World Health Organization
Western Pacific Region

# WPSAR
Western Pacific Surveillance and Response Journal

Special Edition: COVID-19 Clinical Management and Health-care Pathways
Pages 1–39 | p-ISSN: 2094-7321 e-ISSN: 2094-7313

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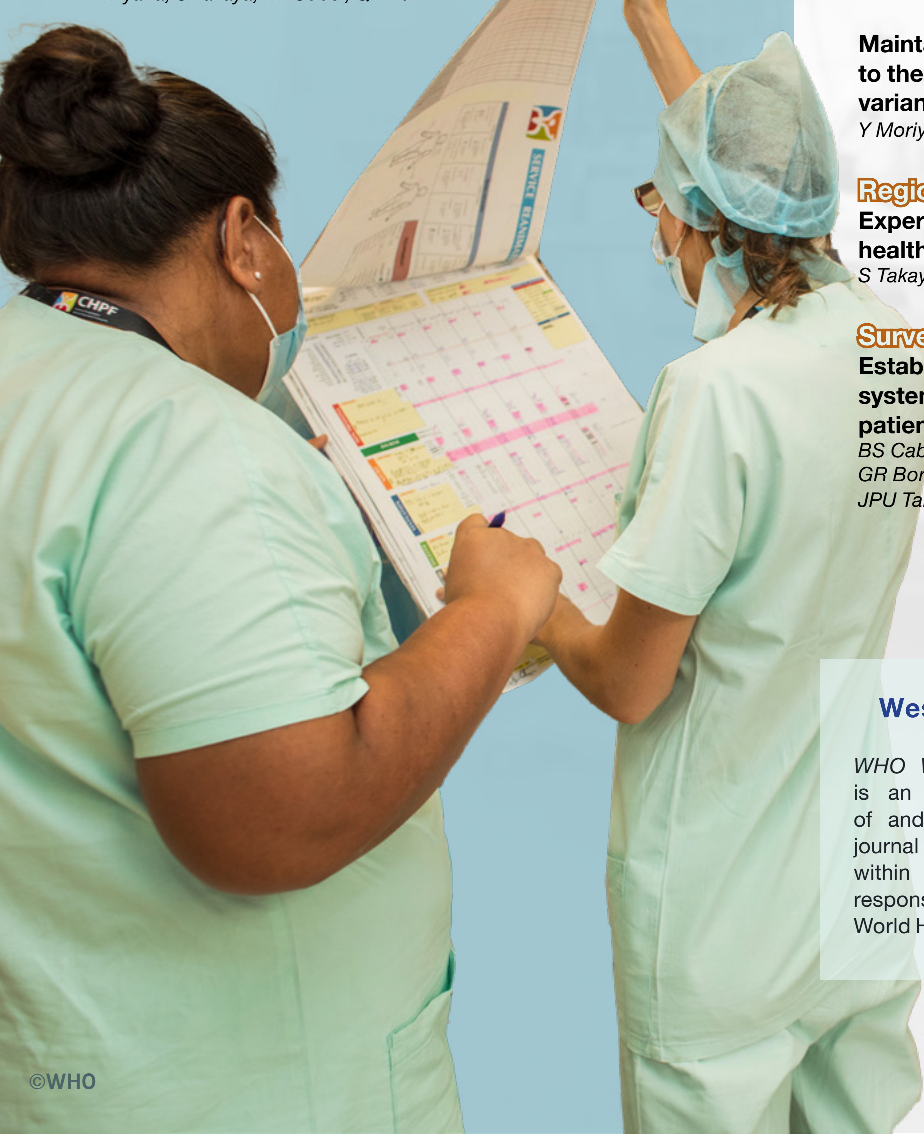
## IN THIS ISSUE






### Western Pacific Surveillance and Response

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p-ISSN: 2094-7321
e-ISSN: 2094-7313




## Disclaimer

# Urgent actions to save lives when ICU bed needs approach or exceed capacity: lessons from Mongolia

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At the beginning of the coronavirus disease 2019 (COVID-19) pandemic, Mongolia took early and stringent response measures that were considered successful until early 2021.[1,2] Following the lifting of a nationwide lockdown in April 2021, there was a rapid resurgence of cases from mid-May to mid-June (**Fig. 1**). By early June, COVID-19 hospital bed and intensive care unit (ICU) bed occupancy in the capital of Ulaanbaatar exceeded total capacity (**Fig. 2**). This impacted both health-care delivery for COVID-19 and other essential health services. At its peak, 2746 new cases (18 June 2021) and 17 deaths (3 July 2021) were reported in a single day, totalling 166 145 cases and 812 deaths as of 1 August 2021.[3]

Mongolia is a lower middle-income country with a population of 3.3 million widely distributed across a vast area of over 1.5 million km$^2$. Health service delivery is organized into national, provincial and sub-provincial levels. There is an average of 80 beds and 30 medical doctors per 10 000 population, with higher ratios in Ulaanbaatar than in the provinces.[4]

World Health Organization (WHO) clinical management guidelines recommend that COVID-19 care pathways be established at the national, subnational and local levels to treat patients in the right settings according to disease severity and risk.[5] However, the national distribution of COVID-19 patients of different disease severity across the health system has rarely been systematically monitored or documented in Mongolia.

In response to the increasingly overwhelmed health capacity, the Ministry of Health and WHO conducted a rapid systems assessment and took action on three key components: influx of patients, care pathway and exit. To manage the influx of new patients into care pathways, more stringent public health and social measures (PHSMs) such as restrictions on business operation and interprovincial movement were introduced from mid-June 2021. To increase care capacity, 1947 additional beds were mobilized by mid-June including approximately 100 additional ICU beds and newly established intermediate facilities and treatment centres in Ulaanbaatar. Intermediate facilities with oxygen supplies and temporary ICU beds accommodated primarily non-severe patients with risk factors for severe disease and severe patients who needed oxygen, while treatment centres provided care for severe and critical patients. Severe patients in intermediate facilities were referred to treatment centres as bed availability and their condition allowed. Despite these measures, bed occupancy was rapidly overwhelmed. By 14 June, 33 deaths were reported among patients with severe disease monitored at home who rapidly deteriorated.

WHO supported the Ministry of Health to map cases into a 3x4 table by disease severity and type of facility as per WHO clinical management guidance in Ulaanbaatar and provinces (**Fig. 3**).[5] Numbers of available beds and patients were reported by each health facility and collated on an online dashboard. A bed management team, comprised of seven members from the Ministry of Health, National Center for Communicable Diseases and the City Health Department, was established on 17 June to oversee health-care utilization at different levels of the health system and coordinate admissions and referrals to optimize the use of resources. By assessing the table

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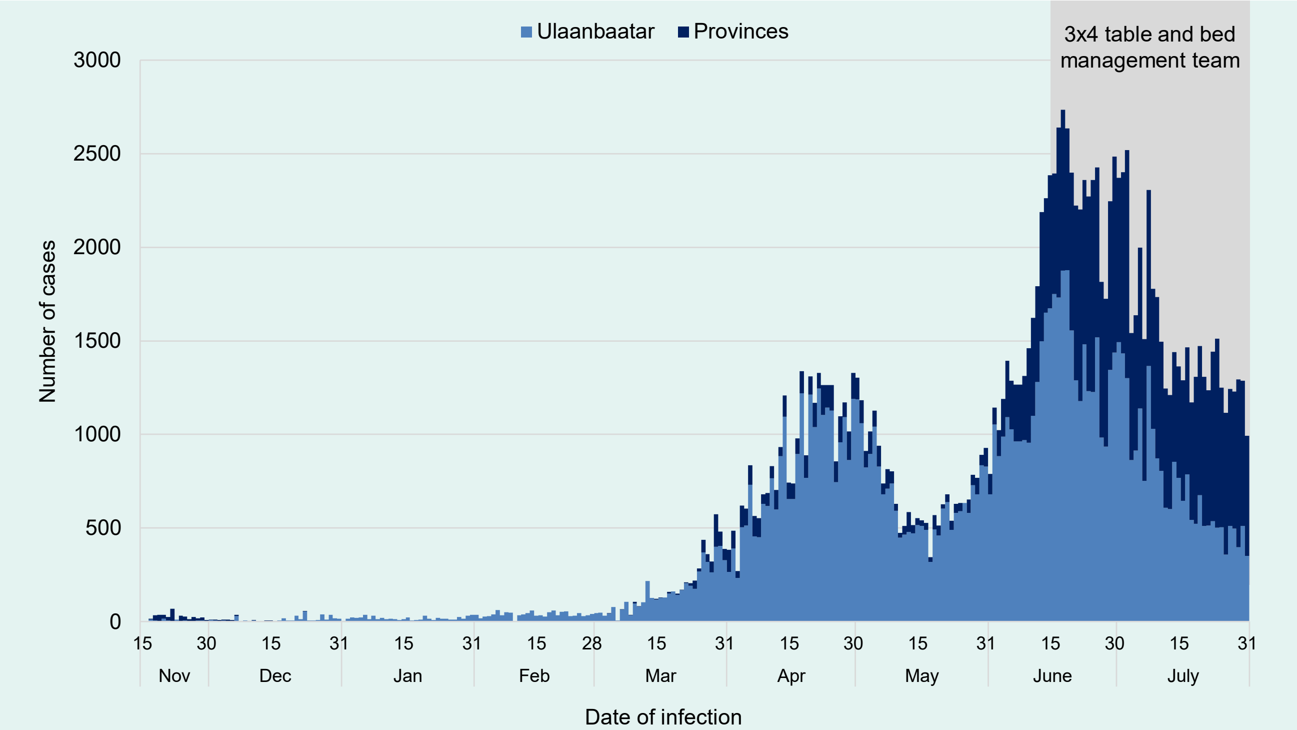
Published: 9 September 2022
doi: 10.5365/wpsar.2023.14.5.942

Fig 1. **Reported daily cases of COVID-19 by Ulaanbaatar and provinces, Mongolia, November 2020–July 2021**




Source: COVID-19 situation report for Mongolia #65: 01 August 2021. Manila: WHO Regional Office for the Western Pacific; 2021. Available from: https://www.who.int/mongolia/internal-publications-detail/covid-19-situation-report-for-mongolia-65, accessed 11 November 2021.

Fig. 2. **COVID-19 bed and ICU occupancy in Ulaanbaatar, 21 May–19 July 2021**

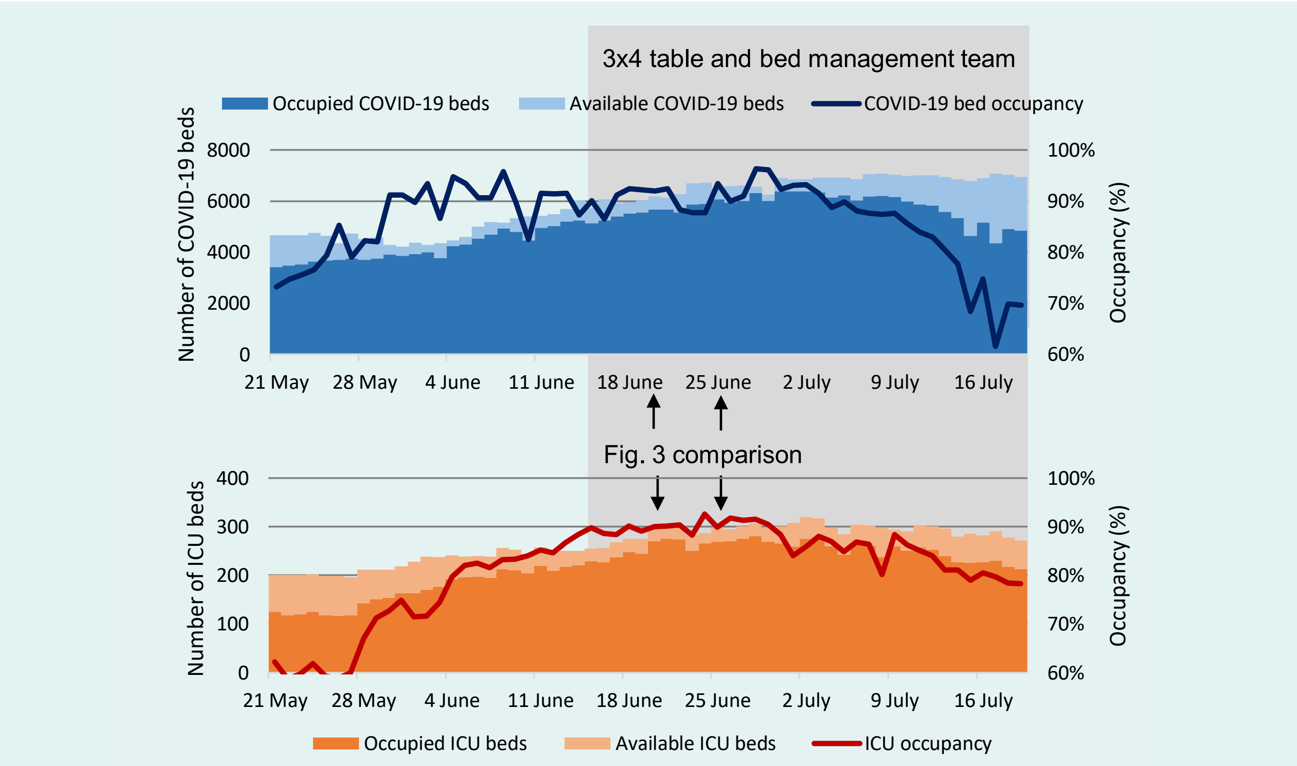


Fig 3. **Patient distribution by severity and facility for two time periods, 22 and 27 June 2021, Ulaanbaatar, Mongolia**

| 22 June | Asymptomatic non-severe (mild/moderate) | Severe | Critical |
|---|---|---|---|
| ICU beds 90.4%/303 | 0 | 75 | 199 |
| COVID beds 86.7%/5132 | 3576 | 876 | 0 |
| Intermediate facilities 65.9%/1841 | 1154 | 59 | 0 |
| Home-based care | 19 874 | 126 | 0 |
| Total | 24 604 | 1136 | 199 |

Waiting patients

| 27 June | Asymptomatic non-severe (mild/moderate) | Severe | Critical |
|---|---|---|---|
| ICU beds 91.5%/307 | 0 | 49 | 232 |
| COVID beds 98.3%/5003 | 4088 | 830 | 0 |
| Intermediate facilities 79.5%/1702 | 1294 | 60 | 0 |
| Home-based care | 25 095 (50 pregnant) | 0 | 0 |
| Total | 30 477 | 939 | 232 |

1. Admit severe waiting patients to hospitals.
2. Monitor disease severity for timely admission to ICU.
3. Discharge patients who do not require critical care in ICU.

from highest to lowest disease severity, three urgent actions were identified, agreed upon and implemented within 2 weeks.

First, all patients with severe disease who were at home were admitted. As of 22 June, the 3x4 table analysis identified 126 patients with severe disease who were at home waiting for hospitalization. Family doctors and district surveillance doctors were monitoring the severity of patients at home via in-person visits or over the phone. Between 22 and 27 June, all of these patients were hospitalized or kept at the newly built intermediate triage and treatment centre, which was equipped with temporary critical care resources including mechanical ventilators.

Second, patients with severe disease or risk factors for severe disease who were in non-ICU COVID-19 beds in hospitals and intermediate care facilities were closely monitored using pulse oximetry for timely admission to the ICU. While severe cases in general wards decreased from 876 to 830 between 22 and 27 June, 33 patients requiring critical care were identified and moved to the ICU.

Third, to create space in the ICU, patients who did not require intensive care were discharged. ICU patients were reassessed daily for disease severity and were discharged to COVID-19 general wards when appropriate. Of the 75 severe patients occupying ICU beds who did not require mechanical ventilation or vasopressor therapy, 26 were transferred to general wards. This increased efficiency in allocating limited critical care resources to patients who most needed them.

In the period following these actions, deaths decreased from a peak of 104 during the week of 28 June to 41 during the week of 19 July and further decreased thereafter. Through live monitoring of bed occupancy, the COVID-19 care pathway continued to be proactively fine-tuned after this initial phase.

