

Impact of the COVID-19 pandemic on emergency department utilization patterns in South Korea

A retrospective observational study

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Abstract

The purpose of analyzing changes in the use of emergency departments (EDs) was to better understand how to use ED resources efficiently during infectious disease outbreaks.

Our study was a retrospective observational study. We analyzed the patterns of visits of adult and pediatric patients to separate EDs during 2020 coronavirus disease 2019 (COVID-19) outbreak to know the changes in the ED utilization. We collected the patient's demographics and time of visit, patients' acuity level at triage, cause of visit, transportation used, disposition, symptom to visit time, length of stay, and top 10 most common complaints. We compared pediatric and adult EDs before and after COVID-19.

The total number of patients who visited the EDs was 197,152 over 3 years. During the COVID-19 outbreak in 2020, the number of visits decreased significantly, especially the number of pediatric patients. The number of ED visits decreased in correlation with a surge in the number of confirmed COVID patients. The proportion of severe cases in pediatric emergency department (PED) visits increased, but there was no difference in adult emergency department. The number of hospitalized PED patients increased, and the number of hospitalized adult emergency department patients decreased. However, both types of ED patients increased in intensive care unit hospitalizations, proportion of deaths, and use of ambulances. The proportion of trauma patients in the PED increased significantly ($P < .001$). The time from symptom onset to ED visit time was reduced for patients. The ED length of stay increased in adults, and decreased for pediatric patients.

COVID-19 brought about many changes to ED utilization. A greater reduction in ED utilization occurred in pediatric patients compared to adult patients. Our study showed changes in the number and characteristics of patients visiting the ED during the COVID-19 period compared to 2018 and 2019.

Abbreviations: AED = adult emergency department, COVID-19 = coronavirus disease 2019, ED = emergency departments, LOS = length of stay, PED = pediatric emergency department.

Keywords: COVID-19, emergency department, utilization

1. Introduction

After the initial report of the 2019 novel coronavirus disease (COVID-19) in Wuhan, China in December 2019, the first

confirmed case of COVID-19 occurred in South Korea on January 20, 2020, and a pandemic was declared by the WHO on March 12th.

Since then, 2 outbreaks have occurred in South Korea, and a third outbreak is currently in progress. As of 12 AM midnight on December 31, 2020, 61,769 cases have been confirmed, among which 917 deaths occurred.

In recent decades there have been several infectious disease outbreaks, and these included acute respiratory syndrome (SARS) in 2002, the novel influenza A/H1N1 in 2009, Ebola virus in 2014, Middle East respiratory syndrome (MERS) in 2012, and Zika virus outbreak in 2015. Among domestic outbreak cases, there were the novel influenza, which had a pandemic declaration by the WHO in 2009, and MERS in 2015.

During the COVID outbreak period, there have been several studies on the use of emergency departments (ED) by patients^[1–15] and the use of ED during each outbreak period exhibited various patterns.

In a study of ED use after the COVID-19 pandemic struck, the total number of emergency room visits in the United States decreased,^[4] and in a single-center study in the United States, the reduced number of visits by children and elderly patients were particularly noticeable.^[5]

In a South Korean study, the number of patients decreased even in multicenter studies of pediatric patients,^[8,16] and it was concluded that the number of patient visits varies according to the government's quarantine policy.^[8]

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HC and MWK contributed equally to this work.

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The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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It has been suggested that the COVID-19 pandemic will show a different pattern of ED use from previous infectious disease outbreaks. This is because quarantine guidelines are being implemented differently from previous outbreaks, and as a result, many changes are being made to the lifestyles of citizens.

Therefore, we sought to analyze ED usage after the COVID-19 outbreak in South Korea, and compare it with usage patterns from previous years, and also to check whether there were differences between adults and children.

The purpose of this analysis of changes in the use of EDs is to understand how ED resources can be used most efficiently, at the time of infectious disease outbreaks that may occur in future.

2. Methods

2.1. Study setting

This was a retrospective observational study. For this study, the dates from January 1, 2020 to December 31, 2020 were defined as the COVID-19 period. We analyzed the patterns of visits of adult and pediatric patients to the ED during this outbreak and compared the results to the same periods in 2018 and 2019. This study was conducted at 1 institution, a university hospital which is 1 of 2 specialized pediatric centers in South Korea, and it is the only local emergency medical center to have a pediatric emergency center. The ED has an annual volume of around 30,000 pediatric patients and 45,000 adult patients.

