



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



Short report

Providing essential clinical care for non-COVID-19 patients in a Seoul metropolitan acute care hospital amidst ongoing treatment of COVID-19 patients

K.D. Lee^a, S.B. Lee^b, J.K. Lim^c, Y.M. Kang^a, I.B. Kim^d, H.J. Moon^e, W.J. Lee^{f,*}

^a Department of Infectious Diseases, Myongji Hospital, Hanyang University College of Medicine, Goyang, Republic of Korea

^b Department of Physical Medicine and Rehabilitation, Myongji Hospital, Hanyang University College of Medicine, Goyang, Republic of Korea

^c Department of Laboratory Medicine, Myongji Hospital, Hanyang University College of Medicine, Goyang, Republic of Korea

^d Department of Emergency Medicine, Myongji Hospital, Hanyang University College of Medicine, Goyang, Republic of Korea

^e New Horizon Cancer Institute, Myongji Hospital, Goyang, Republic of Korea

^f Department of General Surgery, Myongji Hospital, Goyang, Republic of Korea

ARTICLE INFO

Article history:

Received 13 July 2020

Accepted 26 September 2020

Available online 1 October 2020

Keywords:

COVID-19

Non-COVID-19 patients

Hospital infection

Hospital visiting

Essential clinical care

Acute care hospital

SUMMARY

We assessed infection control efforts by comparing data collected over 20 weeks during a pandemic under a dual-track healthcare system. A decline in non-COVID-19 patients visiting the emergency department by 37.6% ($P < 0.01$) was observed since admitting COVID-19 cases. However, patients with acute myocardial infarction (AMI), stroke, severe trauma and acute appendicitis presenting for emergency care did not decrease. Door-to-balloon time ($34.3 (\pm 11.3)$ min vs $22.7 (\pm 8.3)$ min) for AMI improved significantly ($P < 0.01$) while door-to-needle time ($55.7 (\pm 23.9)$ min vs $54.0 (\pm 18.0)$ min) in stroke management remained steady ($P = 0.80$). Simultaneously, time-sensitive care involving other clinical services, including patients requiring chemotherapy, radiation therapy and haemodialysis did not change.

© 2020 The Authors. Published by Elsevier Ltd on behalf of The Healthcare Infection Society. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).



Introduction

The coronavirus outbreak has profoundly impacted the delivery of essential healthcare and management practices in

core clinical settings across the globe. During the COVID-19 pandemic era we have observed health rationing, which affected many lives. Against the backdrop of the grave outcomes associated with the spread of COVID-19 infection, it is important that, where possible, clinical management of non-COVID conditions is not seriously compromised.

Myongji Hospital, located in a Seoul Metropolitan area of Korea, has implemented a strategic system of simultaneously treating both COVID-19 and non-COVID-19 cases. The private

* Corresponding author. Address: Department of General Surgery, Myongji Hospital, 55 Hwasu-ro 14-beon-gil, Deogyang-gu, Goyang, 10475, Republic of Korea. Tel.: +82 31 810 5114; fax: +82 31 810 7329.

E-mail address: lovehospital@gmail.com (W.J. Lee).

acute-care hospital with 560 beds operates a Level I emergency centre and 12 nationally designated negative-pressure isolation beds, including five in the ICU. Consistent with its core functions as an acute care facility engaged in the delivery of essential medical care to both infected and non-infected patients during a pandemic, we hypothesize that a 'dual-track healthcare system' (DTHS) will significantly assist essential areas of clinical care while upholding infection control practices. Public entities have developed technical guidelines for maintaining essential health services during the pandemic [1]. However, there is a paucity of data regarding the effectiveness of systematic measures to effectively control the spread of infection while maintaining steady levels of care for other clinical conditions. The purpose of this study was to quantitatively and qualitatively analyse the changes arising from DTHS application to control the spread of COVID-19 infection while systematically maintaining core functions in the delivery of essential healthcare.

