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Disparities on the rebound in the emergency department in Taiwan during COVID-19 pandemic



Coronavirus disease 2019 (COVID-19) became a global public health emergency. Previous studies revealed a dramatic decline in the volume of emergency departments (EDs) during the pandemic [1–3]. However, evidence regarding the further rebound effects of emergency visits is still lacking. This study aims to investigate emergency visits from Jan 2019 to Jan 2021 in Taiwan.

The National Health Insurance (NHI), a compulsory social insurance system, is a single-payer system in which the coverage rate of its 23 million residents in Taiwan is as high as 99% in Taiwan [4]. The de-identified NHI database of emergency visits from the Taipei Division of the NHI Administration was obtained. This study was approved by the institutional review board of the [blinded for review] and registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (blind for review).

The hospitals were categorized into the responding or non-responding hospitals according to Taiwan Centers for Disease Control (Taiwan CDC). The responding hospitals had the priority to admit the COVID patients as the COVID-contained hospitals. The data was analyzed by a joinpoint trend analysis [5]. The joinpoint software is provided by the National Institutes of Health (NIH) of America, enabling the user to test that an apparent change in trend is statistically significant. The tests of significance use a Monte Carlo Permutation method [6]. The turning point was designated as the joinpoint (JP) and the decline or the increase was depicted as the slope. A p -value of <0.05 was considered significant.

A total of 105 hospitals in which 32 were COVID-contained hospitals were included. The changes in emergency visits in the COVID-contained and non-COVID-contained hospitals were shown in Table 1. The nadir in the COVID-contained hospitals occurred in Apr 2020 with a significant 40% reduction compared with those in Jan 2020. The volume decreased on an average of 19,726 visits per month from Jan (JP, $p = 0.017$) to Apr 2020 (JP, $p = 0.009$), gradually increased on an average of 4229 visits per month from May to Aug 2020, and reached the plateau. However, it did not reach 2019 levels. By contrast, emergency visits have abruptly increased in the non-COVID-contained hospitals since Apr 2020 (JP, $p = 0.019$) (Fig. 1).

The global COVID-19 pandemic had changed medical behaviors. The ED visits strikingly declined worldwide with the highest declines occurring in Apr 2020 [7]. It was possibly related to postponing non-urgent visits, stay-at-home orders, and patients worrying about becoming infected in healthcare settings during the initial phase of the pandemic [2]. However, evidence regarding the further rebound is limited. Our results showed disparities in emergency visits between the COVID-contained and non-COVID-contained hospitals. In the COVID-contained hospitals, the number of emergency visits experienced a

rapid decline and a partial recovery. Meanwhile, a significant multiply growth of emergency visits occurred in the non-COVID-contained hospitals. The turning point for the rebound and the patient diversion was approximate at the time that the last local case was reported (Apr 2020). It suggested that patients did not put off emergency care when needed and transitioned to visit the non-COVID hospitals.

After the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003 in Taiwan, where a series of nosocomial outbreaks resulted in the collapse of hospital operations, a new medical network for highly infectious diseases was established, and responding hospitals for infectious diseases were assigned [8]. The responding hospitals were at least regional hospitals with accreditations, having capacities and professionalism that patients with urgent needs would visit. The COVID pandemic caused a partial patient diversion to the non-COVID hospitals although the total number of emergency visits in 2020 did not reach 2019 levels.

Given the clear benefits of emergency care for serious cardiovascular conditions such as myocardial infarction, stroke, and heart failure, previous studies reported that the dramatic declines in the early pandemic period potentially delayed lifesaving management and worsened patient outcomes [7,9]. The results in this study implied that setting aside some hospitals as the non-COVID hospitals would have a positive impact on emergency care for such life-threatening conditions in a future pandemic.

There were some limitations. First, the infrastructure of the health care system in Taiwan differed from other countries. However, the comprehensive NHI data could represent the real conditions of emergency visits, compared with the tighter private insurance payer system during the pandemic in most of the countries [10]. Second, the de-identified

Table 1
Changes in emergency visits in the COVID-contained and non-COVID-contained hospitals.