By improving the efficient use of COVID-19 and ICU beds, space was made for patients with severe disease or risk factors for severe disease where monitoring was more intense and referral easier. This resulted in immediate reduction of waiting patients. Accomplishing this required that a strict definition of disease severity and corresponding care be ensured and applied, such as that in the WHO clinical management guidelines.

Fear of deterioration both among the public and clinicians, coupled with a financial incentive for hospitals to admit mild cases, were the main drivers behind inefficient bed management. Assuring safe home monitoring and timely admission and updating the reimbursement policy to require approval from bed management teams helped manage conflicting expectations and interests.

When service capacity is near or exceeding the maximum, urgent actions must be taken to minimize preventable deaths.[6] Clinical care pathways alone cannot solve the issue; a comprehensive systems approach, including PHSMs, point-of-entry measures and vaccination, is critical to augment severity-based efficient bed management. The 3x4 table mapping is a simple yet powerful framework to visualize the distribution of patients at different levels across the health system and help policy-makers and facility managers take urgent decisions to save lives.

The limitations of this approach include the possible misclassification of disease severity, data inadequacy and lateness, and the additional workload of monitoring in a disaggregated manner. It is also not possible to conclude if and to what extent the improved bed management contributed to minimizing preventable deaths.

To safeguard against surges overwhelming health systems and ensuring care for the right patients in the right settings, the hospital-centred COVID-19 care pathway needs to be adapted to be more comprehensive, integrating home and intermediate facilities. To that end, safe monitoring, timely referral and optimized bed management are key. For sustained management of COVID-19, it is critical to strengthen multi-source surveillance as described in the Asia Pacific Strategy for Emerging Diseases and Public Health Emergencies (APSED III), including health-care capacity to inform proactive policy decisions and adaptations to health-care pathways.[7]

## *Acknowledgements*

The authors acknowledge the support and guidance of Sergey Diorditsa, Monica Fong, Erdenechimeg Enkhee and Altanzagas Badrakh, WHO Representative Office for Mongolia.

## *Conflicts of interest*

The authors have no conflicts of interest to declare.

## *Ethics statement*

No ethical review is needed because only publicly available information was used.

## *Funding*

No specific funding was received to support this work.

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# How Ho Chi Minh City adapted its care pathway to manage the first large-scale community transmission of COVID-19

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Viet Nam experienced four waves of coronavirus disease (COVID-19) and by 30 September 2022 had recorded a total of 10.3 million cases and 43 057 deaths.[1] Nearly all of Viet Nam's COVID-19 cases (99.9%) were recorded during the fourth wave, which occurred between April 2021 and September 2022. This report describes actions taken in Ho Chi Minh City (HCMC), the largest city in Viet Nam and the epicentre of the fourth wave, to adapt its care pathway to address the largest surge in cases Viet Nam has faced to date.

## COVID-19 care pathway in the first three waves

The first wave of COVID-19 occurred between 22 January and 22 July 2020, with 415 reported cases and no deaths.[2] The second wave commenced on 25 July 2020 and lasted until 27 January 2021, and led to 1136 reported cases, 35 deaths and community transmission in 15 provinces and cities.[2] This wave included outbreaks in hospitals and deaths among patients with comorbidities. The third wave was shorter (28 January to 26 April 2021) and resulted in more cases (1301 reported cases) but no deaths.[2]

During the first three waves, Viet Nam implemented a "Zero-COVID" strategy. This involved extensive monitoring of new cases and contact tracing, the quarantining of exposed persons, strict lockdowns, hospitalization of all COVID-19 cases, and referral of all severe cases to central hospitals for expert management. This strategy enabled Viet Nam to minimize its COVID-19 deaths in the first year of the pandemic. However, the rapid spread of cases during the fourth wave overwhelmed the Zero-COVID strategy and necessitated a major change in the approach to the management of COVID-19 by everyone involved including doctors, nurses, family members and patients.

## COVID-19 care pathway during the fourth wave

The fourth wave began on 27 April 2021 and was dominated by cases caused by the Delta variant. By May, cases had spread to more than 30 provinces and cities. The largest outbreak was in the industrial parks of Bac Ninh and Bac Giang provinces, where the Delta variant spread extremely rapidly and overwhelmed the ability of hospitals to cope with the surge in case numbers.

To provide comprehensive and integrated care for all patients with COVID-19, regardless of symptoms and severity, Bac Giang province introduced a three-level care pathway. Asymptomatic persons and cases with mild symptoms were monitored at "first-level" field hospitals, located at repurposed district health centres and specialized provincial hospitals. Patients with minimal oxygen requirements or with comorbidities that put them at high risk of severe disease were treated at "second-level" facilities – COVID-19 treatment hospitals without intensive care units (ICUs). Designated COVID-19 treatment hospitals that had ICUs – "third-level" facilities – were reserved for patients with severe and critical COVID-19 disease.

[a] Ministry of Health, Hanoi, Viet Nam.
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Published: 30 September 2023
doi: 10.5365/wpsar.2023.14.5.1045

By June 2021, although Bac Ninh and Bac Giang provinces had managed to bring the outbreak under control, it had already spread to other provinces and cities, including HCMC where it caused the largest surge in Viet Nam. Initially, the city responded by introducing the same three-level care pathway as described above (**Fig. 1**). However, on 9 July 2021, the city issued an absolute stay-at-home order to its citizens[3,4] and added a fourth level to the care pathway – establishing specialist hospitals for managing COVID-19 patients with severe underlying diseases and who required specialized care.[5]

Other parts of the health system were also overwhelmed by the rapid rise in case numbers and required changes. In response to the increase in the volume of emergency calls, including requests for ambulances, HCMC expanded its call centre capacity from 1300 to 5000 calls per day.[6] Transportation services were increased from 23 to 323 vehicles by mobilizing 100 ambulances from private businesses and recruiting 200 taxis to take patients newly discharged from hospital back to their homes.[7] Taxi drivers were trained in basic infection prevention and control (IPC) measures including hand hygiene, medical mask wearing and car disinfection and cleaning.

On 13 July 2021, HCMC launched a pilot programme to provide home care for those with asymptomatic COVID-19. At the same time, more than 10 000 health-care workers (HCWs) from across the country were called upon to support the response in HCMC.[8] The Ministry of Health played a key role in the deployment of HCWs from other provinces, communicating closely with health-care facilities in HCMC to understand their needs and training HCWs in IPC and nursing care for COVID-19 patients before their deployment in HCMC. HCWs were closely monitored for onset of COVID-19 symptoms and underwent twice daily temperature checks.

When the daily average number of new cases surpassed 3000, HCMC reconfigured the care pathway for a second time by introducing a fifth level (**Fig. 1**).[9] Hotels, dormitories, schools and other public facilities were used as intermediate care facilities (ICFs) to treat those with asymptomatic infection or mild symptoms without underlying diseases or risk factors. ICFs were equipped to treat mild cases and to stabilize emergency cases before referral to a higher-level facility. Additionally, asymptomatic persons who were homeless, without caregivers or unable to implement IPC measures at home were admitted to ICFs.

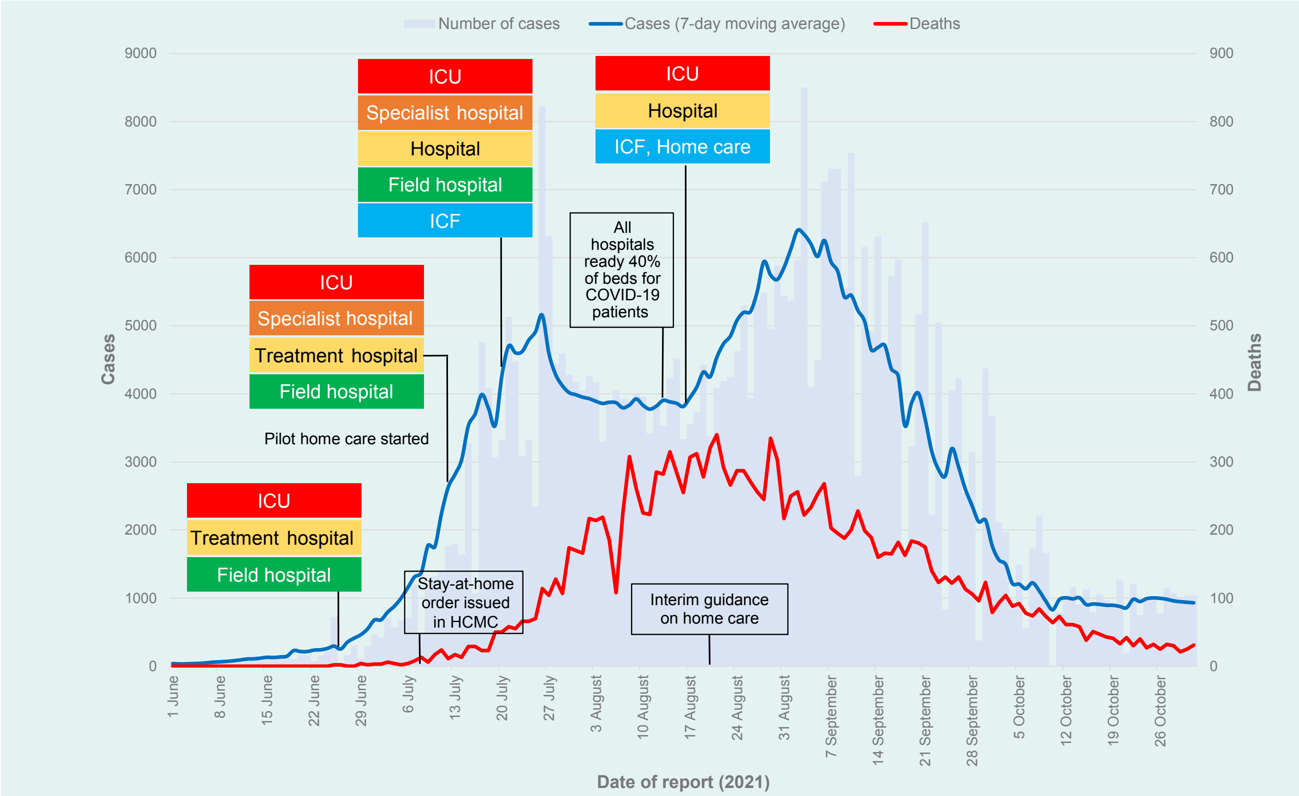
On 16 August 2021, as COVID-19 cases continued to increase, HCMC simplified the care pathway, reducing the number of levels from five back to three (**Fig. 1**). As part of the reconfiguration, home care and ICFs were combined to deliver first-level care. Case numbers started decreasing in September 2021. During the 5 months from June to October 2021, HCMC reported a total of 430 209 cases and 16 551 deaths (a case–fatality ratio of 3.8%).[1]

## Additional measures during the fourth wave

In addition to the timely reconfigurations of the care pathway described above (**Fig. 1**), the following evidence-based measures and support systems were introduced in HCMC to address the surge in COVID-19 cases during the fourth wave and minimize the impact on the health system:[8,10]

- The government mobilized 133 000 military personnel and 126 000 police officers.
- HCMC established 536 mobile health stations to provide rapid tests, vaccinations, first aid and referrals.
- A "network of physician companions" consisting of more than 10 000 medical staff and volunteers across the country provided counselling, health education and psychological support to COVID-19 patients and their families.
- By providing staff and equipment, central hospitals across the country helped to establish 12 ICU centres in HCMC, creating 7900 beds including 3000 intensive care beds.
- A warehouse was set up to supply medicines, equipment and other medical consumables to localities across HCMC.
- An online dashboard for real-time bed occupancy was established and made available to the public by the HCMC health department. This allowed the public to make more informed decisions about which hospital to go to for treatment.

Fig. 1. **Epidemic curve of COVID-19 cases and deaths with changes made to the care pathway, Ho Chi Minh City, 1 June to 31 October 2021**




HCMC: Ho Chi Minh City; ICF: intermediate care facility; ICU: intensive care unit.

- All hospitals, both public and private, were instructed to make up to 40% of their beds available for COVID-19 patients during the fourth wave.
- Interim guidance was issued on home care and the organization of mobile health stations, including the proper use of medication in home care.
- Political party authorities and other political leaders enhanced community engagement on COVID-19 response measures.

Furthermore, government authorities issued updated guidance to support adaptations to the care pathway in response to the evolving pandemic.[11] This information was widely disseminated in a timely manner through regular and ad hoc meetings and via the city's web site. Encouragement of community engagement by local leaders contributed to better understanding of COVID-19 and preventive measures.[11]

## DISCUSSION

In August 2021, at the peak of the fourth wave, HCMC recorded almost 8500 cases of COVID-19 in one day. Throughout the outbreak, both HCMC and the Viet Nam Ministry of Health demonstrated a strong commitment to combating COVID-19 and acted in a timely manner to address the increased demand for COVID-19 case management and referrals using a multisectoral approach. In HCMC, the COVID-19 care pathway was reconfigured several times, while thousands of HCWs and volunteers were mobilized to staff new mobile health units, the expanded ICU capacity and the many thousands of COVID-19 beds that were created as part of the COVID-19 response.

During the fourth wave of the pandemic, HCMC shifted away from a centralized, hospital-based case management model towards an integrated care pathway that used multiple levels of health care, including home care and ICFs. Based on the overall framework issued by the Ministry of Health, HCMC continually adapted its care pathway to respond to the real-time ongoing situation. This flexible approach to the care pathway ensured that the health-care delivery system was able to treat the "right patient at the right time," while avoiding being overwhelmed. High-level commitment and leadership ensured that both the government and society did their part to respond to the pandemic. This was key to HCMC's successful response to the fourth wave of COVID-19.[12]

In conclusion, the ability to make timely adjustments to the care pathway in response to rapidly changing local contexts through multisectoral engagement and high-level commitment helped Viet Nam to mount a successful COVID-19 pandemic response without overwhelming the health-care system.

## *Acknowledgements*

The authors acknowledge the support and guidance of Takeshi Nishijima and Masahiro Zakoji at the WHO Regional Office for the Western Pacific, and staff at the WHO Representative Office for Viet Nam.

## *Conflicts of interest*

The authors have no conflicts of interest to declare.

## *Ethics statement*

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## *Funding*

None.

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# Coronavirus disease and home recovery: a Singapore perspective

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**Objective:** At the beginning of the coronavirus disease (COVID-19) pandemic in Singapore, the strategy initially involved aggressive ring-fencing of infections, before pivoting towards managing recurrent local interspersed outbreaks of COVID-19. A key feature of Singapore's efforts to preserve health-care capacity was the implementation of the nationwide Home Recovery Programme (HRP), whereby patients were allowed to recover at home as long as they met certain criteria. The programme was centrally coordinated by Singapore's Ministry of Health and was supported by telemedicine providers, primary care physicians and government agencies. This report aims to highlight Singapore's experience in coordinating and implementing the HRP, the challenges faced and the outcomes.

**Methods:** Published and internal data from the Ministry of Health in Singapore, along with policy documents, were reviewed together with a brief literature review of similar programmes conducted globally.

**Results:** Implementation of the HRP led to the majority of patients (98%) recovering from COVID-19 in the outpatient setting, with similar mortality rates to inpatient settings. Hospitalization rates for COVID-19 cases were reduced as compared to previously, alleviating strain on the health-care system.

**Discussion:** The HRP was largely successful at preventing health-care capacities from being overwhelmed, while keeping fatalities to a minimum. Nonetheless, the risks of emergent variants of concern remain present, and heightened vigilance and potential modification of existing protocols based on fluctuations in virulence and infectivity are still needed.

As of 14 February 2023, there have been more than 756 million confirmed cases of coronavirus disease (COVID-19) and 6.84 million deaths related to COVID-19 across 200 countries and territories.[1] Singapore was one of the first countries where COVID-19 was detected.[2] As of 8 February 2023, the proportion of Singapore residents who had been officially diagnosed with COVID-19 was 37.5% ($n$ = 2 220 534),[3] although the actual proportion of infections from seroprevalence studies is estimated to be 60%.[4] With 1722 fatalities,[3] Singapore's mortality rate of 0.07% was one of the lowest in the world.