Methods

In this cross-sectional study, data were acquired from medical records for 20 weeks leading to the onset of COVID-19 and compared with data collected over a 20-week period following the outbreak, since 26th January 2020. During the span of 40 total weeks, cases involving AMI, stroke, severe trauma and acute appendicitis were selected as representative morbidities, which required emergency care services. Representative areas of continuous clinical care were chemotherapy, radiation therapy and haemodialysis. For qualitative evaluation of emergency clinical care, door-to-balloon time (DTB) for coronary intervention in AMI patients, door-to-needle time (DTN) for intravenous thrombolysis, and door-to-puncture time (DTP) for mechanical thrombectomy in stroke patients were compared [2,3]. In the case of acute appendicitis, time required for arrival at the emergency department (ED) and mobilizing to the operating room (OR) was measured as door-to-operation time (DTO). The number of hospital days and status post-appendectomy were investigated to calculate the severity of appendicitis [4]. Descriptive statistics included mean with standard deviation of independent variables. The means were compared using Student's *t*-test.

DTHS

The DTHS proposed by our hospital board committee for COVID-19 was established immediately following the initial outbreak in Wuhan, China. This strategic plan to maintain the core functions of an acute-care hospital was designed to simultaneously treat dual patient populations (COVID-19 and non-COVID-19). Generally, maintaining a system of spatially separated ED, outpatient department (OPD), intensive care unit (ICU) and inpatient wards for COVID-19 and non-COVID-19 patients, with medical staff assigned to address the needs of the two categories was critical for successful containment of infection. In addition, it includes technical guidelines for the appropriate use of the buffer zone, 24-h reverse transcription polymerase chain reaction (RT-PCR) testing and application of real-time communication tools to facilitate communication between the two areas under one integrated system.

Results

COVID-19 patient care status

A total of 47 COVID-19 patients were treated in this hospital through 23rd June 2020 [5]. ICU care was provided to 31.9% of patients and ventilator therapy was administered to 23.4% of patients. Case fatality rate was 17.0%. The average number of hospitalized patients per day was 5.26.

Changes in the number of non-COVID-19 patients

The mean weekly number of ED, OPD, inpatient and elective surgeries of adult non-COVID-19 patients decreased to 62.4%, 73.9%, 78.6%, and 79.3%, respectively, compared with pre-COVID-19 patient care ($P < 0.01$). The frequency of non-elective surgery also decreased slightly (from 11.8 cases per week to 9.0 cases per week; $P = 0.03$). The mean weekly number of ED, OPD and vaccination visits in paediatric patient cases in the non-COVID-19 category decreased to 25.6%, 37.8% and 50.7%, respectively, compared with pre-COVID-19 patient care ($P < 0.01$), as shown in [Figure 1](#).

Changes in essential clinical care of non-COVID-19 patients

The mean weekly number of patients with AMI, stroke, severe trauma, and acute appendicitis requiring emergency clinical care did not change significantly: from 1.6 (± 1.3) per week to 1.6 (± 1.1) per week ($P = 1.00$), 6.0 (± 1.3) per week to 5.9 (± 2.1) per week ($P = 0.84$) and 5.6 (± 2.2) per week to 5.4 (± 2.2) per week ($P = 0.77$). In AMI, DTB decreased significantly from 34.3 (± 11.3) min to 22.7 (± 8.3) min ($P < 0.01$). In stroke cases, DTN from 55.7 (± 23.9) min to 54.0 (± 18.0) min ($P = 0.80$), and DTP from 100.5 (± 32.1) min to 116.1 (± 30.9) min ($P = 0.20$) were maintained within appropriate time. In acute appendicitis, DTO showed an increasing trend from 181.2 (± 66.6) min to 208.9 (± 137.3) min without statistical significance ($P = 0.06$) whereas hospital stay decreased from 3.5 (± 3.5) days to 3.1 (± 1.9) days ($P = 0.33$) which was not statistically significant. The mean weekly changes in continuous clinical care during chemotherapy, radiation therapy and haemodialysis ranged from 51.2 (± 16.5) cases/week to 59.9 (± 10.8) cases per week ($P = 0.06$), from 38.6 (± 15.4) cases per week to 49.9 (± 22.5) cases per week ($P = 0.74$) and 389.5 (± 11.9) cases per week to 398.1 (± 9.7) cases per week ($P = 0.02$), respectively [Table 1](#).