2.2. Study patients

We used the National Emergency Department Information System (NEDIS) for the data. The NEDIS database consists of all cases of ED visits that occurred since 2005 in regional and local emergency medical centers and other local emergency medical facilities, accounting for approximate 76% of the national hospital-based ED visit data. The NEDIS database conducts systematic quality control to ensure the quality of the data. All patients who visited the hospital in each of the above years were enrolled using the NEDIS.

2.3. Data collection

2.3.1. Selection of participants. Pediatric patients were defined as patients younger than 18 years of age. We subdivided the pediatric patients into 4 groups: younger than 1 year of age (infants), 2 to 4 years of age (young children), 5 to 10 years of age (school-aged children) and 11 to 17 years of age (adolescents). Adult patients were divided into 18 to 44 years of age (young adults), 45 to 54 (early middle-aged adults), 55 to 64 (later middle-aged adults), and 65 or older (older adults).^[17] The ratio of visiting patients among each age group was checked. No patients were excluded from the study.

2.3.2. Measurements. We checked the number, age, gender, and ED visit time of adult and pediatric ED patients through a chart review. Visiting times were analyzed by season (spring: March-May, summer: June-August, fall: September-November, winter: December-February), daytime visiting hours (6 AM-6 PM), and nighttime visiting hours (6 PM-6 AM). Since 2016, ED triage has been performed in South Korea using the Korean Triage and Acuity Scale (KTAS). The KTAS was developed based on the Canadian Triage and Acuity Scale and has 5 levels: level 1, resuscitation; level 2, emergency; level 3, urgent; level 4, less

urgent; and level 5, nonurgent. We collated data regarding patients' acuity level at KTAS triage using a triage tool in both the adult and the pediatric ED. KTAS levels 1, 2, and 3 were classified as high acuity, whereas levels 4 and 5 were classified as low acuity.

Additionally, we collated data on the cause of the visit (disease/trauma), transportation used for visit (ambulance/private car/other), ED disposition (discharge, general admission, intensive care unit admission, transfer, death), symptom to ED visit time, ED visit time and length of stay (LOS). These data were compared between the study period and 2 other periods in 2018 and 2019. We collated the top 10 most common complaints of adult and pediatric patients for visiting the ED during this outbreak and compared the results to the same periods in 2018 and 2019.

2.4. Statistical analysis

The data were analyzed using the SPSS 22.0 statistical package (SPSS Inc., Chicago, IL). Values of continuous variables are expressed as the mean \pm standard deviation (SD) or the median (and interquartile range), whereas the values of categorical variables are expressed as frequency (and percentage). Fisher exact test and the Pearson χ^2 test were used for categorical variables. Student *t* test was used to compare differences between 2 groups. If needed, the Mann-Whitney *U* test was used. The significance of the differences in the repeated-measures data between groups such as the EDLOS was analyzed using a repeated-measures analysis of variance. A *P* value of $<.05$ was considered statistically significant.

2.5. Primary outcome and secondary outcomes

The primary outcome of this study is to show how the COVID-19 outbreak changed the ED utilization patterns of patients. The secondary outcome is a comparison of patient characteristics between the pediatric emergency department (PED) and the adult emergency department (AED) during the outbreak, and to demonstrate the differences between the 2 EDs.

2.6. Ethics statement

The protocol for this study was reviewed and approved by the Institutional Review Board of CHA University Hospital (IRB No. 2021-01-001). Informed consent was waived. We conducted this study in compliance with the principles of the Declaration of Helsinki.

3. Results

Before the COVID-19 period, the age group that most frequently visited the ED for adult patients was 18 to 44 age group and the least visited was the early middle-aged 45 to 54 age group. This did not change during the COVID-19 period. The proportion of the 18 to 44 age group decreased by 2.6% compared to 2018 and 2019, and those aged 65 or older group increased by 2.0% compared to 2018 and 2019. Before the COVID-19 period, the age group that most visited the ED for pediatric patients was the 2 to 4 age group and the least visited was the 11 to 17 age group. It was the same during the COVID-19 period. The proportion of the 2 to 4 age group decreased by 5.6% compared to 2018 and 2019 and those aged 11 to 17 increased by 2.8% compared to 2018 and 2019 (Table 1).

Table 1
Adult and Pediatric emergency department patient volume by age group.