During the initial phase of the pandemic, Singapore's Ministry of Health (MOH) adopted a policy of compulsory hospital admission and quarantine of all suspected and confirmed COVID-19 cases. As the pandemic progressed, Singapore transitioned towards "living with endemic COVID-19". As part of this policy shift, home-based recovery became the default for low-risk COVID-19 patients, and a national Home Recovery Programme (HRP), which sought to ensure sufficient health-care capacity at all levels while minimizing morbidity and mortality rates, was implemented. In this brief field investigation report, we summarize the concept of the HRP, the development of its risk-stratification algorithms, experience in implementation, outcomes and future challenges.

## METHODS

A PubMed and Ovid MEDLINE search was performed with the terms "COVID-19", "Pandemic", "Home Recovery" and "Singapore" for peer-reviewed English-language

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Published: 30 September 2023
doi: 10.5365/wpsar.2023.14.5.1003

articles published between 20 January 2020 and 2 March 2023. We also reviewed internal data and policy documents from MOH, along with information from other government sources and media releases.

## RESULTS

### Home Recovery Programme

Prior to 10 October 2021, all COVID-19 cases in Singapore were triaged into three tiers of facility-based dispositions: community isolation facilities (CIFs), COVID-19 treatment facilities (CTFs) and hospitals. CIFs were facilities for COVID-19 patients who only had mild symptoms but could not isolate at home due to non-medical reasons, while CTFs were facilities with health-care and nursing support that were designed to monitor patients with chronic illnesses who were at risk of deterioration but remained clinically stable. Therefore, low-risk individuals were isolated at CIFs, intermediate-risk individuals were cared for at CTFs, and hospitals were largely reserved for high-risk or acutely unwell individuals. The triaging system implemented was contextualized to suit Singapore's local needs, to ensure optimal patient placement and delivery of care, while being cognizant of Singapore's high population density and high basal bed-occupancy rates for non-COVID-19 cases in hospitals.

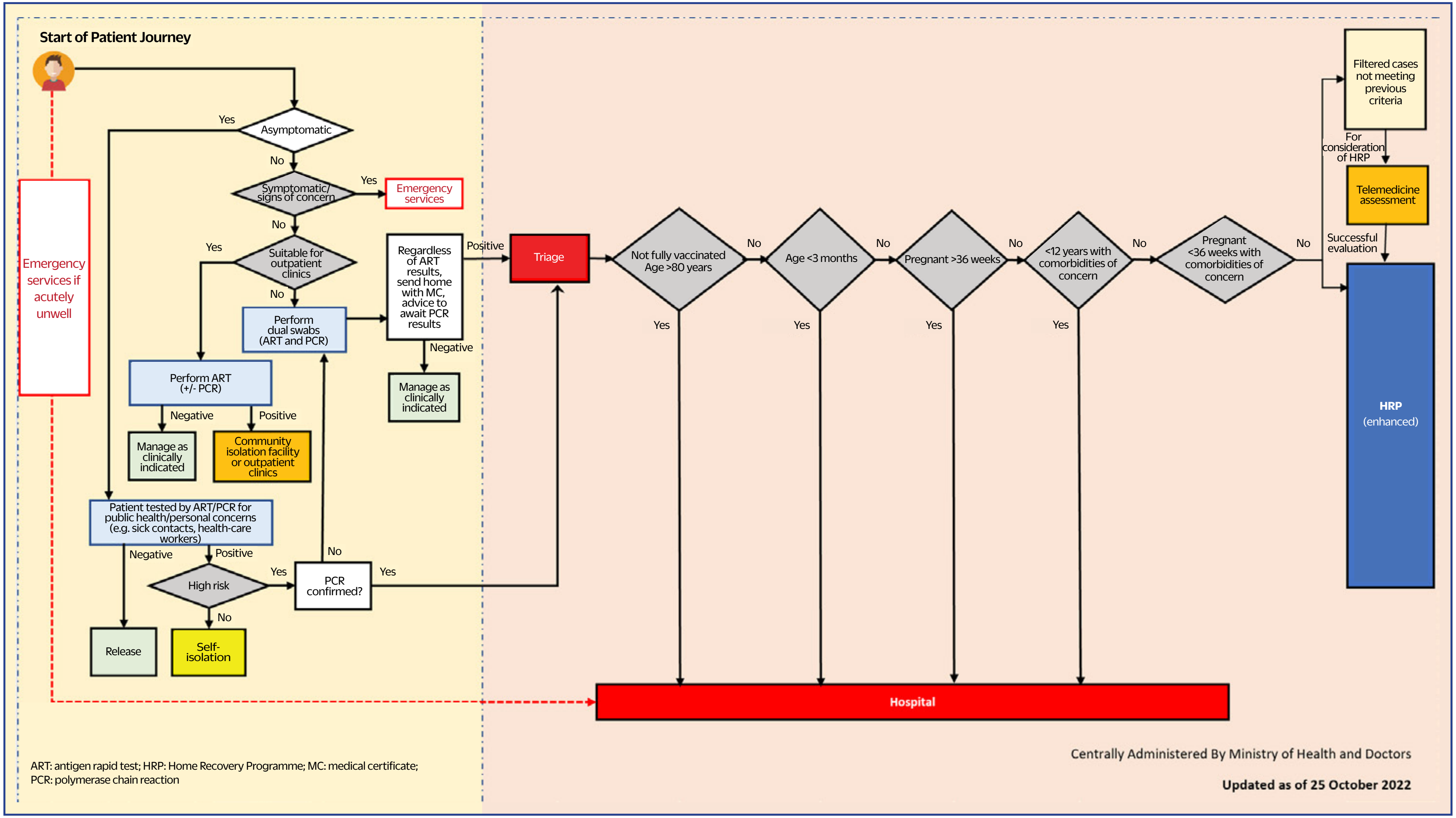
Beginning on 10 October 2021, a policy transition towards home-based recovery was implemented across two main phases spanning the Delta (from October 2021 to January 2022) and Omicron (from January to June 2022) waves in Singapore. In the first phase, MOH instituted and administered a national triaging and patient care programme, the HRP, by engaging telemedicine providers and employing technology to remotely triage all newly diagnosed COVID-19 cases, thereby reducing or obviating the need for face-to-face clinical assessments. The HRP triaging system was centrally administered using a hybrid model combining teleconsultation with automation. The centrepiece of this triage was the National Sorting Logic (NSL), which is a stepwise risk-stratification algorithm that serves to determine the initial disposition of each COVID-19 case (**Fig. 1**). The NSL was developed and periodically updated after analysing local and international data, in consultation with local primary care, infectious disease and public health experts.

Essentially, clinical assessment and triage considered five factors: **C**omorbidities of concern, **A**ge, **V**accination status, **E**xamination/Clinical findings and **S**ymptoms (CAVES). Aided by data integration across national databases, individuals were automatically screened according to their age and vaccination status at the time of diagnosis. High-risk individuals were excluded from the HRP, while remaining patients were further triaged via an online questionnaire that identified potentially vulnerable patients based on comorbidities such as severe immunosuppression and chronic diseases (**Table 1**). The questionnaire was highly simplified, requiring only "yes/no" responses, and was translated into all four official languages of Singapore (English, Mandarin, Malay and Tamil). Individuals who answered "no" to all questions were classified as "very low" risk and were enrolled and cared for under the HRP, while individuals with any "yes" responses underwent additional clinical assessment by a telemedicine provider or doctor to assess suitability for the HRP. Similar risk stratification criteria have been used in other countries such as the United States of America[5] and the United Kingdom of Great Britain and Northern Ireland.[6]

In their care of patients, telemedicine providers operated from a centralized online Telemedicine Allocation and Reconciliation System that served as the COVID-19 case management system and centralized medical records repository for all COVID-19 teleconsultations.[7] This consolidated approach allowed for seamless access to data and the tracking of the HRP's outcomes by MOH.[8] As more data were collected, the NSL was further revised to allow a greater proportion of patients to be safely enrolled in the HRP without needing physical clinical assessment, preserving medical resources without compromising safety.

With the HRP laying the foundation and in anticipation of a larger Omicron wave, MOH further expanded home-based recovery by empowering primary care physicians to care for individuals in the community whether at low or intermediate/high risk for severe COVID-19, if the patients were clinically stable. Primary care physicians were still able to refer intermediate or high-risk patients for telemedicine based on clinical discretion. National clinical and therapeutic guidelines[9,10] were developed and disseminated to the Singapore health-care community. Of note, primary care physicians were then able and encouraged to prescribe antiviral treatments, such as nirmatrelvir/ritonavir and molnupiravir, to eligible high-risk patients.[11] Besides primary care, oral antiviral treatments were also made available at emergency

Fig. 1. **National sorting logic for COVID-19 Home Recovery Programme, 25 October 2022**




ART: antigen rapid test; HRP: Home Recovery Programme; MC: medical certificate; PCR: polymerase chain reaction

Table 1. **CAVES[a] questionnaire used in Singapore, from 15 February and from 22 October 2022**

| **15 February 2022** | |
|---|---|
| **High risk – not suitable for HRP** | **Symptoms of concern (excluding patients from HRP)** |
| Prevailing ineligible criteria for adults:<br>• Not fully vaccinated, ≥80 years old<br>Comorbidities of concern:<br>• Bone marrow/solid organ transplant<br>• Active/current cancer on chemotherapy/treatment<br>• Leukaemia/lymphoma or other haematological malignancies<br>• Disease or medications that suppress the immune system<br>• Advanced/untreated HIV/AIDS<br>• End-stage kidney disease on dialysis<br>• Chronic organ disease at high risk of decompensation, e.g. chronic obstructive pulmonary disease, heart failure, liver failure | • Shortness of breath<br>• Chest pain<br>• Acute stroke symptoms<br>• Palpitations<br>• Symptoms suggestive of deep vein thrombosis<br>• Severe headache not relieved by analgesics<br>• Persistent diarrhoea/vomiting/poor oral intake |
| **Intermediate risk – for closer monitoring via HRP (enhanced)** | **Signs of concern (excluding patients from HRP)** |
| • Obesity (BMI >35 or >100 kg)<br>• Poorly controlled diabetes mellitus<br>• Pregnancy<br>• Not fully vaccinated, 70–79 years old<br>• Fully vaccinated, ≥80 years old | • Tachycardia >100<br>• Tachypnoea >20<br>• Hypotension <100 mmHg<br>• SpO2 <94% |
| **22 October 2022** | |
| **High risk – not suitable for HRP** | **Symptoms of concern (excluding patients from HRP)** |
| Prevailing ineligible criteria for adults<br>• Not fully vaccinated, ≥80 years<br>Comorbidities of concern:<br>• High-risk immunocompromised<br>  ▫ Daily corticosteroid therapy with dose >20 mg (or >2 mg/kg/day for patients <10 kg) or prednisolone or equivalent for >14 days<br>  ▫ Non-steroidal immunosuppressants<br>  ▫ Solid organ cancer on active chemotherapy or with neutropenia<br>  ▫ Solid organ transplants<br>  ▫ Haematopoietic stem cell transplants <5 years duration or on immunosuppressants<br>  ▫ Combined primary immunodeficiency<br>  ▫ HIV infection with CD4 count <200 cells/mm$^3$ (or <15%) and not virologically suppressed<br>• Chronic organ disease at high risk of decompensation, e.g. chronic obstructive pulmonary disease, heart failure, liver failure<br>• End-stage kidney disease on dialysis with comorbidities listed above<br>• Pregnant at ≥36 weeks gestational age or <36 weeks gestational age with complications or comorbidities listed above | • Shortness of breath<br>• Chest pain<br>• Acute stroke symptoms<br>• Palpitations<br>• Symptoms suggestive of deep vein thrombosis<br>• Severe headache not relieved by analgesics<br>• Persistent diarrhoea/vomiting/poor oral intake |
| **Intermediate risk – for closer monitoring via HRP (enhanced)** | **Signs of concern (excluding patients from HRP)** |
| • Obesity (BMI >35 or >100 kg)<br>• Poorly controlled diabetes mellitus<br>• Pregnancy<br>• Not fully vaccinated, 70–79 years old<br>• Fully vaccinated, ≥80 years old | • Tachycardia >100<br>• Tachypnoea >20<br>• Hypotension <100 mmHg<br>• SpO2 <94% |

HRP: Home Recovery Programme.

[a] Comorbidities of concern, Age, Vaccination status, Examination/Clinical findings and Symptoms.

departments, nursing homes, CIFs and acute hospitals, and their availability facilitated community recovery. This preserved the limited telemedicine and facility-based resources to focus on the intermediate- to high-risk group and prevented hospitals from being overwhelmed.

Concurrently, effective public health messaging and awareness campaigns were also conducted, encouraging patients to recuperate at home and adhere to self-isolation and testing protocols. These included using a combination of mainstream media (television, radio and print) and social media (Instagram, Facebook, WhatsApp and Telegram) for mass outreach. Of note, MOH set up, maintained and publicized only one official COVID-19 website (https://www.moh.gov.sg/covid-19) to serve as a single point of reference for the public to obtain up-to-date information on all COVID-19-related health-care policies and key information on what to do when diagnosed with COVID-19. Following a whole-of-government approach, duplicate websites were avoided to minimize conflicting information and facilitate accurate and timely information dissemination, especially during policy transitions.

### Vaccination

Key to home-based recovery was robust vaccination uptake, with 92% of Singaporeans completing their primary series (defined as two mRNA or Novavax-Nuvaxovid doses, or three Sinovac-CoronaVac doses) and 82% of Singaporeans with minimum protection (defined as three mRNA or Novavax-Nuvaxovid doses, or four Sinovac-CoronaVac doses) as of January 2023.[3] With the initial lack of consensus surrounding the optimal number of vaccine doses for adequate protection, especially for the elderly with reduced humoral and cellular immunity, a local study confirmed that a third vaccine dose served to improve immune responses such as memory B-cell and T-cell responses towards the wild type ancestral strains and its variants Delta and Omicron.[12] This helped shape the definition of minimum protection being three mRNA doses as defined previously. Data from another study informed that an additional booster with a live-attenuated vaccine such as Sinovac-CoronaVac was required to achieve protection in patients with an initial vaccine primary series of two mRNA vaccinations, which is also correspondingly reflected in the need for an additional booster for those patients receiving Sinovac-CoronaVac.[13] Local population data confirmed that most vaccinated patients experienced only mild symptoms and could recover with minimal medical support.[14] This was further substantiated by evidence of the milder clinical manifestation of Omicron and its various subvariants relative to previous variants despite their increased transmissibiity.[15] An additional mRNA booster, to complete a regimen of four mRNA doses, had also been shown locally to be effective in reducing the risk of hospitalization and severe disease among the elderly aged ≥80.[16] This provided further impetus for the HRP along with continued public messaging encouraging the elderly to keep their vaccinations up to date.

### Outcomes

Through consistent public messaging, vaccination promotion and leveraging technology, MOH was able to gradually ease public behaviour and mindsets, preserve national health-care capacities, ensure evidence-based policy adjustments, and maintain low mortality rates throughout the implementation of the HRP. More than 93% of all cases managed to fully recover at home under the programme during the Delta wave (October to December 2021). This proportion increased to 98% during the Omicron wave (January to June 2022), with more patients fully recovering at home under the HRP and primary care.[17] During the period when the HRP was implemented (October 2021 to June 2022), there were 1318 deaths out of 1 617 535 cases, for an overall mortality rate of 0.08%.