Discussion

Our analysis confirmed a significant decrease in patient inflow shortly after the start of COVID-19 patient care with a sharper decline in paediatric patients. However, this trend did not compromise essential services involving emergency care of non-COVID-19 patients presenting to our ED.

In order to maintain the core functions of the acute-care hospital while treating COVID-19 and non-COVID-19 patients simultaneously, the influx of COVID-19 patients must be within manageable levels. In Korea, the allocation of COVID-19 patients across hospitals throughout the nation was determined by community health policy officers [6]. Even if a patient

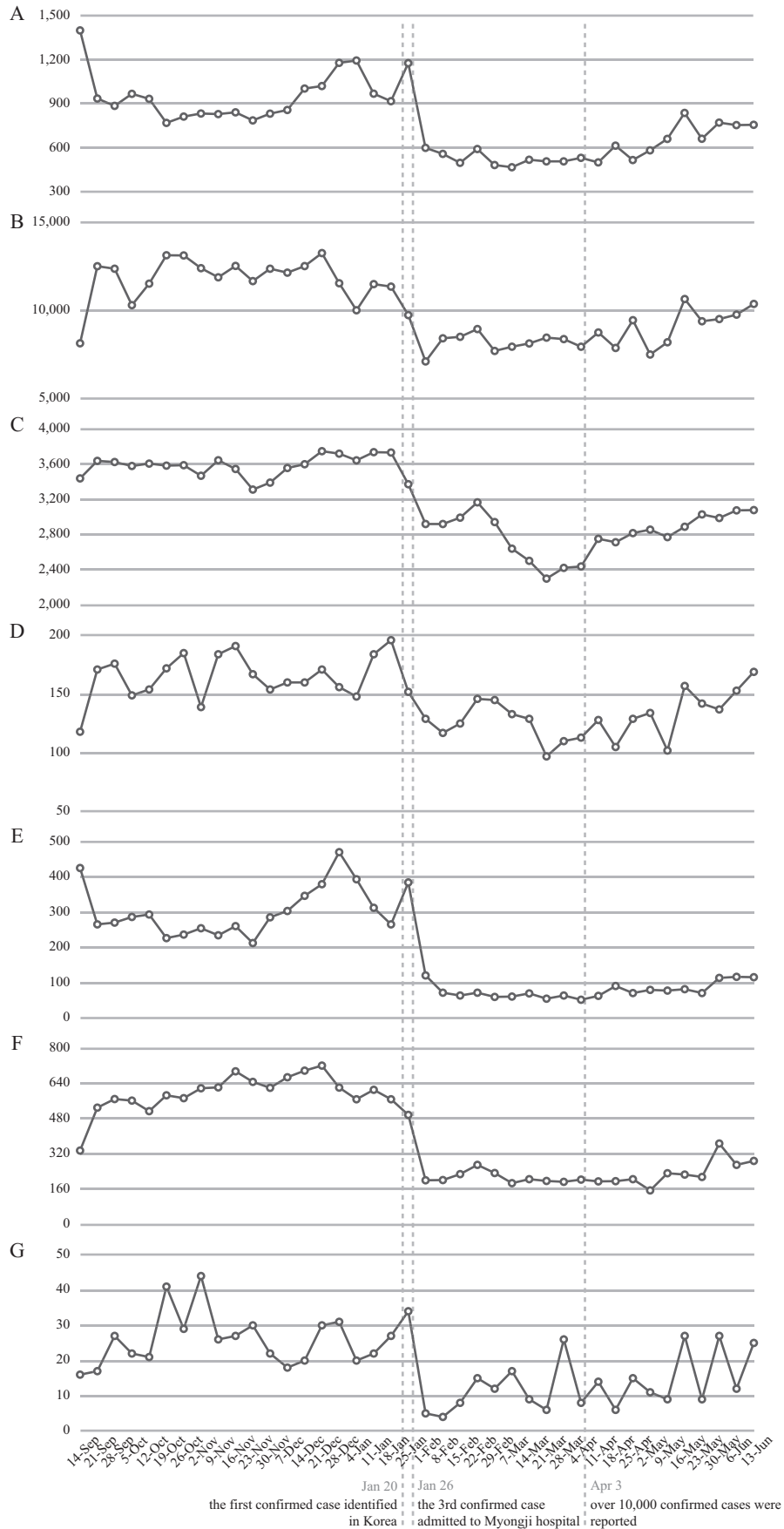


Figure 1. Changes in the weekly number of non-COVID-19 patients before and after the start of COVID-19 care.