	2018	2019	2020	P value
AED Age, N(%)	45,300	45,144	37,935	<.001*
18-44 yrs	19,756 (43.61)	18,890 (41.84)	15,232 (40.15)	
45-54 yrs	7202 (15.9)	7155 (15.85)	6073 (16.01)	
55-64 yrs	7835 (17.3)	8039 (17.81)	6818 (17.97)	
65 yrs or more	10,507 (23.19)	11,060 (24.5)	9812 (25.87)	
PED age, N(%)	33,693	30,988	16,040	<.001*
<1 yrs	5317 (15.78)	4154 (13.41)	2477 (15.44)	
2-4 yrs	18,462 (54.79)	16,670 (53.8)	7805 (48.66)	
5-10 yrs	6993 (20.76)	7240 (23.36)	3849 (24.0)	
11-17 yrs	2921 (8.67)	2924 (9.44)	1909 (11.9)	

AED = adult emergency department, PED = pediatric emergency department.
 * Chi-square test.

According to ER disposition, both pediatric and adult patients had the highest percentage of discharged patients during the COVID-19 period, the number of hospitalized PED patients increased, and the number of hospitalized AED patients decreased. However, both ED sets were increased in intensive care unit hospitalizations. The percentage of deaths for both was

also increased. The proportion of trauma patients in the PED increased by 11.4%, which was statistically significant ($P < .001$). As a means of visiting the hospital, the use of ambulances increased for both adult and PED patients. The time from symptom onset to ED visit time was reduced from 1592.9 minute to 1352.8 minute for adults and 1481.1 minute to 1128.5 minute for pediatric patients. The EDLOS increased from 218.2 minute to 225.5 minute in adults, whereas the EDLOS decreased from 112.5 minute to 108.8 minute for pediatric patients (Table 2).

The total number of patients who visited the ED for 3 years was 197,152 and all patients were included in the study. During the COVID-19 outbreak in 2020, the patient number (53,975 patients) was markedly decreased compared to the other period years of 2018 (78,993 patients) and 2019 (76,132 patients). The number of ED visitors during the COVID-19 period decreased by 23,025 (29.9%) compared to the average number of patients visiting the ED in the other 2 periods. There was a total of 37,935 adult ED visits during the COVID-19 period, which was 7287 (16.1%) less than the average number of visitors in 2018 to 2019, and there were 16,040 ED visits by pediatric patients during the COVID-19 period which was 16,300 (50.4%) less than the previous average of 32,340 for 2018 and 2019. Compared to 2018 and 2019, during the COVID-19 period, the decrease in the

Table 2
The number of emergency department patients in 2018-2019 compared to those in 2020.

	PED			AED		
	2018-2019	2020	P value	2018-2019	2020	P value
N(%)	64,681	16,040	.279[†]	90,444	37,935	<.001[†]
Male	36,022 (55.69)	9009 (56.17)		40,720 (45.02)	17,711 (46.69)	
Female	28,659 (44.31)	7031 (43.83)		49,724 (54.98)	20,224 (53.31)	
Age (Mean ± SD)	3.92 ± 4.06	4.36 ± 4.41	<.001*	49.91 ± 18.92	50.96 ± 19.12	<.001*
ER visit time N (%)			<.001 [†]			<.001 [†]
Spring	16,767 (25.92)	3371 (21.02)		22,134 (24.47)	9409 (24.8)	
Summer	16,332 (25.25)	3904 (24.34)		23,242 (25.7)	9842 (25.94)	
Fall	15,780 (24.4)	3584 (22.34)		22,601 (24.99)	8704 (22.94)	
Winter	15,802 (24.43)	5181 (32.3)		22,467 (24.84)	9980 (26.31)	
Day (6 AM-6 PM)	26,598 (41.12)	6660 (41.52)	.358 [‡]	46,630 (51.56)	20,230 (53.33)	<.001 [†]
Night (6 PM-6 AM)	38,083 (58.88)	9380 (58.48)		43,814 (48.44)	17,705 (46.67)	
KTAS, N(%)			.02 [†]			.262 [†]
KTAS:1-2	3032 (4.69)	822 (5.12)		12,461 (13.78)	5137 (13.54)	
KTAS:3-5	61,649 (95.31)	15,218 (94.88)		77,983 (86.22)	32,798 (86.46)	
Illness, N(%)			<.001 [†]			.043 [†]
Yes	51,695 (79.92)	10,989 (68.51)		68,163 (75.36)	28,387 (74.83)	
No	12,986 (20.08)	5051 (31.49)		22,281 (24.64)	9548 (25.17)	
By visit, N(%)			<.001 [‡]			<.001 [†]
Ambulance	3181 (4.92)	1066 (6.65)		23,279 (25.74)	11,064 (29.17)	
Personal car	61,493 (95.07)	14,974 (93.35)		67,156 (74.25)	26,866 (70.82)	
Other	7 (0.01)	0 (0)		9 (0.01)	5 (0.01)	
EDLOS(min)			<.001*			<.001*
Mean ± SD	112.49 ± 103.37	108.8 ± 97.54		218.18 ± 286.63	225.53 ± 246.86	
Symptom to arrival (min)			<.001*			<.001*
Mean ± SD	1481.06 ± 3483.88	1128.5 ± 3089.09		1592.89 ± 5599.05	1352.83 ± 4807.98	
Disposition N(%)			<.001 [†]			<.001 [†]
Discharge	64,369 (99.52)	15,914 (99.22)		84,739 (93.73)	35,519 (93.7)	
General admission	114 (0.18)	27 (0.17)		1580 (1.75)	444 (1.17)	
ICU admission	129 (0.2)	60 (0.37)		3378 (3.74)	1487 (3.92)	
Transfer	60 (0.09)	32 (0.2)		241 (0.27)	146 (0.39)	
Death	9 (0.01)	6 (0.04)		466 (0.52)	311 (0.82)	