## DISCUSSION

### Initial challenges and experience in implementation

The implementation of the HRP encountered several challenges, including the definition of comorbidities of concern in the screening checklist,[17] along with operational issues in coordination during the surge in COVID-19 cases during the initial roll-out period.[18] To accurately describe "comorbidities of concern" in the screening questionnaire, the list of comorbidities that MOH's Expert Committee on COVID-19 vaccinations had earlier defined was referenced, while also formulating distinct risk categories for certain conditions. For instance, an initial pragmatic body mass index threshold of ≥35 for obesity was set, taking into consideration the weight distribution in Singapore. However, subsequently a more straightforward cut-off point of 100 kg was selected for the sake of simpler execution. As for operational issues encountered during the implementation of the HRP, additional agencies such as the Singapore Armed Forces and the People's Association (a statutory board that promotes social cohesion among neighbourhood committees) were enlisted to increase support for telemedicine and patient communications.[19]

## Future challenges

Through effective utilization of technology, mobilization of primary care and government agencies, widespread vaccination, and the deployment of therapeutic countermeasures, Singapore successfully implemented its novel HRP strategy nationwide, preserved health-care capacities and ensured minimum fatalities. It is anticipated that with the maintenance of up-to-date vaccinations and the wider use of oral antivirals in higher-risk patients, the mainstay of COVID-19 care will continue to be largely managed by patients at home or in primary health-care settings. More real-world data will be needed, however, to inform future vaccination strategies for COVID-19 after a primary course or initial boosters are completed, and to define the cost effectiveness and optimal deployment of oral antiviral treatments.

## Conclusion

Regardless of the uncertainty, the lessons learned and strategies developed thus far will likely remain relevant in dealing with future variants or pandemics. Singapore's experience shows that it is possible to minimize morbidity and mortality in an unprecedented pandemic. It involved a combination of responsive and calibrated public health policies informed by science. The concept of the HRP, enabled by an NSL, should remain adaptive and ready to respond to new variants of concern with differing characteristics and to future pandemics.

### *Acknowledgments*

The authors thank Dr Joshua Tan from the Crisis Strategy and Operations Group as well as the National Public Health and Epidemiology Unit for their assistance with data and inputs for this manuscript.

### *Conflicts of interest*

The authors have no conflicts of interest to declare.

### *Ethics statement*

This study was exempt from ethical approval from the authors' institutions.

### *Funding*

None.

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# Implementation and use of a national electronic dashboard to guide COVID-19 clinical management in Fiji

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**Problem:** From April to September 2021, Fiji experienced a second wave of coronavirus disease (COVID-19) precipitated by the Delta variant of concern, prompting a need to strengthen existing data management of positive COVID-19 cases.

**Context:** With COVID-19 cases peaking at 1405 a day and many hospital admissions, the need to develop a better way to visualize data became clear.

**Action:** The Fiji Ministry of Health and Medical Services, the World Health Organization and the United Nations Office for the Coordination of Humanitarian Affairs collaborated to develop an online clinical dashboard to support better visualization of case management data.

**Outcome:** The dashboard was used across Fiji at national, divisional and local levels for COVID-19 management. At the national level, it provided real-time reports describing the surge pattern, severity and management of COVID-19 cases across the country during daily incident management team meetings. At the divisional level, it gave the divisional directors access to timely information about hospital and community isolation of cases. At the hospital level, the dashboard allowed managers to monitor trends in isolated cases and use of oxygen resources.

**Discussion:** The dashboard replaced previous paper-based reporting of statistics with delivery of trends and real-time data. The team that developed the tool were situated in different locations and did not meet physically, demonstrating the ease of implementing this online tool in a resource-constrained setting. The dashboard is easy to use and could be used in other Pacific island countries and areas.

## PROBLEM

From April to September 2021, Fiji experienced its second and largest wave of coronavirus disease (COVID-19), peaking in July 2021 at 1405 cases in one day. The country's health system was overstretched by COVID-19 testing and triage, with up to 300 hospital admissions per day, reinforcing the need for infection prevention and control measures and resources to treat critical patients. The situation challenged health facilities' ability to regularly report on hospital census data and management of COVID-19 cases. Lack of timely hospital information made it difficult to monitor adherence to preparedness and response plans and clinical management guidelines developed by the Fiji Ministry of Health and Medical Services (MHMS); it was also difficult to adapt to suit the changing situation at the divisional and national levels.[1] It became evident that there was a need to strengthen existing COVID-19 hospitalization reporting systems and data analysis. In addition, visualization of the data in real time could help clinicians and public health staff to respond promptly to the unfolding situation.[2]

## CONTEXT

Before the COVID-19 pandemic, the Fiji MHMS used an electronic health information system known as the Patient Information System (PATIS)[3] to monitor health service

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Published: 22 February 2023
doi: 10.5365/wpsar.2023.14.5.967

delivery in major hospitals and health centres. However, data from PATIS are summarized manually[3] and reported monthly from the subdivision level, which prompted each division (regional area) to develop its own method for COVID-19 hospitalization monitoring and reporting.[3–5] The various methods were largely paper based and involved increased data entry and analysis so that they could be presented in a PowerPoint format at daily national incident management team (IMT) meetings. The greater workload for health-care workers and the limited capacity for data extraction and analysis meant that a better COVID-19 case management reporting system was needed to enable timely information on COVID-19 admissions from the facility to the national level.

## ACTION

In August 2021, the Fiji MHMS, the World Health Organization (WHO) and the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA) collaborated to create an electronic COVID-19 clinical management dashboard to track COVID-19 case severity, bed occupancy, availability of medical oxygen and oxygen delivery equipment, and management of cases isolating at home. A dashboard is defined as a single-screen visual representation of data from several sources that uses graphics and tables to display qualitative and quantitative indicators.[6]

A multidisciplinary team that included clinicians, data experts and epidemiologists from different organizations (including Fiji MHMS, WHO and UN OCHA) collaborated remotely to develop the dashboard. Key objectives of the COVID-19 clinical dashboard were to track the isolation and case management of confirmed COVID-19 cases, monitor the application of the clinical care pathway and manage clinical care resources to sustain the country's existing health-care capacity. An initial prototype of the dashboard was developed using sample data. The prototype was reviewed by the health facilities before further refining the data collection form to facilitate its daily use. To ensure that a technology is usable and achieves its intended purpose, end users must be involved throughout the design process.[6] The literature on dashboard conception and design suggests a timeline of 6–12 months;[7] however, our dashboard was implemented within 4 weeks.

Data collection was a twofold process: baseline data captured existing health facility capacity to manage COVID-19 cases, then dynamic data captured daily numbers of COVID-19 cases being monitored in hospitals and daily use of resources. The data collection fields captured hospital information, available beds, beds in use, patient occupancy, COVID-19 admissions (disaggregated using WHO clinical severity guidelines), COVID-19 deaths, oxygen availability and oxygen use.

The process of data collection replicated existing processes, with staff appointed by the health facilities or MHMS uploading information about COVID-19 cases isolating in health facilities and in the community to a Google form each day. Access to the Google form link was limited to users verified by the teams at WHO or MHMS, to streamline data entry and prevent errors. The process was piloted in two major hospitals before being expanded to include all health facilities in Fiji. In September 2021, data management officers were recruited at the national level to oversee data quality and assist in monitoring COVID-19 hospital analysis for IMT reporting.

End users were given a link to view the dashboard; this allowed them to view current data from their own device. In this context, end users were nursing and medical heads of hospital departments and public health managers at the Fiji MHMS. As end users became more familiar with the dashboard and the data required to inform clinical and care pathway decision-making, further changes were made to the dashboard. These changes included the addition of home isolation in September 2021, with data on the number of COVID-19 cases isolating at home, their risk for severe disease (high, moderate or low) and recovered cases and deaths. In October 2021, the tool was expanded to track the monitoring and visits to COVID-19 patients in home isolation. Once the consultation period had finished and the dashboard was in consistent use, a nationwide webinar was convened on interpretation of the dashboard and ongoing online support was provided for users.

The dashboard complemented other tools and platforms used during the pandemic response such as daily morning briefs, standard operating procedures and clinical guidelines to inform and support decision-making in the overall response. The dashboard replaced a paper-based system that required time and expertise, and it made visualization of the data easier for the Fiji MHMS. Whereas the paper-based approach to reporting data was punctuated by delays and inconsistencies in reporting, this real-time mode of the dashboard allowed more immediate actions in response to the data.

## OUTCOME

The current iteration of the Fiji dashboard presents information on number of new COVID-19 hospital admissions, positive COVID-19 cases by symptom severity and place of isolation (hospital, non-hospital or home), number of COVID-19-related deaths, use and availability of oxygen resources, and monitoring of the status of positive cases in home isolation. The dashboard is customizable to geographical location, facility type and facility name, enabling all users at local, divisional and national levels to use the same dashboard to meet their needs and inform their response.

### Application at the local level

The dashboard was used by hospitals across the country to guide case management. It provided real-time visibility of COVID-19 patients in hospital and non-hospital isolation. Divisional hospitals could use the dashboard to monitor severe and critical cases at lower-level facilities (e.g. subdivisional hospitals or intermediate care facilities), and identify cases that might require transfer to higher-level care, supporting resource planning.

The dashboard provided further visibility of positive COVID-19 cases in home isolation, which triggered discussions in daily morning briefs about monitoring and management of high-risk patients in home isolation, and assisted in planning home monitoring and referrals. Such discussions helped to identify service gaps such as lack of transport or staff; they also provided the opportunity to assist teams challenged with logistics and other resources.

The dashboard informed the allocation of important resources. For example, disease severity informed the skill mix of hospital staff to match clinical care demands. Oxygen-use data allowed hospital management to source and allocate supplies and necessary equipment to ensure that oxygen was available to patients when needed. Information on disease severity included on the dashboard helped in allocating patients to the most appropriate health facility for the level of care required. Such decisions help facilities and health authorities to make the best use of existing resources.

### Application at the divisional (regional) level

The dashboard allowed clinical and public health managers or leaders to view trends such as increases in COVID-19 cases in health facilities across the country in real time. Thresholds on ward occupancy and oxygen use provided by the dashboard supported decisions to activate surge-capacity plans in anticipation of an increase in demand for resources.

### Application at the national level

At the national level, the dashboard was part of incident management reporting and COVID-19 technical planning meetings. Fiji's IMT reviewed the dashboard together with COVID-19 surveillance data to monitor and manage the response strategy. Community surveillance data provided information on the scope of the outbreak, while the dashboard highlighted the impact of the outbreak on health-care demand. At the height of the second wave, health facilities quickly reached maximum bed capacity and Fiji's health-care resources were overstretched. At the national level, this triggered IMT to adapt the national clinical care pathway to prioritize hospitalization of critical and severe COVID-19 cases and introduce home isolation for mild and moderate cases. The dashboard was used to monitor this shift in response strategy, and an overall decline in hospital admissions was seen. As COVID-19 patient admissions declined, facilities could dedicate resources back to non-COVID-19 health-care needs, and the health workforce was better equipped to meet demand.

The dashboard also helped to strengthen communication between the community and health facilities to identify opportunities for improving response mechanisms. Capturing COVID-19 deaths in the dashboard – disaggregated by community, hospital and death before arrival – highlighted where COVID-19 deaths were occurring. An observed rise in deaths before arrival at health facilities led to a mortality review. The review found there were potential delays in seeking care and emphasized the need for increased community engagement and communication on when and how to access care.

The introduction of the dashboard into national COVID-19 reporting and planning provided evidence to guide decision-makers on the necessary interventions to counteract the adverse effects of COVID-19 in Fiji.

Examples of data visualization from the electronic dashboard that helped to guide monitoring and clinical management were the number of new cases (**Fig. 1**) and the number of severe and critical cases in hospitals (**Fig. 2**).

### Challenges

Development of the dashboard included some challenges. The development phase involved many hours of discussion between the development team and the health facilities to clarify understanding. There were also challenges related to human resources, with overstretched health facilities expressing difficulty in identifying available staff to collect and enter data. Until processes were established, this led to gaps in data that the development team needed to regularly return to and complete. Another challenge was incorrect interpretation of the dashboard, which occurred when screenshots of the dashboard were used in presentations or the media without context or appropriate interpretation. To address this issue, a short webinar on how to interpret the dashboard correctly was presented to end users, and it was recommended that the dashboard be used only at an operational level.

## DISCUSSION

Since 2020, many dashboards have been created around the world to track and present information on the COVID-19 pandemic; these dashboards have been pivotal in guiding decisions and health system responses.[6–9] However, much of the literature pertaining to clinical dashboards was published before the pandemic and is fragmented, reporting on different types of dashboards at strategic, tactical and operational levels.[6,10] One key benefit of an electronic dashboard is that information can be consolidated at a glance to improve decision-making.[6,7,10] Electronic dashboards present a variety of information including patient data such as age, vital signs and oxygen requirements, severity of illness and risk of deterioration (taken from electronic health records); and overall hospital data such as critical care resources, test positivity rate, COVID-19-related bed occupancy and mortality.[6,11–14]

The online dashboard we created allowed key decision-makers to visualize case numbers and place of isolation in real time. Additionally, with many cases isolating at home having risk factors for severe disease, the dashboard provided oversight of this vulnerable group by tracking their level of risk and the date on which the MHMS had last been in contact to check their clinical status.

Communication is critical to an effective and successful pandemic response. Sharing information on the progress of the pandemic helps to inform key stakeholders, for example, by assisting clinical staff with patient care, and helping hospital management and support staff with surge-capacity plans and forecasting logistics, supplies and human resource deployment. Forums such as head of department meetings, executive management meetings and local task force meetings are used to share clinical dashboard trends. Also, Ibrahim et al.[8] found that the development and implementation of an electronic dashboard in their health facility enabled physicians to efficiently assess patient volumes and case severity to prioritize clinical care and appropriately allocate services.

There are several important limitations to our dashboard. The first is that we focused on the development and implementation of an electronic dashboard in Fiji. In comparison to other Pacific island countries, Fiji has a relatively large health system that makes it difficult to transfer this online dashboard directly to other country contexts. However, we believe that Fiji's experience and associated challenges are useful to consider when implementing an electronic dashboard elsewhere. Interpretation of this real-time dashboard also requires a thorough understanding of the dashboard's data fields, Fiji's COVID-19 situation and overall response strategy. For instance, an increase in COVID-19 hospitalization seen in June and July 2022 may be due to increased testing, awareness of COVID-19 diagnosis and referral to health facilities. For accurate interpretation, the dashboard should be reviewed in collaboration with other COVID-19 information. Additional limitations included the many hours required to develop the dashboard, incomplete and inconsistent data (particularly following a resurgence of COVID-19), misunderstandings about how the information was collected and efforts to twist the messages that the dashboard presents.[2,15]

The dashboard is a simple online tool that is easy to use and has applications across different facets of clinical outbreak response. The availability of real-time information via the dashboard facilitates a quick response.

