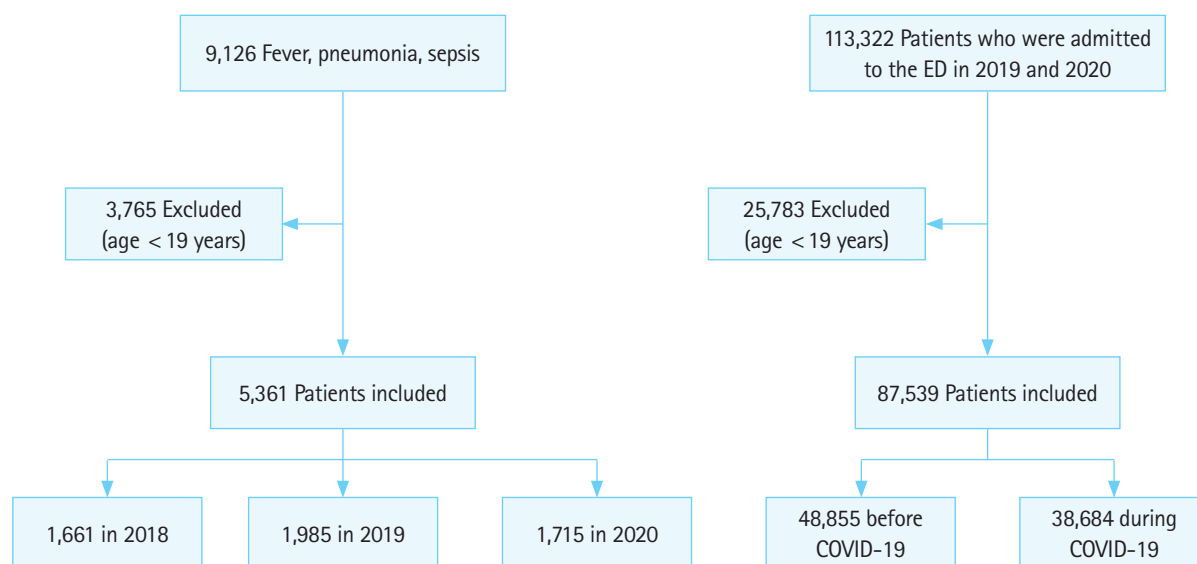


Fig. 1. Study population. ED, emergency department; COVID-19, coronavirus disease 2019.

total numbers. Data of continuous variables with normal distribution are presented as mean and standard deviation. All variables were compared using the chi-square test and analysis of variance at a significance level of $P < 0.05$. Post hoc test was performed using the Tukey test. We constructed boxplots to compare the LOS in the ED between patients who were admitted and those who were discharged.

RESULTS

In this study, a total of 5,361 patients with the ICD-10 CM codes of fever ($n = 1,661$), pneumonia ($n = 1,985$), and sepsis ($n = 1,715$) were included between February and June in 2018, 2019, and 2020 (Fig. 1). Table 1 shows patients' demographics, diagnosis, visit route, disposition, and LOS in the ED. The mean age was 61.0 ± 19.0 years in 2018, 55.0 ± 20.0 years in 2019, and 62.0 ± 17.0 years in 2020 ($P < 0.001$). The proportion of patients with fever in 2020 (60.0%) was higher than in 2018 (54.4%), but similar to 2019 (60.0%). The proportion of patients with pneumonia in 2020 (31.8%) decreased compared with 2018 (41.1%). Regarding the visit route to the ED, the proportion of patients from the outpatient department decreased in 2020 (0.5%) compared with 2018 (2.0%) and 2019 (1.2%). Transferred patients from other hospitals also decreased in 2020 (18.5%) compared with 2018 (14.5%). ICU ad-