Period	COVID-contained hospitals		Non-COVID-contained hospitals	
	Visits	Changes (%) ^a	Visits	Changes (%) ^a
Jan 2020	197,186	+21.51	22	+29.41
Feb 2020	137,939	−19.54	15	−44.44
Mar 2020	125,221	−21.31	14	+40.00
Apr 2020	118,284	−25.97	222	+1287.50
May 2020	127,916	−20.78	1326	− ^b
Jun 2020	138,624	−17.54	1691	+169,000.00
Jul 2020	141,728	−15.82	2002	+14,200.00
Aug 2020	144,831	−13.12	2282	+14,162.50
Sep 2020	141,441	−16.74	2407	+19,958.33
Oct 2020	151,124	−9.18	3092	+12,268.00
Nov 2020	142,311	−6.47	2826	+14,030.00
Dec 2020	137,207	−17.04	2979	+12,852.17
Jan 2021	140,840	−28.58	3096	+13,972.73

^a Compared with visits during the same period in the previous year.

^b The visits in May 2019 were zero.

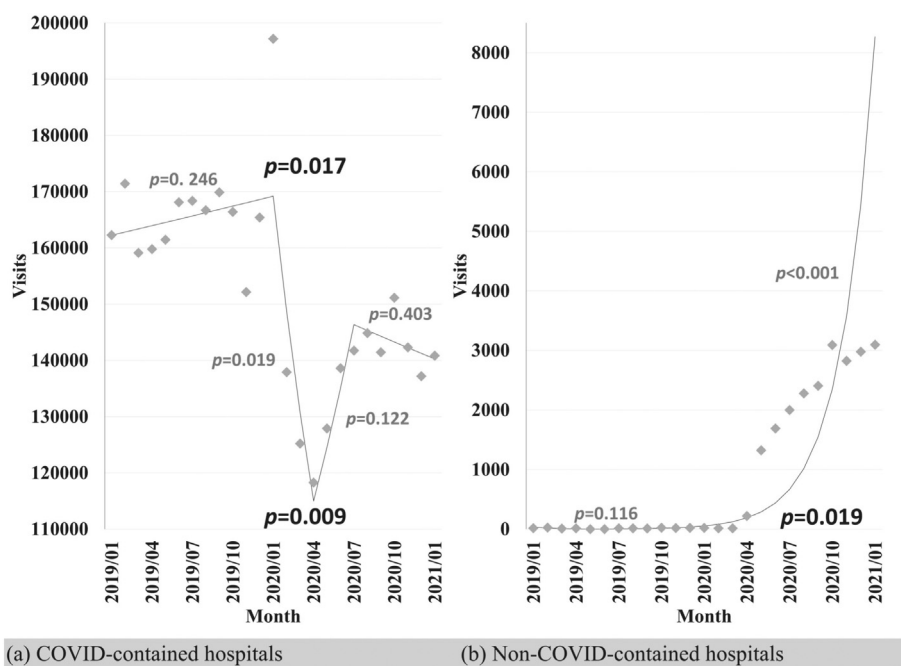


Fig. 1. The volume of the emergency departments from Jan 2019 to Jan 2021. The squares were actual numbers and the line was depicted schematically for the best-fit models. (a) There were two significant joinpoints (bold *p*-value) in emergency visits in the COVID-contained hospitals; (b) There was one significant joinpoint (bold *p*-value) in non-COVID-contained hospitals.

data was at the aggregate level. The details of diagnoses and patient outcomes could not be accessed. Third, medical expenses were not included in the analysis and future studies would be warranted.

In summary, a significant rebound effect occurred following Apr 2020. However, the COVID pandemic had a different impact on emergency visits: a rapid decline and slow rebound in the COVID hospitals and an abrupt growth in the non-COVID hospitals. To avoid the worse outcomes owing to delayed or postponed emergency care, setting non-COVID hospitals would be a possible solution.

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Ethics Approval Statements

This study was approved by the ethics committee of the institutional review board of the National Taiwan University Hospital (202006225RINA) and registered at [ClinicalTrials.gov](https://clinicaltrials.gov) (NCT04497467).