Fig. 1. **Dashboard interface**

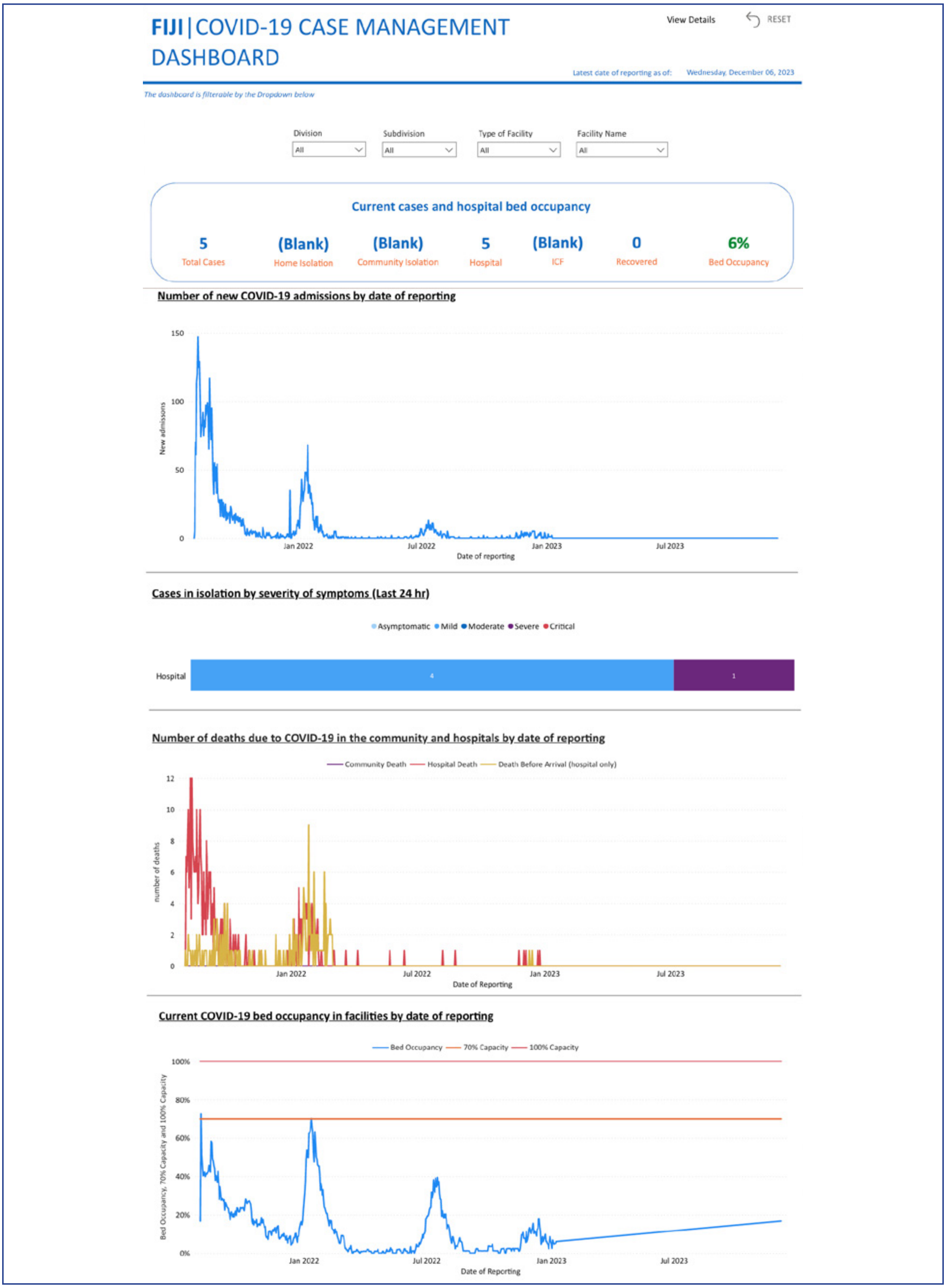
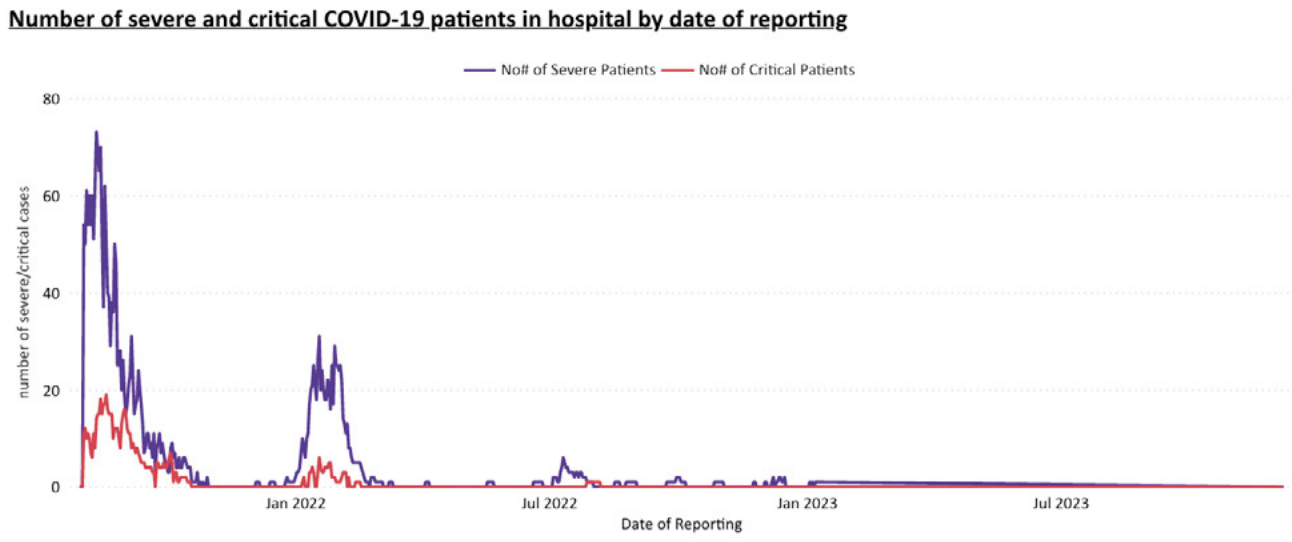


Fig. 2. **Data capture of hospitalized cases with severe or critical disease severity**




Owing to its ease of use, the dashboard can be altered to meet users' data needs, making this a cost-effective and relatively simple solution for data management and visualization across low-resource settings. It is hoped that the dashboard can be used beyond COVID-19 to track hospital census data and other infectious disease outbreaks.

## *Acknowledgements*

The authors would like to acknowledge the clinicians and divisional and subdivisional health staff across Fiji who, alongside their significant clinical duties at the peak of the COVID-19 outbreak in Fiji, diligently collected and entered clinical data on a daily basis to inform public health decision-making and to track and analyse the patterns of COVID-19 cases. The authors would also like to acknowledge the support of the Fiji Ministry of Health and Medical Services, the United Nations Office for the Coordination of Humanitarian Affairs and the World Health Organization.

## *Conflicts of interest*

The authors have no conflicts of interest to declare.

## *Ethics statement*

This manuscript describes the implementation and use of an electronic dashboard; hence, there are no patient identifiers or impacts to patient populations from publishing this article.

## *Funding*

None

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# Maintaining health-system functionality in response to the surge of COVID-19 cases due to the Omicron variant, Japan

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**Problem:** The Omicron variant of severe acute respiratory syndrome coronavirus 2 caused the largest surge of coronavirus disease (COVID-19) cases in Japan starting in the summer of 2022. We describe the mechanisms introduced to provide appropriate health care to all Omicron cases, provide appropriate health care to all non-COVID-19 patients, and protect health-care workers (HCWs) while providing necessary health services. Optimization of care for elderly patients was particularly important.

**Context:** Japan is home to 125 million people, of whom 28.6% are 65 years or older. Between January and June 2022, the country experienced 4.3 times more COVID-19 cases than in the previous 2 years (7.3 million vs 1.7 million).

**Action:** To adjust care pathways, inpatient treatment capacity was increased, a home-based care system was established, and an on-site treatment scheme at long-term care facilities was started. Among essential health services, disruption of emergency care became most noticeable. Administrative and financial support was provided to hospitals with emergency departments to maintain emergency medical services. To protect HCWs while maintaining hospital services, flexible exemptions were introduced to enable those who became close contacts to return to work, and broadly targeted contact tracing and testing in case of nosocomial outbreaks were all helpful.

**Outcome:** As a result of the adjustments made to inpatient capacity and patient flow, bed occupancy for COVID-19 patients decreased, mostly because many patients were cared for at home or in temporary-care facilities.

**Discussion:** From this study, we extracted two essential lessons to aid in current and future health emergencies: how to balance the provision of acute medical care for elderly patients and maintain their well-being; and how to maintain essential health services.

## PROBLEM

The Omicron variant of concern (VOC) of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was first reported in Japan on 30 November 2021, and quickly spread throughout the country. As of 31 January 2022, Omicron accounted for more than 90% of all SARS-CoV-2 cases[1] and caused the sixth wave of coronavirus disease (COVID-19) in Japan (**Fig. 1**).[2] Although Omicron had decreased risk of severe disease,[3] its higher transmissibility resulted in the largest surge of cases to date. The number of COVID-19 cases reported in the first 6 months after Omicron began circulating in Japan was 4.3 times higher than the total number of COVID-19 cases between January 2020 and November 2021, with 7.3 million cases compared to 1.7 million reported in the previous 2 years.[2]

The unprecedented number of COVID-19 cases challenged the medical system in Japan, which provides virtually all citizens with national health insurance and access to medical care. The rapid increase in COVID-19 cases meant that existing care pathways and patient flow became more challenging. Maintaining health services for non-COVID-19 conditions, an issue since the beginning of the pandemic, intensified and placed a strain on the front lines of the health-care system, such as the emergency departments. The rapid increase in COVID-19 cases also reduced the number of available health-care workers (HCWs), as a significant number either became infected

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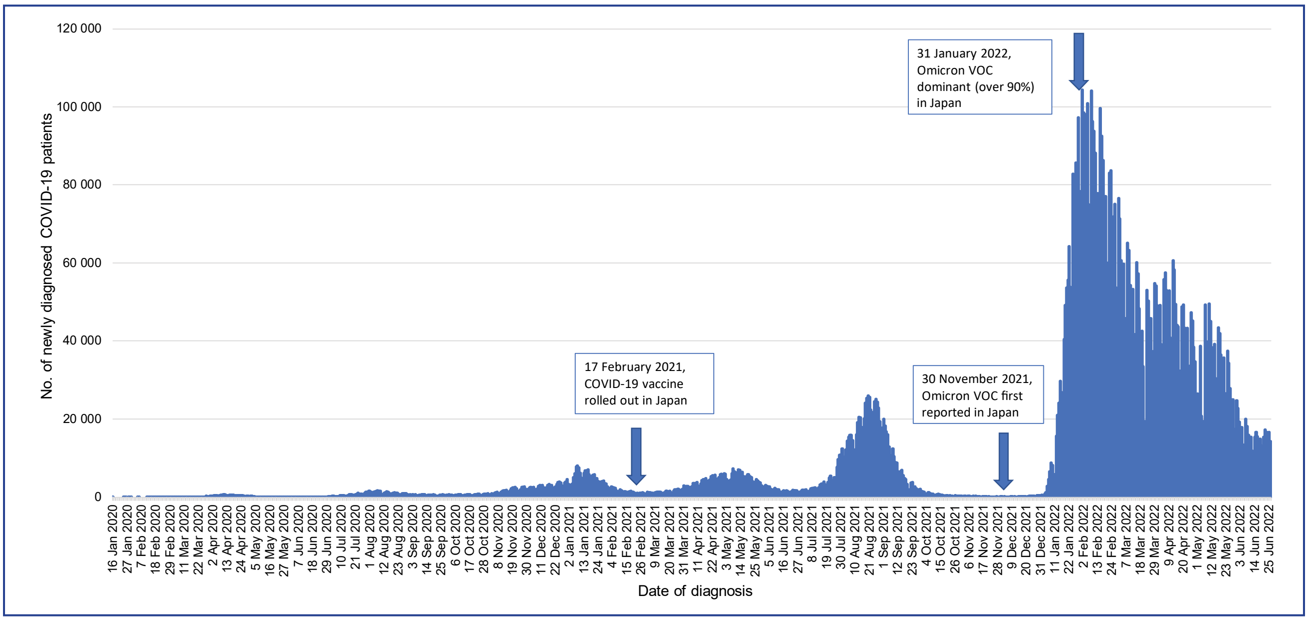
Published: 6 February 2024
doi: 10.5365/wpsar.2023.14.5.1048

Fig. 1. **Daily new confirmed COVID-19 cases in Japan, from 16 January 2020 to 31 June 2022**




*Source:* Visualizing the data: information on COVID-19 infections.[2]

with SARS-CoV-2 or were close contacts of confirmed cases. Therefore, protecting HCWs from infection while maintaining necessary health services during this time of community transmission was another challenge during the Omicron wave.

In this article, we describe the mechanisms introduced to provide appropriate health care to all Omicron cases, provide appropriate health care to all non-COVID-19 patients, and protect HCWs while providing necessary health services.

## CONTEXT

Japan is the world's first super-aged society. In 2020, 28.6% of its 125 million population were aged 65 years or older.[4] This had an impact on the surge of Omicron cases, as elderly COVID-19 patients often have baseline comorbidities that require additional medical care, which tends to prolong their hospitalization, puts a significant burden on hospital staff and stagnates patient flow.

Isolation and quarantine criteria and treatment protocols changed throughout the COVID-19 response as new evidence for COVID-19 became available,[1] and care pathways were continually adjusted accordingly. COVID-19 was relatively well controlled in Japan until the emergence of the Omicron VOC.[1]

COVID-19 vaccination started in Japan on 17 February 2021, with coverage of the primary series reaching 74% by 1 December 2021, which was before the identification of the first COVID-19 case due to the Omicron VOC in the country. At that time, the third dose (booster vaccination) had not yet been initiated.[5]

## ACTION

### Providing appropriate health care to all Omicron cases

From January 2020, when COVID-19 began to spread in Japan, inpatient capacity was increased and a smoother patient flow was developed to manage the growing number of COVID-19 cases. Prior to the pandemic, there were 1888 beds for emerging and re-emerging infectious diseases in 411 designated hospitals nationwide. This was increased to approximately 25 000 beds by November 2021 in response to the pandemic, and further increased to 40 000 by April 2022 in response to the emergence of the Omicron VOC.[6] Nevertheless, the rapidly increasing demand overwhelmed bed capacity.

In February 2022, to better utilize the limited designated beds, the Ministry of Health, Labour and Welfare (MHLW) recommended discharging or transferring patients to non-acute hospitals if they did not require oxygen by day 4 of hospitalization.[7] This recommendation was based on evidence from a February 2022 report published by the National Hospital Organization Clinical Data Archives, which stated that it was rare (0.9%, 12/1312) for patients hospitalized for COVID-19 to require oxygen after day 4.[8] The MHLW cautioned that patients aged >60 years may still need careful monitoring.[7]

Subsequently, a home-based care system was established to reduce the number of hospitalized cases. In January 2022, the MHLW instructed local governments to distribute pulse oximeters to patients at home, promote the use of an online self-reporting system, and establish follow-up centres for patients at risk of severe disease. Although most patients with the Omicron VOC had mild disease, sudden deterioration was possible, especially in elderly people and those with comorbidities. The home-based care system introduced by the Tokyo Metropolitan Government assessed the risk of severe disease based on age and existing comorbidities (**Fig. 2**).[9] The MHLW also approved presumptive diagnosis of COVID-19 without testing for people who were living with a confirmed COVID-19 case and developed symptoms suggestive of COVID-19.[10] Until this time, laboratory confirmation of SARS-CoV-2 infection had been compulsory for diagnosis, which led to a bottleneck in the care pathway during the Omicron wave. An on-site treatment scheme at long-term care facilities (LTCFs) was established to assist with managing COVID-19 cases. Previously, residents of LTCFs who contracted COVID-19 were transferred to acute-care facilities, even when this meant transferring a large proportion of the residents. This was because LTCFs found it difficult to implement appropriate infection prevention and control (IPC) measures. During the Omicron wave, the Tokyo Metropolitan Government began dispatching medical teams to LTCFs that requested a transfer of two or more residents with COVID-19 to local hospitals to provide medical services including monoclonal antibody therapy and antiviral drugs. This scheme spread throughout Japan, with 94% of LTCFs reporting that they had a consultation system with local doctors and nurses as of May 2022.[11] IPC specialists were included in the dispatch team and provided advice and training to LTCF staff.