AED = adult emergency department, PED = pediatric emergency department.
 * Wilcoxon rank sum test.
 † Chi-square test.
 ‡ Fisher exact test.

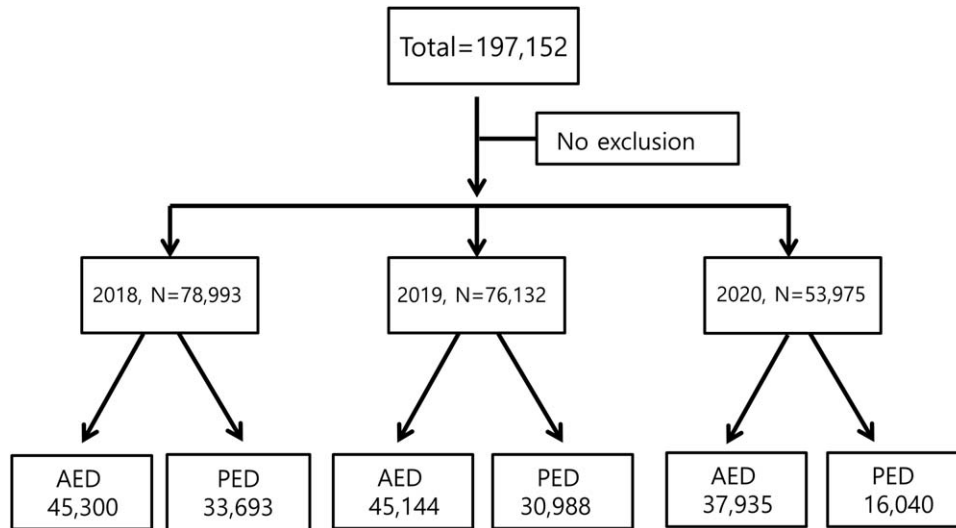


Figure 1. Patient flow chart. AED=adult emergency department, ED=emergency department, PED=pediatric emergency department.

number of pediatric ED patients was significantly greater than the decrease in the number of adult ED patients (Fig. 1).

On January 20, 2020, the first COVID-19 patient was confirmed in South Korea. As a result, the number of adult and pediatric ED patients decreased rapidly from February.

There have been 2 surges in the number of infected cases in 2020. The number of ED visits by patients decreased in correlation with those surges in the number of confirmed patients. On February 10th, the number of confirmed patients increased rapidly due to an outbreak among religious groups in the city of Daegu. This first surge in patients led to a decrease in ED patients in March. PED visits averaged 2500 patients monthly before COVID-19, but in March decreased by 1559 (62.3%) visits to 941. AED visits averaged 3700 patients monthly before COVID-19, but in March decreased by 775 (26.5%) visits to 2925. Compared to February, the number of AED patients decreased by 126 patients (4.1%) and PED patients decreased by 312 patients (24.9%) in March. The number of patients in both EDs decreased, but the decrease in pediatric visits was more significant.

After a mass demonstration in Seoul on August 15th, the number of confirmed cases increased sharply again for the second surge. As a result, the number of AED visits in September decreased. The number of PED visits was 956, a decrease of 169 (15%) compared to the previous month. The number of AED visits was 2706, a decrease of 509 (15%) compared to the previous month. The average number of hospital ED visits by patients recovered in October. The number of patient visits to the AED and PED decreased when there was a surge in confirmed COVID-9 cases. During the first surge, the number of PED patients decreased significantly compared to the AED and during the second surge the decrease in AED and PED visits was at the same rate (Fig. 2).