Table 1. Comparisons of baseline characteristics

Characteristic	2018 (n = 1,661)	2019 (n = 1,985)	2020 (n = 1,715)	P-value
Age (yr)	61.0 ± 19.0	55.0 ± 20.0	62.0 ± 17.0	< 0.001 ^{a)}
Male sex	821 (49.4)	982 (49.5)	828 (48.3)	0.726
ICD code				
Fever	904 (54.4)	1,270 (64.0)	1,029 (60.0)	< 0.001 ^{a,b)}
Pneumonia	683 (41.1)	608 (30.6)	563 (32.8)	< 0.001 ^{b)}
Sepsis	74 (4.5)	107 (5.4)	123 (7.2)	0.002
Visit route				
Direct visit	1,321 (79.5)	1,682 (84.7)	1,458 (85.0)	< 0.001 ^{b)}
Transfer	307 (18.5)	280 (14.1)	249 (14.5)	< 0.001 ^{b)}
Outpatient	33 (2.0)	23 (1.2)	8 (0.5)	< 0.001 ^{a,b)}
ED disposition				
Discharge	853 (51.3)	1,154 (58.1)	922 (53.7)	< 0.001 ^{a)}
Admission	778 (46.9)	814 (41.0)	748 (43.6)	0.002 ^{a,b)}
ICU	209 (12.6)	205 (10.3)	235 (13.7)	0.005 ^{a)}
Transfer	14 (0.8)	13 (0.7)	36 (2.1)	< 0.001 ^{a,b)}
Death	16 (1.0)	4 (0.2)	9 (0.5)	0.008
ED LOS (min)	177.0 ± 115.0	154.0 ± 85.0	208.0 ± 239.0	< 0.001 ^{a,b)}

Values are presented as number (%) or mean ± standard deviation.

ICD, International Classification of Diseases; ED, emergency department; ICU, intensive care unit; LOS, length of stay.

^{a)} $P < 0.05$ compared between 2019 and 2020. ^{b)} $P < 0.05$ compared between 2018 and 2020.

mission significantly increased in 2020 (13.7%) compared with 2019 (10.3%). The proportion of patients who were transferred to other hospitals at the ED in 2020 (2.1%) increased compared with 2018 (0.8%) and 2019 (0.7%). There was no significant change in the ED mortality. The LOS in the ED in 2020 significantly increased compared with 2018 and 2019 (177.0 ± 115.0 minutes in 2018, 154.0 ± 85.0 minutes in 2019, and 208.0 ± 239.0 minutes in 2020).

Fig. 2 shows the annual change of LOS in the ED according to the patients' disposition at the ED. There was no significant change in LOS in 2020 among the discharged patients (129.9 ± 92.6 minutes in 2018, 117.5 ± 78.4 minutes in 2019, and 124.9 ± 121.6 minutes in 2020). Among patients who were admitted or transferred or who expired, LOS in 2020 significantly increased compared with that in 2018 and 2019 (356.0 ± 303.7 minutes in 2018, 292.5 ± 214.7 minutes in 2019, and 546.0 ± 398.7 minutes in 2020).

LOS in the ED by diagnosis is detailed in Table 2. In patients with pneumonia and sepsis, LOS in 2020 significantly increased compared with 2018 and 2019 (LOS of patients with pneumonia, 253.0 ± 101.0 minutes in 2018, 220.5 ± 57.5 minutes in 2019, and 416.0 ± 150.5 minutes in 2020; LOS patients with sepsis, 264.0 ± 86.0 minutes in 2018, 281.0 ± 93.0 minutes in 2019, and 447.0 ± 198.5 minutes in 2020).

Among all ED patients, ED LOS during the COVID-19 pandemic in 2020 was longer than that before the COVID-19 pandemic in 2019, particularly in patients who were admitted (235.0 ± 91.0 minutes vs. 274.0 ± 146.0 minutes, $P < 0.001$) and who were transferred to another hospital (213.0 ± 93.5 vs. 255.0 ± 162.5 , $P < 0.001$) (Table 3). ICU admission (4.4% vs. 5.0%, $P < 0.001$) and transfer