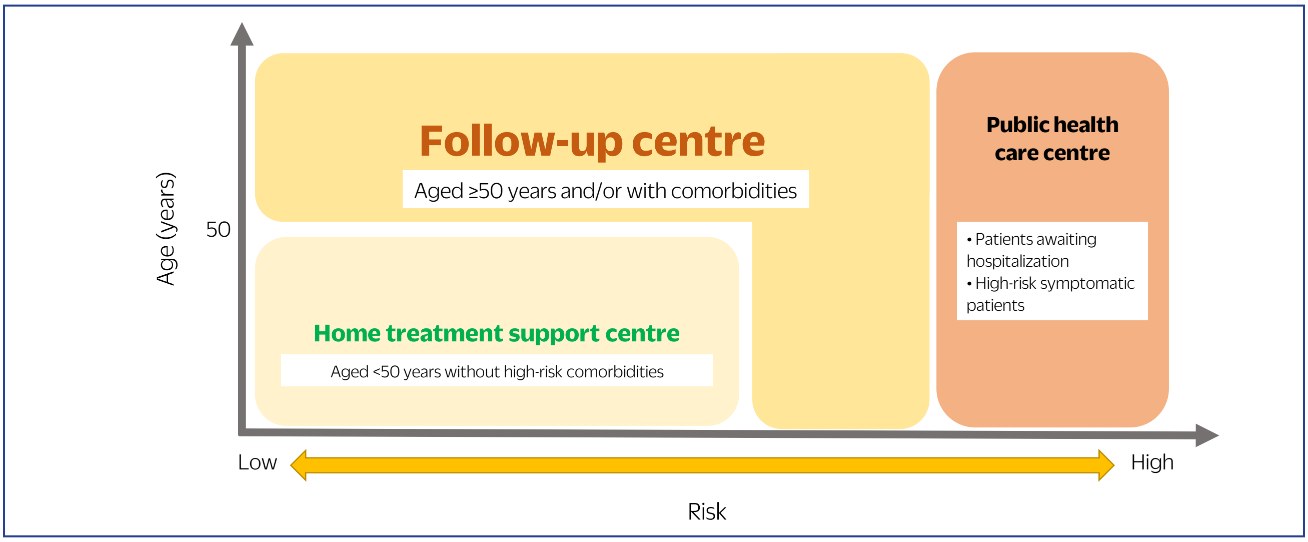
This on-site treatment scheme at LTCFs was particularly useful due to Japan being a super-aged society. When elderly patients with COVID-19 were admitted to acute-care hospitals, it was inevitable that they were put under strict IPC measures and isolated from their family, familiar caregivers and their daily routine. This could result in decreased cognitive stimulation, physical exercise and social engagement, and cause or worsen cognitive and physical impairment.[12] Even outside an acute-care setting, at LTCFs and in the community, elderly people were often physically and socially isolated or distanced. Conversely, by treating patients with COVID-19 in LTCFs, elderly patients received treatment in a familiar environment. The prevention and treatment of COVID-19 in elderly people and the mitigation of its negative impact on their overall well-being needs to be well balanced.

COVID-19-designated hospitals were the main providers of COVID-19 care, with other hospitals, clinics and facilities having limited roles for COVID-19 cases. As a result, many designated hospitals became overwhelmed. Task-shifting from designated hospitals to other health-care facilities, especially the provision of care for patients with non-severe COVID-19 disease, was used to decrease the burden on designated hospitals. In June 2022, to accelerate the task-shifting, the MHLW required simpler IPC measures for health-care and nursing settings that were providing care to COVID-19 cases.[13] These measures specified that: COVID-19 patients could be cared for in facilities with appropriate zoning without dedicated wards; excessive environmental disinfection would be risk-based and target high-touch surfaces; and droplet and aerosol precautions would be prioritized and contact precautions could be minimized.

## Maintaining health services for non-COVID-19 conditions

The COVID-19 pandemic had a wide impact on health services, which was further exacerbated during the Omicron wave. For example, the number of difficult transport cases, when paramedics had to call more than four hospitals or spend longer than 30 minutes identifying a hospital to which they could take their patients,[14] was used as a proxy measure of health-care availability. Between mid-January and early March 2022, the number of difficult transport cases was approximately five times higher than during the pre-pandemic era (3417 between 20 January and 9 February 2020, compared with 15 722 between 17 January and 6 February 2022), with two thirds of these patients needing non-COVID-19 medical care.[14]

Fig. 2. **Home-based care system introduced by the Tokyo Metropolitan Government for COVID-19 patients with mild disease in Tokyo**




Health observation is conducted by health centres and follow-up centres for those who are homebound and deemed to be at high risk due to symptoms, age or underlying medical conditions.

*Source:* (76th) Tokyo Metropolitan Government Monitoring Conference on COVID-19.[9]

Many health-care facilities had to accept patients who were potentially infected with SARS-CoV-2, which required extra space, materials and human resources for IPC measures. This resulted in emergency departments receiving fewer patients despite functioning at full capacity. In late January 2022, the MHLW published a plan to maintain emergency medical services for non-COVID-19 patients in medical institutions with emergency departments. This plan included financial support to set up medical tents and portable container units to expand hospital space. Temporary accommodation was also established for COVID-19 patients waiting to be hospitalized.[15]

## Protecting health-care workers

Many HCWs had to take leave from work either due to their positive COVID-19 status or their close contact with a confirmed case. This resulted in fewer staff in health-care institutions, which again was exacerbated during the Omicron wave. In January 2022, the MHLW declared that HCWs who were close contacts could continue working, provided that they had completed a primary vaccination series and had a negative daily rapid antigen test for COVID-19. When a HCW became a positive case, rapid contact tracing was important to minimize further exposure of HCWs.

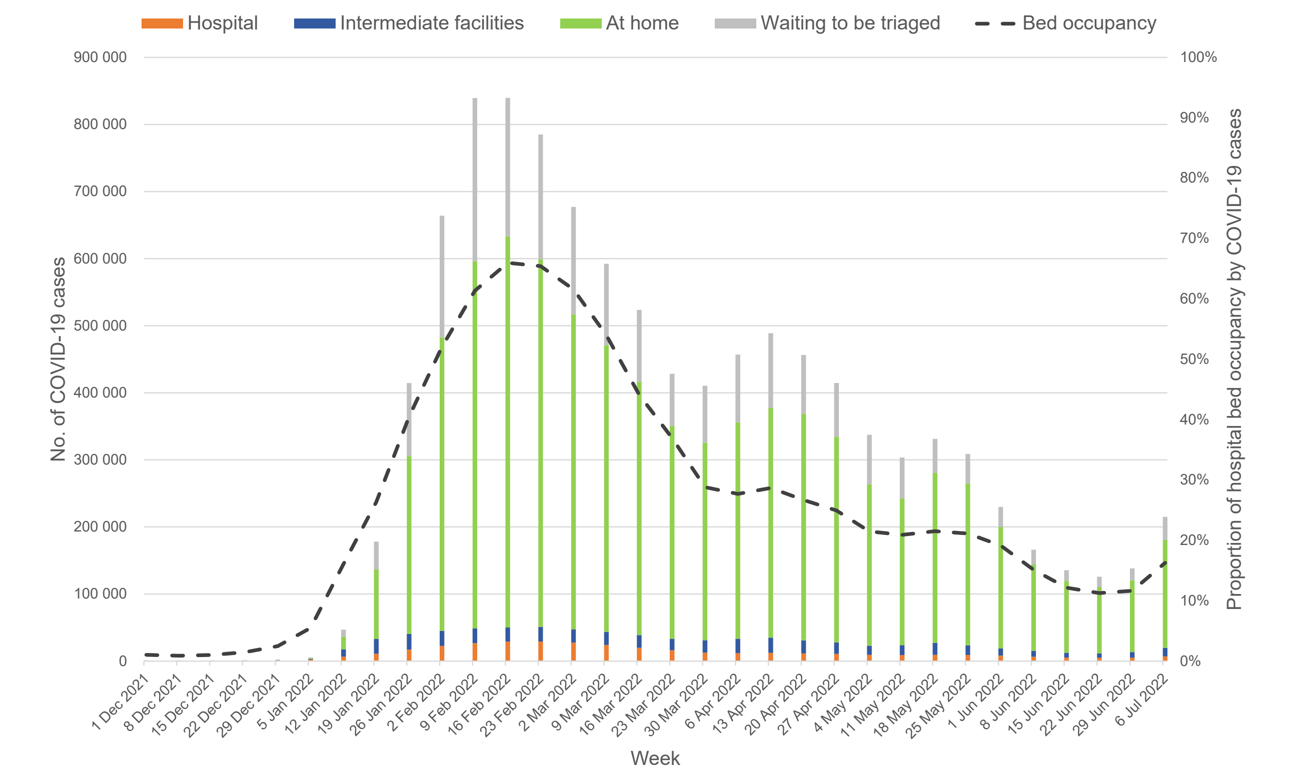
As the Omicron VOC had a shorter serial interval than the previous SARS-CoV-2 variants, outbreaks had often spread beyond identified contacts at the time of investigation.[16] This was a change from the nosocomial outbreaks due to previous SARS-CoV-2 variants or seasonal influenza virus and, therefore, initial screening for nosocomial outbreaks due to the Omicron VOC needed to be broadly targeted. To prevent the introduction of SARS-CoV-2 by patients with minor symptoms or asymptomatic infection, many hospitals implemented testing for COVID-19 for patients at the time of hospitalization.

Given the importance for health-care facilities to have a business continuity plan during the pandemic, the MHLW requested that the National Center for Global Health and Medicine publish guidance on plan development during COVID-19 outbreaks to maintain essential health services.[17]

# OUTCOME

As a result of the adjustments made to inpatient capacity and patient flow, bed occupancy for COVID-19 patients decreased (**Fig. 3**).[6] This was mostly because many patients were cared for at home or in intermediate facilities (**Fig. 3**).

Fig. 3. **Number of COVID-19 cases in Japan by location of treatment and bed occupancy of COVID-19 cases, from 1 December 2021 to 6 July 2022**




*Source:* Survey on the state of medical care and the number of inpatient beds.[6]

## DISCUSSION

The unprecedented number of COVID-19 cases during the Omicron wave disrupted Japan's health-care system and created a variety of challenges. This is despite Japan having more acute-care beds (7.7 per 1000 persons in 2019) compared to other Organisation for Economic Co-operation and Development countries.[18] The rapid surge of cases during the Omicron wave still resulted in many patients waiting to be hospitalized and having inpatient COVID-19 treatment provided primarily at designated hospitals, which stagnated care pathways and overburdened hospitals. In response to these challenges, bed capacity in designated hospitals was increased, and a home-based care system and on-site treatment scheme at LTCFs were established. IPC measures and policies evolved flexibly to protect HCWs while maintaining essential health services. However, although MHLW supported hospitals with emergency departments to safeguard emergency medical services, difficult transport cases were still seen nationwide.

Two important lessons were gleaned from the experience. The first is how elderly people are cared for during health emergencies, and that having on-site treatment schemes at LTCFs and in the community may be preferable to care in acute-care hospitals. A Spanish study reported a significant decline in functional, cognitive and nutritional status in elderly nursing home residents regardless of infection status during the early phase of the COVID-19 pandemic.[12] Maintenance of a holistic quality of life needs to be incorporated into clinical management plans, as well-balanced care benefits are not just for the infected but for the entire elderly population.

The second lesson is how to maintain essential health services during health emergencies. When designated COVID-19 hospitals became overwhelmed, task-shifting was important to distribute the burden to non-designated hospitals, clinics and other health-care facilities. Also, adjusting care pathways, such as home-based care for asymptomatic or mild cases and presumptive COVID-19 diagnosis of those living with confirmed cases, reduced the burden on designated hospitals and contributed to maintaining essential health services, including emergency medical care for patients with acute life-threatening conditions.

The COVID-19 pandemic will not be the last health emergency. It is crucial to prepare for the next pandemic using the lessons from the current one. This includes:

- adjusting patient-care pathways when the number of patients increases and controlling patient flow as circumstances change and new scientific evidence emerges;
- ensuring that care continues to be provided to patients with other diseases, especially those who require emergency care;
- preventing the spread of infection in hospitals through IPC measures; and
- maintaining the HCW workforce through appropriate policies.

Each of these actions needs to be tailored to the infectious disease and the evidence as it develops during the outbreak or pandemic. Japan's experience in calibrating care pathways in their super-aged society holds valuable lessons that can benefit other countries.

## *Conflicts of interest*

The authors have no conflicts of interest to declare.

## *Ethics statement*

This article did not contain patient information and did not require ethics committee approval.

## *Funding*

None.

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# Experiences in COVID-19 clinical management and health-care pathways in the Western Pacific

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The coronavirus disease (COVID-19) pandemic has transformed clinical practice and health systems. This paper provides an overview of COVID-19 clinical management and health-care pathway challenges that the World Health Organization and its Member States in the Western Pacific Region have faced. The experiences and lessons identified can help countries to better prepare for future pandemics.

The coronavirus disease (COVID-19) pandemic has highlighted the importance of optimizing clinical management and health-care pathways during public health emergencies. This report provides an overview of clinical management and health-care pathway challenges that the World Health Organization (WHO) and its Member States in the Western Pacific Region faced during the COVID-19 pandemic.

On 31 December 2019, the WHO Representative Office for China notified the Regional Office for the Western Pacific that cases of pneumonia of unknown origin had been reported in Wuhan, Hubei Province.[1] Since then, health-care workers have had to adapt their approach to clinical management and health-care pathways as they tackled multiple challenges caused by unprecedented case numbers, including overwhelmed hospitals, inadequate bed capacity and resources, and staff shortages as they too contracted COVID-19. Moreover, as new evidence emerged, health-care workers were constantly having to make adjustments to their clinical practice and care pathways. Many health systems around the world struggled to provide the right care to the right patients at the right time while safeguarding wider essential health services.

In the early phase of the pandemic, patient flow in hospitals was compromised by the requirement of a negative polymerase chain reaction (PCR) test and clinical recovery for releasing patients from isolation.[2] This meant that asymptomatic patients remained in isolation long after they were no longer infectious, taking up vital hospital bed capacity. Although test-based criteria were changed to time-based criteria in June 2020,[3] some Member States were reluctant to adopt the revised WHO recommendations. By sharing scientific evidence for time-based criteria and practices of other Member States, the Regional Office encouraged Member States to fine-tune their care pathways and/or update their protocols and practices as new evidence became available.

The Delta variant was responsible for the first major surge of reported cases that occurred in many countries in the Western Pacific Region from June 2021 (**Fig. 1**). Rapid increases in cases of severe disease needing hospitalization, cases of mild disease needing monitoring and isolation, and close contacts needing quarantine, coupled with a reduced health workforce (due to absence caused by either infection or the need to quarantine), created a tremendous strain on health systems. Inefficiencies in allocating patients to the right level of care exacerbated the problem.