AED visits had a high proportion of women, and PED visits had a high proportion of boys. The average age of adult visitors during the COVID-19 period was 51.0 ± 19.1 years, while that of children was 4.4 ± 4.4 . For an analysis of seasonal ED visit time, PED usually had a high proportion of patient visits in spring before the COVID-19 period. The highest proportion of patients

during the COVID-19 period was in the winter. The AED usually had a high proportion of patient visits in the summer before COVID-19. The highest proportion of patients during the COVID-19 period was in the winter. Visiting hours were the same during COVID-19 as in previous years, with the highest proportion of patients at night time for children and day time for adults. The proportion of severe cases in PED (KTAS 1-2) increased by 5.12% from 4.69% respectively, and there was no difference in AED.

Of the top 10 most common complaints expressed by pediatric and adult patients visiting the ED, fever was the most common during both the COVID-19 and the 2018, 2019 periods. However, the number of patients with fever decreased sharply compared to 2018 and 2019. The number and proportion of patients with a cough was 305 (1.9%), which was significantly reduced compared to the 1372 (4.07%) visits in 2018 and the 1155 (3.73%) visits in 2019. Scalp contusion accounted for 267 (1.66%) visits in 2020, up from 79 (0.23%) in 2018 and 209 (0.67%) in 2019. The number of visits due to abdominal pain 1051 (6.55%) decreased by 530 compared to 2018 and 61 compared to 2019. But the percentage of patients who visited the hospital due to abdominal pain increased (Fig. 3).

In adult patients the most common complaint was abdominal pain 3117 (8.22%) followed by fever 1603 (4.23%), dizziness 2089 (5.51%). During the COVID-19 period, complaints of respiratory symptoms such as cough, and sore throat decreased, as they had for PED visits. The number of chest pain patients increased to 382 (1.01%) during the COVID-19 period compared to 110 (0.24%) in 2018 and 220 (0.49%) in 2019 (Fig. 4).

4. Discussion

COVID-19 is one of the most serious worldwide healthcare problems seen in recent years. Since the first case of COVID-19 in 2020, South Korea has experienced 3 waves, and currently there are about 400 cases confirmed per day. In this retrospective study, the total number of patients visiting the ED during the COVID pandemic decreased in both the AED and the PED. Of