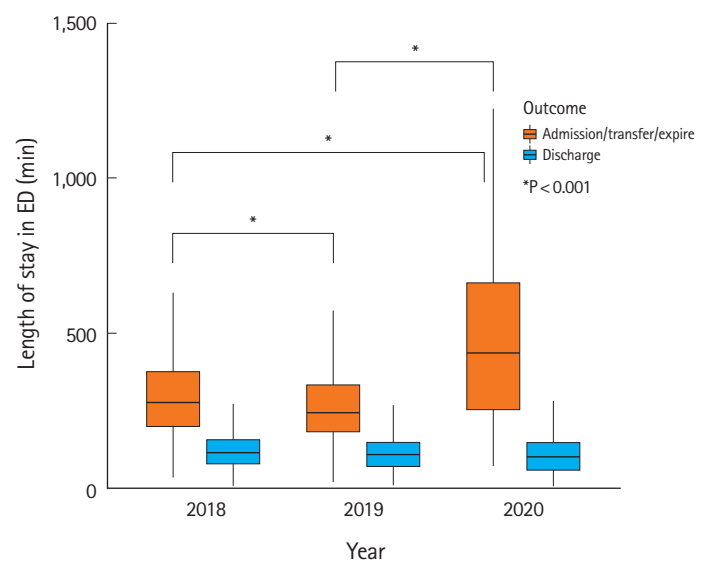


Fig. 2. Box plot of the length of stay in the emergency department (ED) according to disposition.

Table 2. Comparisons of LOS and outcomes in patients with fever, pneumonia, and sepsis

Variable	Fever			Pneumonia			Sepsis					
	2018 (n = 904)	2019 (n = 1,270)	2020 (n = 1,029)	P-value	2018 (n = 683)	2019 (n = 608)	2020 (n = 563)	P-value	2018 (n = 74)	2019 (n = 107)	2020 (n = 123)	P-value
ED LOS (min)	127.0 ± 56.0	179.0 ± 56.0	212.0 ± 86.0	0.412 ^{a)}	253.0 ± 101.0	220.5 ± 57.5	416.0 ± 150.5	<0.001 ^{a,b)}	264.0 ± 86.0	281.0 ± 93.0	447.0 ± 198.5	<0.001 ^{a,b)}
Disposition				0.909				0.051				0.476
Discharge	750 (83.1)	1,062 (83.6)	861 (83.8)		101 (14.8)	91 (15.0)	60 (10.7)		1 (1.4)	1 (0.9)	0 (0)	
Non-discharge	153 (16.9)	208 (16.4)	167 (16.2)		582 (85.2)	517 (85.0)	503 (89.3)		73 (98.6)	106 (99.1)	123 (100)	

Values are presented as mean ± standard deviation or number (%).

LOS, length of stay; ED, emergency department.

^{a)}P < 0.05 compared between 2018 and 2020. ^{b)}P < 0.05 compared between 2019 and 2020.

Table 3. Comparison of outcomes of all patients in the emergency department between 2019 and 2020

Outcome	2019 ^{a)} (n = 48,855)	2020 ^{b)} (n = 38,684)	P-value
ED length of stay (min)			
All patients	120.0 ± 46.0	125.0 ± 52.0	<0.001
Admission	235.0 ± 91.0	274.0 ± 146.0	<0.001
Discharge	102.0 ± 44.0	102.0 ± 47.0	0.767
Transfer	213.0 ± 93.5	255.0 ± 162.5	<0.001
Disposition			
Admission	11,295 (23.1)	9,870 (25.5)	<0.001
ICU admission	2,138 (4.4)	1,928 (5.0)	<0.001
Transfer	348 (0.7)	339 (0.9)	0.008
Cardiac arrest in the ED	102 (0.2)	84 (0.2)	0.859
ED mortality rate	284 (0.6)	285 (0.7)	0.006

Values are presented as mean ± standard deviation or number (%).

ED, emergency department; ICU, intensive care unit.

^{a)}Before coronavirus disease 2019. ^{b)}After coronavirus disease 2019.

rate (0.7% vs. 0.9%, P = 0.008) increased in 2020 compared with 2019. The in-hospital arrest rate in the ED was not different, but ED mortality in 2020 was significantly higher than that in 2019 (0.7% and 0.6%, respectively, P = 0.006).

DISCUSSION

This study showed that ED LOS, ICU admission, and transfer to other hospitals significantly increased during the COVID-19 pandemic in 2020 compared with the prior years among patients with fever, pneumonia, and sepsis according to the ED diagnosis of ICD-10 CM code. We also observed that ED mortality worsened along with other outcomes in overall ED patients during the COVID-19 period.