During the surge of cases, health-care services experienced a constantly changing flow of patients as each day new patients with rapidly fluctuating medical needs entered the health-care pathway while others recovered and exited the health system. In hospital

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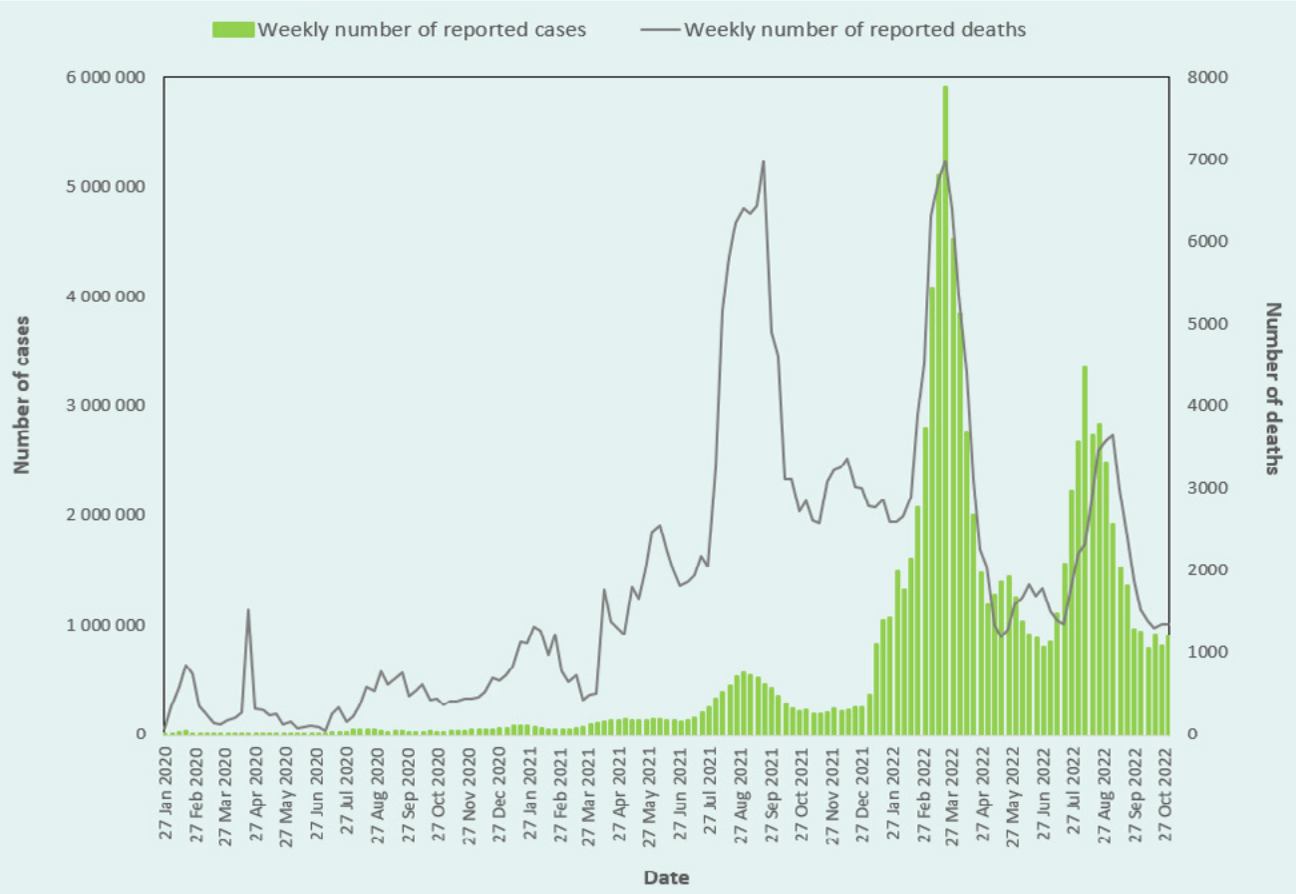
Published: 22 June 2023
doi: 10.5365/wpsar.2023.14.5.1017

Fig. 1. **Confirmed COVID-19 cases and deaths in the Western Pacific Region, 21 January 2020 to 31 October 2022**




*Source*: WHO coronavirus (COVID-19) dashboard (https://covid19.who.int).

settings, intensive care unit (ICU) beds or COVID-19-designated beds had to be used for patients requiring critical care. This meant that ICU bed use, from admission to discharge, needed to be closely monitored and managed not just at the hospital level but across the local health system. In addition, patients with severe disease or with risk factors for developing severe disease required close monitoring for signs of deterioration which might necessitate admission to the critical care system. In Ulaanbaatar, Mongolia, for example, the occupancy of COVID-19-designated beds and ICU beds very quickly exceeded the available capacity in early June 2021. By monitoring the distribution of patients according to disease severity in each type of facility on a daily basis using a simple visualization system, the Ministry of Health was able to improve bed use.[4] This prompt action led to an immediate reduction in the number of patients waiting to be hospitalized. Similarly in the Philippines, a national surveillance system was developed to track bed utilization in all public and private hospitals in early 2020. This indicator-based system not only provided data to inform COVID-19 responses and policies, but helped avoid the overwhelming of health-care resources, showing a maximum bed utilization rate of 71.7% during the country's Delta variant surge in mid-2021.[5]

At hospitals that accommodated patients with respiratory failure, oxygen capacity quickly became an urgent priority. Oxygen therapy is a cornerstone of treatment for respiratory diseases including COVID-19; however, its availability remains suboptimal in many low- and middle-income countries. Hospitals struggled not only with forecasting oxygen use and securing a sustainable supply of oxygen and consumables, but also with maintaining their oxygen system, ventilators and pulse oximeters because of the limited availability of trained biomedical engineers or similarly trained personnel. In Fiji, the situation was ameliorated by the introduction of an electronic COVID-19 clinical dashboard in mid-2021. The dashboard, which provided information not only on the availability of oxygen and its delivery devices but also on case severity, bed occupancy and management of patients isolating at home,[6] helped hospitals to track and forecast oxygen use in real time at the facility level. Across the Region, the WHO Regional Office supported oxygen scale-up through the procurement of ventilators, pulse oximeters and other consumables, and by training health-care workers on the use of ventilators and intensive care. The Regional Office was also instrumental in the procurement of 14 pressure swing absorption oxygen plants for 11 Member States in the Region, including eight Pacific island countries.

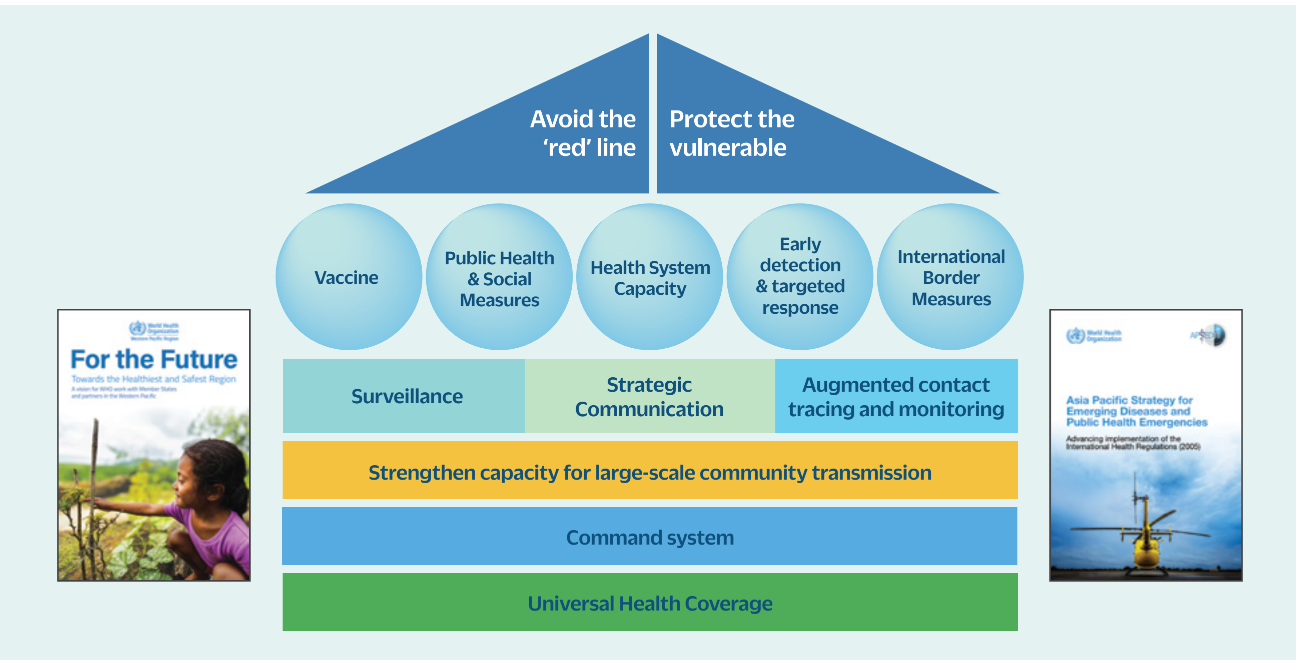
The pandemic called for a rapid expansion of health-care capacity. Many countries such as Viet Nam responded by establishing intermediate care facilities to accommodate patients with mild disease so that hospitals and treatment centres could focus on those with severe or critical disease.[7] The ability to transfer patients between facilities with different levels of medical care played a key role in facilitating this health-care pathway. Some Member States such as Japan and Singapore also established home-based care systems for those with mild disease or asymptomatic infection.[8,9]

As the pandemic progressed, the importance of being able to monitor the overall use of the health-care system became increasingly apparent. This form of situation monitoring, or "red-line analysis",[10] aims to predict when health-care systems might potentially become overwhelmed by a surge in case numbers using a simple projection model and indicators such as occupancy rates of ICU beds and COVID-19 designated beds. The Regional Office supported Member States in setting up such monitoring systems.[10]

Throughout the pandemic, the Regional Office has supported its Member States by sharing experiences and the best available scientific evidence. This form of support was not limited to provision of information but extended to assisting countries in interpreting the available evidence, as well as formulating and implementing policies according to their local context. In this regard, the Regional Office hosted individual sessions with the governments of Cambodia, the Lao People's Democratic Republic and Mongolia, which resulted in the development of specific policies to optimize care pathways in each country.

In October 2021, after the Delta wave subsided, the focus of the Regional Office's support and advocacy switched from pandemic response to sustained management of COVID-19. Countries were encouraged to focus effort on five key areas, as recommended by the Asia

Fig. 2. **Five key areas and three supporting pillars for transitioning to sustained management of COVID-19**




*Source*: reproduced from WHO Regional Committee for the Western Pacific (RC72/INF/2).[7]
The 'red' line is the point at which health capacity is exceeded.

Pacific Strategy for Emerging Diseases Technical Advisory Group. The five key areas were: 1) vaccines; 2) public health and social measures; 3) health system capacity; 4) early detection and targeted response; and 5) international border measures (**Fig. 2**).[10] The aims of the strategy shift were to safeguard the health system from being overwhelmed; protect high-risk groups; prevent severe disease and deaths; and support social and economic recovery. Amid this effort, the Region experienced another surge of cases, starting in January 2022 and driven by the Omicron variant (**Fig. 1**). Although increased vaccination coverage across the Region helped protect vulnerable populations to some degree, the rapid increase in case numbers put pressure on health systems and resulted in increased mortality in some Member States.

The Western Pacific Region has evolved a wealth of experience in COVID-19 clinical management and health-care pathways at both national and subnational levels and across a range of economic and health system development levels. The challenges, successes and lessons shared by Member States may help countries to improve their clinical management and health-care pathways for future pandemics of respiratory infections, build robust health security preparedness capacity and move closer to universal health coverage.

## *Acknowledgements*

The authors acknowledge the support and guidance of Dr Babatunde Olowokure and the COVID-19 Incident Management Support Team at the WHO Regional Office for the Western Pacific.

## *Conflict of interest*

The authors have no conflicts of interest to declare.

## *Ethics statement*

Ethical review was not required because only publicly available information was used.

## *Funding*

None.

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# Establishing a national indicator-based surveillance system for hospital bed utilization by COVID-19 patients in the Philippines

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In March 2020, the Philippine Department of Health (DOH) designed and rapidly implemented a national surveillance system for the utilization of hospital beds by patients with coronavirus disease (COVID-19) to produce complete and timely data for use by various levels of governance in response to the COVID-19 pandemic. The DOH launched the DOH DataCollect (DDC) Bed Tracker system, a web-based application that collects information from all 1906 public and private hospitals and infirmaries across the country using a modular data collection tool. Data on the maximum number of occupied COVID-19-designated beds ($n$ = 28 261), hospital bed utilization rate (71.7%), and mechanical ventilator number ($n$ = 1846) and utilization rate (58.5%) were recorded in September 2021 during the Delta surge of cases in the Philippines. Data on human resources, personal protective equipment and supplies, and other operational indicators were added to the system during various modifications. Information from the DDC was used to inform the COVID-19 response and operations at national and local levels and facilitated research at academic and nongovernmental agencies. The development of the DDC system demonstrates that an effective surveillance system for use by all health-care facilities is achievable through strong national leadership, the use of available technology and adaptive information systems, and the establishment of networks across different health facilities and stakeholders.

The first case of coronavirus disease (COVID-19) in the Philippines was confirmed on 30 January 2020. By 1 March 2020, there were 633 suspected COVID-19 cases admitted to hospitals across the country.[1] Given the increasing number of cases and the infectious nature of the disease,[2] data on hospital admissions were vital for health system policies and decision-making for the COVID-19 response,[3] including health facility operations, patient referrals, and public health and social measures.

Prior to the COVID-19 pandemic, health information systems (HISs) in the Philippines were fragmented; there was a lack of IT infrastructure in health facilities and a devolved health system, with some hospitals managed by the national government and others by local governments. With the sudden increase in COVID-19 cases in February 2020, health facilities needed guidance through government policies to address inconsistencies, untimeliness and poor quality of data submissions. Data collection methods included consolidated spreadsheets from health facilities and daily enquiries about their hospital bed utilization rates. There were no standardized processes, no prior data cleaning and no validation of submissions. In March 2020, the demand for data on hospital beds and medical equipment increased, but existing systems were unable to provide hospital admissions data to decision-makers.

The urgent need for hospital admissions data at this time exposed the vulnerability of the HIS and the lack of routine surveillance systems, especially on health

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Published: 30 September 2023
doi: 10.5365/wpsar.2023.14.5.1038

emergencies and health facility capacity. Also, some existing registries and information systems for active surveillance of specific diseases and health events were poorly integrated from the local to national level.[4] Previous attempts to create a health emergency preparedness and response information system to improve the government's action and response during emergencies[5] had not materialized. With these fragmented systems, policy- and decision-makers did not have access to the information they needed and, therefore, had to rely on ad hoc data collection.

There was an urgent need to establish a national indicator-based surveillance system to gather timely and accurate information on the capacity of health-care facilities for COVID-19 patients and to project demands for resources. These data were vital to informing key responses and operations on COVID-19.[6] On 3 March 2020, the Philippine Department of Health (DOH) DataCollect (DDC) Bed Tracker system was launched to regularly receive data from all public and private hospitals and infirmaries in the country on their health resource availability and needs.[3] This paper describes the establishment of the DDC system and how it was used during the Philippines' COVID-19 response.

## METHODS

There were four stages in the establishment and improvement of the DDC system for COVID-19 hospitalizations in the Philippines, which started in February 2020 and are still ongoing. A team of policy-makers, physicians, data analysts and IT developers in the DOH was assigned to lead and perform the continuous development, analysis, report generation and dissemination of the DDC system. A network of regional officers and hospital data entry officers was also formed to ensure proper implementation and regular monitoring of the system on the ground.

### Stage 1: planning

The main objective of the DDC system was to monitor the occupancy rate of COVID-19-designated beds and equipment in all public and private hospitals and infirmaries in the Philippines. The DOH designed an application programming interface (API) that gathered information on COVID-19 and non-COVID-19 bed utilization from all hospitals and infirmaries across the country. This API referenced the National Health Facility Registry (NHFR) to create user accounts for the facilities to access during the data collection process. It had several initial indicators and monitoring questions (**Box 1**).

Box 1. **Summary of variables and indicators collected in the Philippines by the DOH DataCollect Bed Tracker system (Version 3)**

- Aggregate number of occupied and vacant beds and equipment designated for COVID-19 suspected, probable and confirmed cases, which includes intensive care unit beds, ward beds, isolation beds and mechanical ventilators:
  - to calculate the bed and equipment occupancy rate.
- Aggregate number of human resources for health (HRH) that are admitted or quarantined due to COVID-19:
  - to estimate the percentage of unavailable HRH to assess compliance to infection prevention control measures and to inform HRH augmentation.
- Aggregate number of available personal protective equipment (PPE) and other supplies for COVID-19:
  - to estimate the current PPE supply to inform resource allocation and supply chain management.

### Stage 2: implementation

The DDC system (https://hfpddc.doh.gov.ph ), originally a mobile application, was launched on 3 March 2020. The DOH issued Department Memorandum 2020–0136, dated 25 March 2020, and Department Circular 2020–0158, dated 27 March 2020, mandating all hospitals and infirmaries to submit reports daily, weekly and as needed.[3] The facilities' data entry officers submitted the required data (**Box 1**) through the DDC system's API, which were then stored in the DOH data warehouse.

Orientation sessions for facility encoders were conducted before the start of the DDC system and before each update was implemented. The DOH and its regional officers constantly provided technical support to facility encoders regarding DDC processes, interfaces and tools. The regional officers also conducted periodic reviews of DDC questions and indicators, monthly monitoring of submissions to ascertain compliance, and quick assistance in validating flagged entries in the system. Facilities were required to submit incident reports to document any corrections in data submissions. Correspondingly, identified errors were rectified by the DOH through direct and documented editing of the data warehouse. The validated data were then extracted to update dashboards and create daily reports (**Fig. 1**).