Table 1
Changes in essential clinical care for non-COVID-19 patients before and after the start of COVID-19 care

Variables		Before (mean ± SD)	After (mean ± SD)	P
AMI	No./week	1.6 (± 1.3)	1.6 (± 1.1)	1.00
	DTB time (min)	34.3 (± 11.3)	22.7 (± 8.3)	< 0.01
Stroke	No./week	6.0 (± 1.3)	5.9 (± 2.1)	0.84
	DTN time (min)	55.7 (± 23.9)	54.0 (± 18.0)	0.80
	DTP time (min)	100.5 (± 32.1)	116.1 (± 30.9)	0.20
Severe trauma	No./week	1.9 (± 1.3)	1.9 (± 1.5)	1.00
Acute appendicitis	No./week	5.6 (± 2.2)	5.4 (± 2.2)	0.77
	DTO time (min)	181.2 (± 66.6)	208.9 (± 137.3)	0.06
	Hospital stay (day)	3.5 (± 3.5)	3.1 (± 1.9)	0.33
Chemotherapy	No./week	51.2 (± 16.5)	59.9 (± 10.8)	0.06
Radiation therapy	No./week	38.6 (± 15.4)	49.9 (± 22.5)	0.74
Haemodialysis	No./week	389.5 (± 11.9)	398.1 (± 9.7)	0.02

AMI, acute myocardial infarction; DTB, door-to-balloon time for coronary intervention; DTN, door-to-needle time for intravenous thrombolysis; DTP, door-to-puncture time for mechanical thrombectomy; DTO, door-to-operation time.

has tested positive in one facility, the patient could be potentially transferred to another hospital for treatment depending on the severity of their condition, the hospital bed utilization rate, and status of medical and human resources. Under these circumstances, the average daily number of COVID-19 patients in our hospital during the 5-month study period was 5.26, and the average bed operation rate was 43.8%. The existence of a central allocation system legislated by local government is one of the key factors preventing hospitals from being overwhelmed by COVID-19 patients. Korea, as a whole, has controlled the epidemic better than many other countries due to the strong emphasis on social distancing and self-isolation practices as well as adequate supply of personal protective equipment. Thus, the community prevalence of infection spread was controlled and managed very well.

The influx of paediatric patients decreased at a more rapid rate than that of the adults. An almost 50% decline in vaccination was cause for concern. However, this finding may not be directly attributed to the pandemic crisis. In Korea, vaccinations for children are available free of cost and administered at any public health centre, hospital or clinic. Therefore, the delay in mass immunization may not necessarily be attributed to decreased vaccination of children in our hospital. However, further investigation is needed to precisely determine the overall status of vaccination in the communities [7].

The DTB in AMI patients ironically diminished and was attributed to a reduction in the actual door-to-call time under conditions of a smaller patient volume presenting to the ED. The increased availability of procedure rooms owing to decreased elective procedural case load contributed to a significantly shorter calling-to-catheter time. The findings suggest that our hospital manpower and resources safely handled clinical cases even under conditions of potential infection spread.

There was no change in the number of chemotherapy and radiation treatments. In the case of haemodialysis, there was an increase in the care of patients after the start of COVID-19 from 389/week to 398/week ($P=0.02$), though the actual change in case number was small. The observed increase in patients requiring haemodialysis can be attributed to a direct influx from two nearby medical centres, as a result of closure due to an in-house cluster outbreak.

Other medical centres, such as Myongji, treating both infected and non-infected patients by operating nationally designated isolation bed units, are obligated to admit and treat all severe COVID-19 patients [8]. In such a situation, the operational strategies based on the DTHS model play an important role in preventing the shut-down as a result of poor in-house infection control.