Declaration of Competing Interest

All authors declared no competing interests.

References

[1] Sung CW, Lu T, Fang CC, Huang CH, Chen WJ, Chen SC, et al. Impact of COVID-19 pandemic on emergency department services acuity and possible collateral damage. *Resuscitation*. 2020;153:185–6. <https://doi.org/10.1016/j.resuscitation.2020.06.021>.

[2] Wong LE, Hawkins JE, Langness S, Murrell KL, Iris P, Sammann A. Where are all the patients? Addressing Covid-19 fear to encourage sick patients to seek emergency care. *NEJM Catalyst*. 2020:1–12. <https://doi.org/10.1056/CAT.20.0193>.

[3] Giamello JD, Abram S, Bernardi S, Lauria G. The emergency department in the COVID-19 era. Who are we missing? *Eur J Emerg Med*. 2020;27(4):305–6. <https://doi.org/10.1097/MEJ.0000000000000718>.

[4] Cheng SH, Lee TT, Chen CC. A longitudinal examination of a pay-for-performance program for diabetes care: evidence from a natural experiment. *Med Care*. 2012; 50(2):109–16. <https://doi.org/10.1097/MLR.0b013e31822d5d36>.

[5] Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. *Stat Med*. 2000;19(3):335–51. [https://doi.org/10.1002/1097-0258\(20000215\)19:3](https://doi.org/10.1002/1097-0258(20000215)19:3).

[6] NIH. Joinpoint Trend Analysis Software. <https://surveillance.cancer.gov/joinpoint/>; 2020. [accessed September 18 2020].

[7] Hartnett K, Kite-Powell A, DeVies J, Coletta MA, Boehmer TB, Adjemian J, et al. Impact of the COVID-19 pandemic on emergency department visits - United States, January 1, 2019–May 30, 2020. *MMWR Morb Mortal Wkly Rep*. 2020;69(23): 699–704. <https://doi.org/10.15585/mmwr.mm6923e1>.

[8] Kao HY, Ko HY, Guo P, Chen CH, Chou SM. Taiwan’s experience in hospital preparedness and response for emerging infectious diseases. *Health Secur*. 2017;15(2): 175–84. <https://doi.org/10.1089/hs.2016.0105>.

[9] Pines JM, Zocchi MS, Black BS, Celedon P, Carlson JN, Moghtaderi A, et al. The effect of the COVID-19 pandemic on emergency department visits for serious cardiovascular conditions. *Am J Emerg Med*. 2021;47:42–51. <https://doi.org/10.1016/j.ajem.2021.03.004>.

[10] Cutler D. How will COVID-19 affect the health care economy? *JAMA*. 2020;323(22): 2237–8. <https://doi.org/10.1001/jama.2020.7308>.

Jia-Yu Chen

Department of Emergency Medicine, National Taiwan University Hospital, Taipei, Taiwan

Yu-Chuan Liu

National Health Insurance Administration, Ministry of Health and Welfare, Taipei City, Taiwan

Yueh-Ping Liu

Department of Emergency Medicine, National Taiwan University Hospital, Taipei, Taiwan
Department of Medical Affairs, Ministry of Health and Welfare, Taipei City, Taiwan

Chia-Hui Chou

National Health Insurance Administration, Ministry of Health and Welfare, Taipei City, Taiwan

Yi-Chu Chen

Institute of Epidemiology and Preventive Medicine, College of Public Health, National Taiwan University, Taipei, Taiwan

Department of Nursing, Fu-Jen Catholic University, New Taipei City,
Taiwan

Emergency Medicine, College of Medicine, National Taiwan University,
Taipei, Taiwan

E-mail address: wanchinglien@ntu.edu.tw

Wan-Ching Lien
Department of Emergency Medicine, National Taiwan University Hospital,
Taipei, Taiwan

Po-Chang Lee
National Health Insurance Administration,
Ministry of Health and Welfare, Taipei City, Taiwan

Department of Emergency Medicine, College of Medicine,
National Taiwan University, Taipei, Taiwan

*Corresponding author at: Department of Emergency Medicine,
National Taiwan University Hospital, Taipei, Taiwan; Department of

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