### Stage 3: data processing, analysis and dissemination

The data gathered from the DDC system underwent automated data processing, which includes deduplication and merging of variables stored in the NHFR such as geographic information, facility service capabilities, ownership, and the number of beds. The data were then analysed to create detailed internal reports such as weekly health facility capacity reports, which were disseminated to the DOH executive, technical and regional offices, and other national government agencies for decision- and policy-making. The data were also available through the DOH's open-access database called DataDrop, with internal and public-facing dashboards, and used for public information materials for the official country COVID-19 bulletin and reports.[7] The data were also used for academic research and analyses by nongovernmental agencies.

### Stage 4: iterations

The dynamic demand for information changed over the course of the pandemic. Therefore, the DDC questions and indicators were continuously updated by the DOH according to the needs of decision- and policy-makers, prevailing guidance from stakeholders, reviews of related information systems used internationally, and feedback from key informants. Lessons identified from previous DDC system versions were also used to refine the implementation and resource materials, including the tools, report templates and dashboard designs of succeeding DDC versions.

## RESULTS

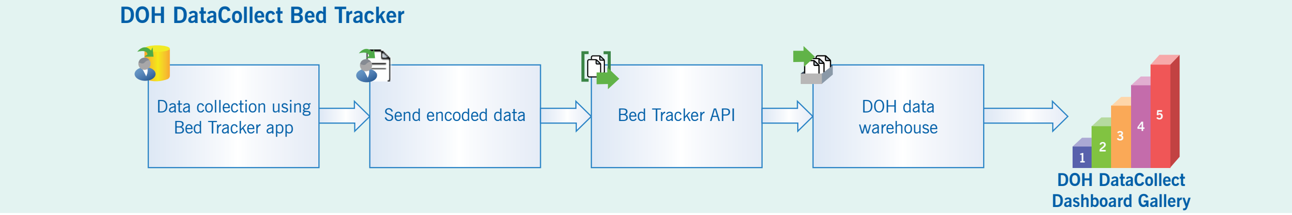
The first version of the DDC system was released with four variables being collected weekly. The 10th version, launched on 26 August 2022, has variables collected on a daily and weekly basis. The data completeness from 1906 public and private hospitals and infirmaries reached 80–95% by the third version of the DDC system, released in April 2020, and has improved to 98% as of December 2022 (**Table 1**). This shows how the system gained acceptability from health facilities as the immediate feedback and response from the government was highly valuable.

The DDC system provided the number of occupied COVID-19-designated beds and the corresponding occupancy rates (**Fig. 2**). The maximum number of occupied COVID-19-designated beds of 28 261 and the maximum utilization rate of 71.7% were recorded in September 2021 during the country's COVID-19 Delta surge (**Fig. 2**). The number of mechanical ventilators in use by COVID-19 patients also peaked in September at 1846 units, with a utilization rate of 58.5% (**Fig. 2**).

The DDC data were used by the government and other stakeholders in the country for the following purposes:

- Implementing the COVID-19 Alert Level System, which decides the quarantine status of each province in the country based on the health-care utilization rate.
- Modelling and forecasting by the subtechnical working group analytics for COVID-19. The spread of COVID-19 infections was slowed and prevented by risk-based public health interventions (for example, mobility restrictions) implemented by the Philippine COVID-19 Inter-Agency Task Force for the Management of Emerging Infectious Diseases based on the health-care utilization rates.[8]
- Determining geographic areas and hospitals with the highest percentage of unavailable human resources, hospitals lacking in supplies (for example, personal protective equipment, oxygen), and other commodities.

Fig. 1. **Data flow of the DOH DataCollect Bed Tracker system**




API: application programming interface; app: mobile application; DOH: Philippine Department of Health.

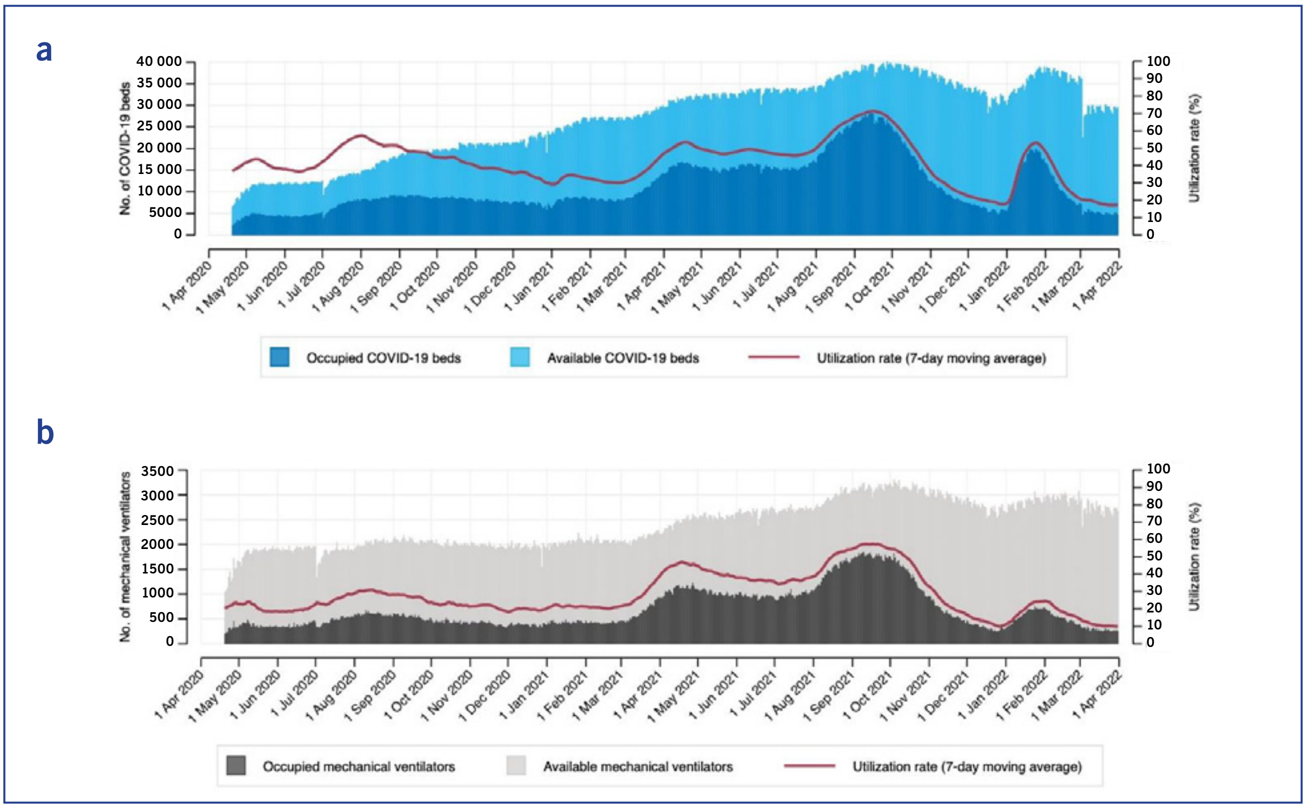
*Source:* DOH DataCollect System functional design document (base version). Manila: Philippine Department of Health; 2020 [unpublished].

Table 1. **Version updates, response rates and lessons identified from the DOH DataCollect Bed Tracker system**

| Version/date | Version updates | Response rate | Lessons identified |
|---|---|---|---|
| **Version 1:** 3 March 2020<br>**Version 2:** 15 March 2020 | **Daily module:** variables on intensive care unit occupied and unoccupied beds and mechanical ventilator occupied and unoccupied beds only | All COVID-19-designated hospitals only: 100% (weekly response) | Data collection from all hospitals and improved variables are needed. |
| **Version 3:** 16 April 2020 | **Daily module:** disease severity of admitted patients (e.g. asymptomatic, mild, moderate, severe, critical) added, deaths and human resources for health (HRH) among patients quarantined or admitted due to COVID-19 recorded<br>**Weekly module (new):** supply of personal protective equipment<br>**Baseline module (new):** other information about HRH and hospital equipment and services | National level: 80–95% daily 90–99% imputed (14 days) | Delineating the functions of DOH offices and other stakeholders is needed for a more efficient system.<br>Regular monitoring of compliance of data entry is required, with involvement of key leaders as well as technical staff. |
| **Version 4:** 2 July 2020 | **Daily module:** emergency department consultations and step-down care transfers added<br>**Weekly module:** additional health-care supply monitoring<br>**Baseline module:** infection prevention and control implementation<br>**Mortality module (new):** patient-level variables to monitor deaths among suspected, probable and confirmed cases | National level: 90–95% daily 98–99% imputed (14 days) | Not all variables are useful or have policy implications.<br>Some information may be useful occasionally but may not be as meaningful when generated regularly. |
| **Version 5:** 10 December 2020<br>**Version 6:** 10 May 2021 | **Daily module:** unused variables removed and variables for moderate COVID-19 cases and new COVID-19 admissions included<br>**Weekly module:** HRH variables transferred from daily to weekly reporting<br>**Baseline module:** unused variables removed<br>**Mortality module:** no changes<br>**National Patient Navigation and Referral Center (NPNRC) module (new):** for direct patient referrals | National level: 90–95% daily 98–99% imputed (14 days) | Daily health facility reporting is possible but reporting every 2 hours requires dedicated hospital coordinators.<br>To improve data quality, the utility of each data collection unit needs to be recognized through analytical reports and dashboards. |
| **Version 7:** 21 September 2021 | **Daily module:** oxygen consumption variables added<br>**Weekly module:** paediatric case admissions variables added<br>**Baseline module:** no changes<br>**Mortality module:** no changes<br>**NPNRC module:** twice daily reporting<br>**Vaccination module (new):** vaccination status of patients admitted in hospitals and reported cases of COVID-19 adverse events following immunization included | National level: 98% daily 98–99% imputed (14 days) | Orientation courses for data entry officers and coordinators are helpful.<br>Analysis of all variables should be planned and monitored. |
| **Version 8:** 3 March 2022<br>**Version 9:** 1 July 2022<br>**Version 10:** 26 August 2022–present | **Daily module:** bed occupancy disaggregated by COVID-19 vaccination status<br>**Weekly module:** unused variables removed<br>**Baseline module:** unused variables removed<br>**Mortality module:** no changes<br>**NPNRC module:** haemodialysis chair variables added<br>**Vaccination module:** retrospective reporting implemented and transition to web application completed | National level: 98% daily 98–99% imputed (14 days) | Transition to a web application made the system accessible to all types of devices. |

DOH: Philippine Department of Health.

Fig. 2. **Utilization rates of COVID-19-designated hospital beds (a) and mechanical ventilators (b), the Philippines, 20 April 2020 to 31 March 2022**




- Avoiding the health system being overwhelmed (crossing the "red line") by monitoring indicators on hospital resources, which informed stakeholders on the allocation of COVID-19 beds and equipment, health-care workers and supplies.[9]

- Monitoring indicators on health-care workers' infections that affected health facility operations during COVID-19 surges through implementation of infection prevention and control (IPC) protocols while oxygen shortage problems were addressed by increasing supply in areas with high medical oxygen consumption rates and critical care utilization rates during the surge of Delta and Omicron variants of COVID-19.

- Informing daily operations and patient referrals in facilities as well as areas needing step-down care, and quarantine and isolation facilities. Prompt medical treatments were given to Filipinos needing hospital care using data on patient navigation and referral systems among health facilities through the establishment of the National Patient Navigation and Referral Center. Well planned procurement and efficient distribution of vaccines in the country used evidence-based COVID-19 vaccine effectiveness reports, which incorporated hospitalization data of vaccinated individuals in the DDC system.

- The open sharing of data with the public, specifically researchers and think tanks from the academic community and the private sector, for their own review and analysis.

## DISCUSSION

The DDC system and its corresponding contribution to health facility monitoring and surveillance systems overcame many HIS issues in the Philippines by standardizing, centralizing and digitizing data submission from health facilities to the DOH. The timely establishment of the DDC system provided these data from health facilities during the COVID-19 pandemic. Data timeliness, precision and ease of use were prioritized in the design of the system.

The success of the DDC system was a result of strong leadership, a dedicated and competent management team, a strong network of government units, an adaptive information system with proper design, and the innovative use of available technology.[10] The system had high-level political support, which helped produce the needed resources to develop the system and orchestrate its nationwide implementation. Laws and policies were introduced that mandated reporting by hospitals and infirmaries through the system.[3,10] The DDC system used existing networks for collaboration and coordination and had different units working together, with regional officers working between the national government and local governments.

The DDC system was planned and then modified based on current needs and situations following the "enter, store, process, communicate, and present" concept.[11] Data entered by all hospitals were automatically stored, processed and analysed for communication materials. These were presented to decision-makers to facilitate timely response including public health and social measures, strategic resource allocation, and local and facility-based operations. Furthermore, publishing the data from the DDC system demonstrated the DOH's transparency, enabled data quality assurance as external stakeholders could provide feedback on the data, and facilitated research by academic and nongovernmental agencies.

The DDC system had two main limitations. First, the system did not collect real-time data for patient referrals, unlike nationally integrated electronic medical record (EMR) systems. Instead, it collected daily aggregated tallies per facility, which required data entry into the DDC system, even in hospitals with mature EMR systems. This challenge could be addressed by further improving hospital HISs by investing in IT infrastructure in the Philippines. Second, the responsiveness of the system to collect new indicators depends on decision-makers' ability to anticipate their information needs.

The DDC system became the first online monitoring and surveillance system for daily health facility operations of all hospitals and infirmaries in the Philippines despite the challenges of a devolved health system. The system was easily accessible and did not require resource-intensive IT infrastructure. It had high response rates and timely reporting from health facilities. Due to the success of the DDC system, similar data collection applications were developed for the 11 000 COVID-19 isolation and quarantine facilities nationwide, as well as vaccination data (i.e. the COVID-19 Vaccination Quick Count). While originally designed for COVID-19 pandemic surveillance, the DDC system can be used to build an effective and long-term HIS for universal health-care monitoring. This includes plans to convert the DDC system into a modular profiling system for all health facilities in the country covering primary, secondary, tertiary and specialized levels of health care.

## CONCLUSION

The need for up-to-date information on bed utilization from health facilities during the COVID-19 pandemic led to the development of the Philippines' DOH DataCollect Bed Tracker system. This indicator-based surveillance system provided data for evidence-based policies and tailored COVID-19 responses. Even with existing HIS challenges and the resource limitations of a lower-middle-income country, this timely, effective and responsive surveillance system was established through strong national leadership, appropriate expertise and management, teamwork, use of an adaptive information system with relevant surveillance design, and proper use of available technology. The success of the DDC system contributes to an integrated and responsive surveillance system for universal health care in the Philippines.

### *Acknowledgements*

The authors thank Undersecretary Lilibeth C David, Undersecretary Enrique A Tayag, former Undersecretary Gerardo V Bayugo, Director Ma Theresa G Vera, Director Melissa T Sena, Ms Charity L Tan of the DOH and the WHO Representative Office for the Philippines for providing overall guidance and direction during the implementation of the DOH DataCollect system and for their inputs and comments on this article. The authors also thank all directors of DOH Centers for Health Development, the Minister of Health of Bangsamoro Autonomous Region in Muslim Mindanao, regional officers and facility encoders for implementing the DDC system and the indicator-based surveillance system.

## *Conflicts of interest*

The authors have no conflicts of interest to declare.

## *Ethics statement*

The work, analyses, reports, results and implications shown in this paper were part of routine surveillance activities of the Philippine DOH. No identifiable patient information is included in the aggregated data submitted by health facilities. Furthermore, the Single Joint Research Ethics Board of the DOH certified that this article is exempt from review as it qualifies as a public health practice/activity.

## *Funding*

This work and the surveillance activities reported herein were funded by the Philippine DOH following the issuance of Department Memorandum 2020-0136 and Department Circular 2020-0158, Harmonized and Daily Health Facility Reporting of COVID-19-Related Essential Resources and Supplies Using the DOH Data Collect Application.[3]

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