We suggest that the increase in LOS might be due to evaluation of the COVID-19 test results before making a decision on admission. Once the COVID-19 pandemic began, the reverse transcription-polymerase chain reaction (RT-PCR) test was performed in patients who had fever or respiratory symptoms. If the patients had pneumonia or no clear focus for fever, the patients were admitted to the general ward after a negative COVID-19 RT-PCR test result. If the test confirmed that the patient was COVID-19 positive, they would be admitted to a specialized hospital designated for COVID-19. In our hospital, we performed abdomen pelvis computed tomography or chest computed tomography to clarify the source of infection depending on signs indicating viral pneumonia on chest radiography. In pneumonia and sepsis cases, the LOS in the ED was relatively longer because the decision to admit or transfer needed to be made. Patients could not be admitted until the COVID-19 test results were obtained. In our

study, a comparison of the LOS in the ED between discharged and non-discharged patients indicated a slight difference in the LOS in the ED for discharged patients, but the LOS in the ED significantly increased for non-discharged patients. Similar to the results of this study, Sun et al.¹⁵ suggested that the COVID-19 pandemic has led to an increase in the LOS in the ED for admitted or transferred patients and had increased ED crowding.

As with the previous avian influenza A and severe acute respiratory syndrome (SARS) pandemics, preventing ED crowding has become an important issue. During SARS, patients were classified into appropriate places through websites or call centers, and standardized ED hospitalization criteria were identified for patients with respiratory symptoms. Restricting the influx of patients can be accomplished by triage points before and upon ED arrival. While few patients who had avian influenza A or SARS will ultimately require hospital-based care, many of them can be counseled and/or tested in an outpatient setting, which is similar to what was observed in our study. At the hospital, diverting low-risk patients with respiratory symptoms to an alternate site of care, such as a medical tent, may be a useful strategy to prevent ED crowding and worsening of ED LOS.^{16,17}

A rapid test for COVID-19 in the ED would probably reduce the LOS in the ED.¹⁸ Other COVID-19 tests, such as the COVID-19 immunoglobulin M and immunoglobulin G rapid test lateral flow immunoassay performed in the ED of a tertiary hospital in northern Italy, were designed to provide rapid diagnosis. However, this test is not recommended because it can result in misdiagnosis of the disease owing to a poor sensitivity of <20%.^{19,20} COVID-19 testing is currently performed using the RT-PCR test, which takes a longer time. A more efficient COVID-19 testing may be needed and increasing the frequency of COVID-19 testing may be an effective way to reduce the time to obtain the results. Furthermore, creating a ward for cohort isolation, so that patients without COVID-19 results can wait, may be another alternative. Patients who do not have COVID-19 test results can be moved to the infection ward and when the test results are available, they can be moved to their final ward.²¹

In addition to the time taken in the screening process for COVID-19, there are other factors that have increased the ED LOS and crowding. First, to treat infected patients and block spreading of infectious diseases, we quarantined them and asked them to put on personal protective equipment. In the case of our hospital, the clinic is divided into general treatment rooms, screening rooms, and negative pressure isolation rooms. The time for patient examination in the screening room was relatively longer than that in the negative pressure isolation room. Second, as the COVID-19 pandemic continued, medical staff could not avoid exposure to

COVID-19 infection. The self-isolation of exposed medical staff may increase the burden of fellow medical staff. In our ED, according to the physician's duty schedule, if one doctor self-isolated, the mean working hours per week increased by 8 hours, and when two doctors self-isolated at the same time, the mean working hours per week increased by 18 hours. Third, problems of cooperation with other departments led to an increased burden on the ED. As the COVID-19 pandemic continued, other departments also lacked human resources. Thus, they were unable to manage their patients in the ED waiting for admission, which increased the ED workload. Fourth, delay in ICU admission may have impaired the quality of care in ED due to increased ED crowding and workload.

This study has several limitations. First, we could not confirm whether the quality of ED care was impaired and whether the ED crowding worsened during the COVID-19 pandemic. We did not use direct indicators such as loading of ED index, crowdedness index, emergency care workload unit, the Emergency Department Work Index, the National ED Overcrowding Scale, or the Real-time Emergency Analysis of Demand Indicator to determine whether there was an increase in workload in the ED due to the COVID-19 pandemic.²²⁻²⁴ Second, as we performed this study retrospectively at a single center, it cannot represent the ED care process of most patients at other hospitals. Third, patients with different disease codes may have been excluded because our study targeted only patients with respiratory diseases and fever.

In conclusion, this single-center study showed that ED LOS, ICU admission, and transfer to other hospitals significantly increased during the COVID-19 pandemic among patients with fever, pneumonia, and sepsis. In addition, ED mortality worsened along with other outcomes in overall ED patients during the COVID-19 pandemic.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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