Another variable in the implementation of a DTHS is compartmentalization of treatment areas [9]. The hospital resources are basically allocated among COVID-19 and non-COVID-19 patients in a 2:8 ratio. In our hospital, an area which holds 112 beds (20% of 560 beds) was allocated to the exclusive care of COVID-19 patients in a completely separate building apart from non-infected admissions. Operation of the buffer zone is another important element of DTHS to ensure safety and protection. The buffer zones accommodating patients requiring immediate and active hospitalization while awaiting confirmation of test results were subdivided into two zones for separate monitoring of patients with overt respiratory symptoms (BZ1) and those without (BZ2). During this study period, 9% and 37.5% of patients were hospitalized through BZ1 and BZ2, respectively.

Hospitals are facing a prolonged COVID-19 crisis and are exposed to a number of risk factors that hinder maintenance of their core functions, including a lack of medical resources, exhaustion of overworked medical staff, and financial challenges. A careful and creatively planned DTHS plays a key role in dispelling concerns of hospital safety among patients as well as protecting staff and visitors against potential spread of infection into the community at large. During a pandemic with unprecedented healthcare demands, it is crucial to understand the realities of providing essential medical services while combating further spread of infection by establishing appropriate countermeasures within the system.

Acknowledgements

The authors wish to acknowledge the following individuals for their valuable input: Sang Jun Park, Research Vice President; Jong-Ho Park, Professor of Neurology; Jong Min Kim, Assistant Professor, Department of Pediatrics; Dong Jin Oh, Professor of Department of Nephrology; Yun Hyeong Cho,

Professor, Department of Cardiology; Byung Jun Park, Professor, Department of Gynecology; all serve on faculty at Myongji Hospital, Hanyang University College of Medicine, Goyang, Korea.

Conflict of interest statement

We report no conflicts of interest relevant to this article.

Funding sources

None.

References

- [1] COVID-19: operational guidance for maintaining essential health services during an outbreak: interim guidance. World Health Organization; 2020. Available at: <https://apps.who.int/iris/handle/10665/331561>.
- [2] Foo CY, Bonsu KO, Nallamotheu BK, Reid CM, Dhippayom T, Reidpath DD, et al. Coronary intervention door-to-balloon time and outcomes in ST-elevation myocardial infarction: a meta-analysis. *Heart* 2018;104:1362–9.
- [3] Tan BYQ, Ngiam NJH, Sunny S, Kong WY, Tam H, Sim TB, et al. Improvement in door-to-needle time in patients with acute ischemic stroke via a simple stroke activation protocol. *J.Stroke Cerebrovasc Dis* 2018;27:1539–45.
- [4] Kim M, Kim SJ, Cho HJ. Effect of surgical timing and outcomes for appendicitis severity. *Ann Surg Treat Res* 2016;91:85–9.
- [5] Lim J, Jeon S, Shin HY, Kim MJ, Seong YM, Lee WJ, et al. Case of the index patient who caused tertiary transmission of COVID-19 infection in Korea: the application of lopinavir/ritonavir for the treatment of COVID-19 infected pneumonia monitored by quantitative RT-PCR. *J Korean Med Sci* 2020;35:e79.
- [6] Her M. How Is COVID-19 affecting South Korea? What is our current strategy? *Disaster Med Public Health Prep* 2020:1–3. <https://doi.org/10.1017/dmp.2020.69>.
- [7] Kim KH, Cho EY, Kim DH, Kim HW, Park JY, Eun BW, et al. Guidelines for Coronavirus Disease 2019 Response in Children and Adolescents. *Pediatr Infect Vaccine* 2020;27:24–34.
- [8] Her M. Repurposing and reshaping of hospitals during the COVID-19 outbreak in South Korea. *One Health* 2020;10:100137.
- [9] Yen MY, Schwartz J, King CC, Lee CM, Hsueh PR. Recommendations for protecting against and mitigating the COVID-19 pandemic in long-term care facilities. *J Microbiol Immunol Infect* 2020;53:447–53.