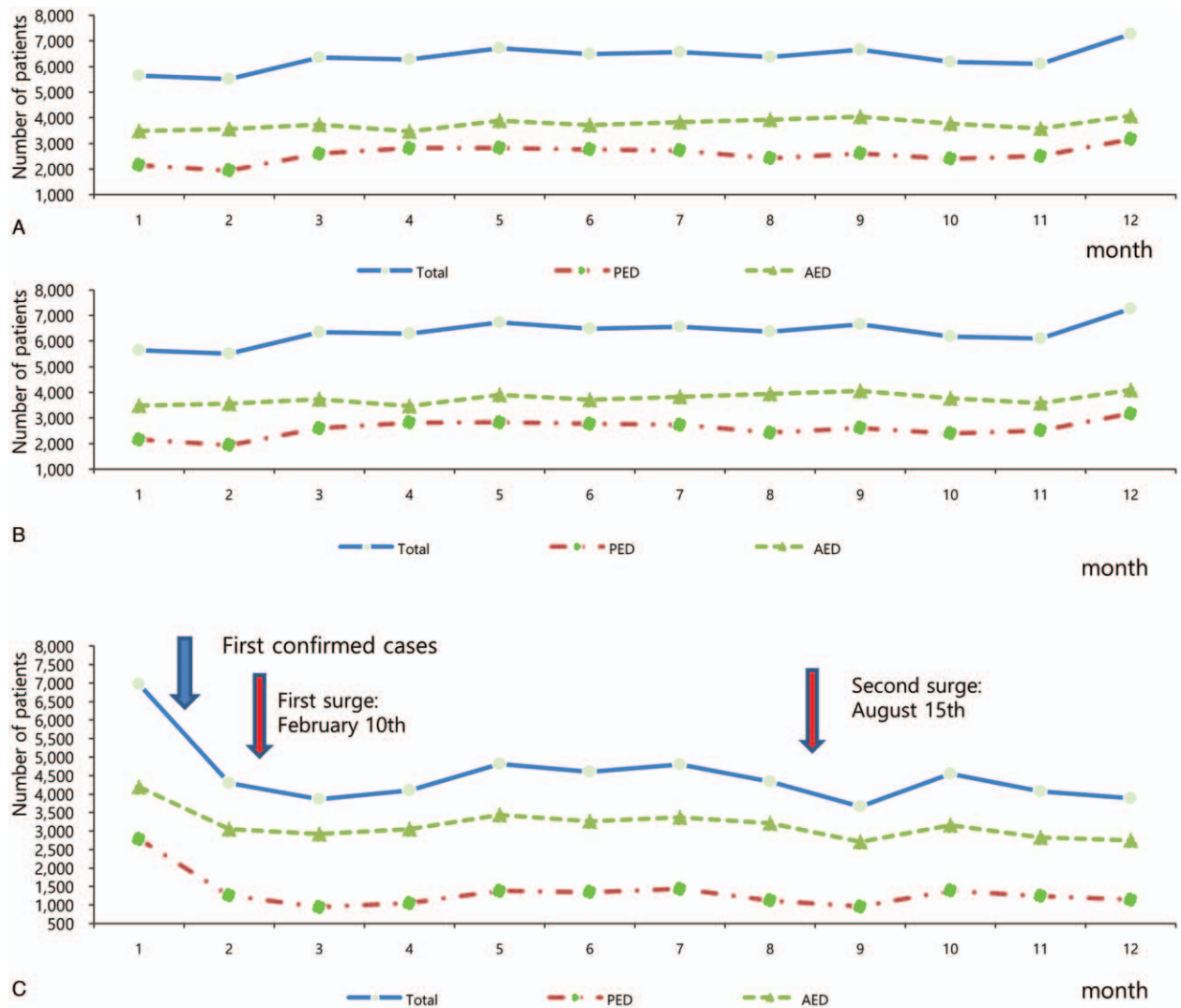


Figure 2. Number of adult and pediatric emergency department visits per month from 2018 to 2020. (A) Total number of AED and PED visits from January to December in 2018. (B) Total number of AED and PED visits from January to December in 2019. (C) Total number of AED and PED visits from January to December in 2020. The blue arrow indicates surges in the number of infected cases in 2020. The red arrow shows when the first confirmed patient occurred. The number of ED visits by patients decreased in correlation with a surge in the number of confirmed patients. AED=adult emergency department, ED=emergency department, PED=pediatric emergency department.

particular note, there was about 50.4% overall decline in PED compared to 2018 to 2019. The proportion of trauma patients in children increased by 11.4%, and the proportion of severe patients increased by 0.43% ($P=.02$). The time from symptom onset to hospitalization decreased in both ERs, and EDLOS increased in AED and decreased in PED. By age group, the proportion of patients aged 2 to 4 decreased the most, and the proportion of young adults aged 18 to 44 decreased the most.

The average age of the patients was significantly increased in each of the ED compared to 2018 to 2019.^[8] In PED, the rate of visits by 11 to 17 years school-age patients increased. With the stay-at-home order, the frequency of younger age children’s ED visits decreased due to the lower prevalence of viral diseases such as influenza and acute gastroenteritis, which are most common among children of preschool age. This reduced prevalence occurred as a result of parents refraining from going out, and the number of children being sent to childcare centers was severely curtailed. However, adolescents can go out on their own without

the guidance of parents, and although schools limited the number of attendees in places such as childcare institutions, the reduction would have been less than that of younger children due to the continued operation of afterschool academies and other facilities.

In the AED, the proportion of patients over 65 years of age increased by about 2%. The explanation is likely to be that when patients in nursing homes/nursing hospitals developed fever or respiratory symptoms, it was difficult to treat them elsewhere, so they had no choice but to visit the emergency room. In addition, patients are thought to have visited the ED because of awareness of the high mortality rate from COVID-19 in the elderly aged 65 or older. This awareness was the result of extensive media coverage of COVID-19.^[18] On the other hand, the age group that was most well equipped to check COVID-19 information and statistics through the media and social media corresponds to the age group of guardians caring for children aged 0 to 10. The decline in emergency room visits in this younger age group is readily understandable. The proportion of patients with K-TAS

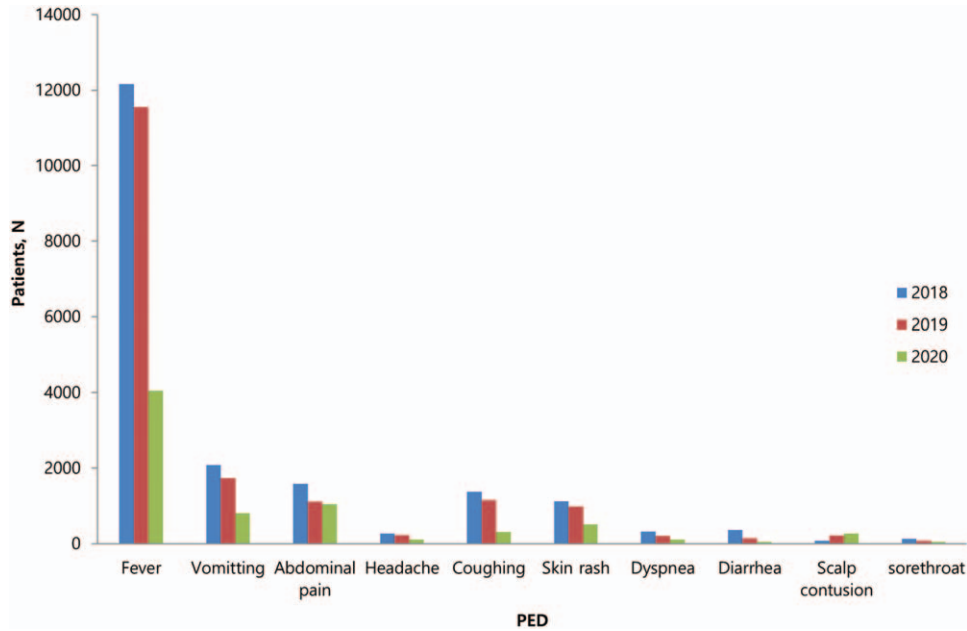


Figure 3. The top 10 most common complaints of pediatric patients visiting the ED during COVID-19 and 2018, 2019 periods. AED=adult emergency department, PED=pediatric emergency department.

level 1-2 in the PED increased significantly. The relative decline in pediatric patients overall can be expected considering that the severity of problems seen in the PED is generally lower than in the AED.^[9] A primary point regarding PED visit volume, was that there were fewer minor symptoms patients. Other studies have reported that the emergency admission rate has risen during the COVID-19 outbreak conditions, but few studies have classified this by age group.^[19,20] This indicates that the use of the PED for

nonemergency situations was quite common. Reviewing this trend, the proportion of total hospitalized patients coming through EDs increased in the PED and decreased in the AED, but the rate of ICU admission and ED mortality increased significantly in the AED. These results are thought to be due to an increase in the proportion of patients who required treatment in the ICU setting through emergency 119 visits by the high-risk patient group over 65 years old.

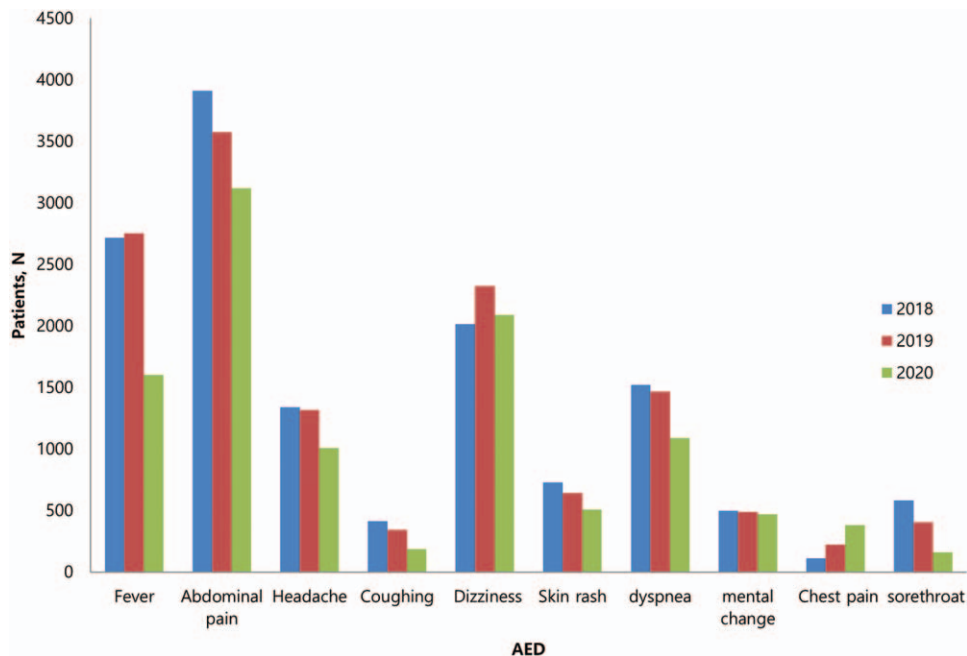


Figure 4. The top 10 most common complaints of adults visiting the ED during COVID-19 and 2018, 2019 periods. AED=adult emergency department, PED=pediatric emergency department.

Previous studies have reported that there were significant reductions in the number of trauma patients due to travel avoidance and reduced use of motor vehicles.^[21,22] In this study also, although there is a decrease in the number of trauma patients due to a decrease in the total number of patients, the proportion of trauma patients has increased. This pattern may be partly explained by the use of daytime outpatients department (OPD) in the case of medically ill patients. Although there was a decrease in number of patients throughout the hospital, the decrease in OPD patients was relatively small compared to that in ED patients.

PED LOS was shortened compared to the base years, but increased in AED. As the number of COVID-19 patients in Korea increased, when deciding whether to hospitalize patients with fever or respiratory symptoms, the AED physicians check the COVID-19 test result and based on the result make a decision on the type of admission district and transfer. A COVID-19 confirmed patient in the ED will be transferred to a nationally designated hospital through the national transfer system. Due to the COVID-19 tests confirm protocol, the AED EDLOS is longer than the PED LOS for hospitalization which does not check for test results. These different approaches are thought to be reflected in the average LOS in AED. Furthermore, when a patient was admitted in PED, a COVID-19 test was performed and the patient was able to be admitted to the quarantine ward immediately without first checking the test result.

There are several reasons for the decline in ED utilization. As mentioned in other studies, the primary reason for the decrease in visits to medical institutions is COVID-19 fear.^[23,24] One study showed that this fear reduced ED utilization even for critically-ill patients such as myocardial infarction and stroke,^[25–27] whereas another showed that patients with nonemergency diseases also decreased their ED use.^[28–30] In addition, there was a substantial decrease in seasonal influenza and other viral diseases, which easily spread in normal times but during COVID-19 have been limited by social distancing, reductions in the number of people allowed at gatherings, limitations on the operation of schools and other spaces, and an emphasis on personal hygiene such as mask-wearing and hand washing.^[31]

This study is significant in that includes overall data for 1 year compared to previous studies that analyzed only the first few months of the pandemic. After a third wave in a year, the number of ED visitors can be seen to decrease over that period. Other studies have shown a decrease in the number of patients during the reference year^[4] and during the COVID-19 outbreak, but based on the results of previous studies, we know that the total number of ED visits during the outbreak period decreases.^[1,10,15] It is possible to reconsider the efficiency of ED operation in the future by understanding differences in the ratio of traumatic to nontraumatic patients, by age, severity, etc. People's perception of diseases in the early and mid-pandemic will be different, and diseases that develop into an endemic will bring another perception change. South Korea's experience from several outbreaks is thought to be helpful in predicting future outbreaks and preparing a framework for redistributing and using medical personnel, facilities, and equipment. Furthermore, this study was conducted in a hospital that has both pediatric and AEDs, which are the largest basic units among emergency rooms classified by the South Korean emergency medical system, so it was easy to understand the differences in utilization of each ED. It also needs to be emphasized that our hospital is not a nationally designated hospital that cares for COVID-confirmed patients. Even during

the COVID-19 pandemic, a variety of patient groups similar to those in the previous year visited the ED because the hospital was not authorized to admit COVID-19 and therefore there was much less risk of interacting with COVID patients.

There are several limitations in this study. First, it is a retrospective observational study. COVID-19 is still ongoing, and therefore the true number of patients continues to increase or decrease. Second, because it is a single center study, the results do not represent ED utilization in the whole country, and this may limit the generalizability of the results worldwide. Third, final diagnosis and underlying disease were omitted from our data. Underlying disease might be a major factor that can affect the patient's severity and the outcome of ED disposition. In future studies, if the patient's underlying disease and final discharge diagnosis are confirmed and analyzed with annual data from the entire country, the pattern of pediatric and adult ED use can be analyzed more accurately.

By operating a nationally-designated hospital, South Korea needed more human medical resources in a particular location, and emergency medical personnel were therefore redistributed. Considering that the COVID-19 is still in progress, this study is expected to help reconsider the efficiency of ED operations in future outbreaks and a multi-center study or a nation-wide study will be able to obtain more general results based on this study. Although statistics for 2020 in the national information database have not been collected yet, comparing the trends of emergency ED utilization before and at the time of COVID-19 across the country, more meaningful research results and responses to future outbreaks will be possible.

5. Conclusion

COVID-19 has brought a greater reduction of ED utilization occurred in pediatric patients than in adult patients. Our study showed changes in the number and characteristics of patients visiting the ED during the COVID-19 period compared to 2018 and 2019, so this should be helpful during the ongoing COVID-19 period for ED planning, as well as beneficial for potential future pandemic patients.

Author contributions

Conceptualization: So Hyun Paek

Data curation: So Hyun Paek

Supervision: So Hyun Paek

Writing – original draft: So Hyun Paek, Hyunglan Chang, Min Woo Kang

Writing – review & editing: So Hyun Paek, Hyunglan Chang, Min Woo Kang

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