

# Hong Kong's early detection, assessment, and response system (S-EDAR) for infectious disease outbreak: abridged secondary publication

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## KEY MESSAGES

1. The enhanced system for early detection, assessment and response (S-EDAR), incorporating readiness and recovery, will guide the development of future preparedness, readiness, response, and recovery plans, which have the capacity to strengthen control of public health threats across pandemic trajectories with different transmission scenarios.
2. This multi-level mixed-methods study synthesised the evidence from different sources and types of knowledge derived from the literature and policy document reviews, expert workshops, comparative case studies, modelling studies for control measures, key informant interviews, and focus-group discussions, followed by a group Delphi study to affirm the feasibility and relevance of component statements.

3. We developed an expanded and enhanced S-EDAR, which is a robust, evolutionary, whole-of-government, and whole-of-society system to enable the four phases of preparedness, operational readiness, rapid response, and recovery to strengthen health system and community resilience in future pandemics.

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## Introduction

The changing epidemiology in the protracted COVID-19 pandemic has created challenges in research methodology for developing an enhanced system of early detection, assessment and response (S-EDAR), which needs to be adaptable to the characteristics of different agents and dynamic contextual factors. In early phases of the pandemic, evidence to inform decisions was often not available and, if available, subject to uncertainty, leaving decision makers to rely on non-codified and contextual knowledge.<sup>1</sup> This study aimed to develop the S-EDAR components from diverse knowledge sources, using a multi-stage mixed-methods approach. Objectives for the early phase of the study were: (1) to review the early detection, assessment, and response measures for COVID-19, (2) to document and analyse the different components of Hong Kong's S-EDAR to the COVID-19 under different transmission scenarios, (3) to identify barriers and facilitators in the implementation of key response measures, (4) to evaluate the effectiveness of surveillance and detection, and the impact of response measures, and (5) to determine enhancements required for pandemic control. In addition, objectives for the extended phase were: (1) to study the responses to the

evolving pandemic, particularly to the surveillance mechanisms, and how these informed decisions for public health and social measures (PHSMs) and response readiness, (2) to review the literature and overseas experiences in the trajectory of protracted pandemic for calibrating PHSMs and health system and community resilience, (3) to assess the impact of the epidemic on the health system and community resilience, (4) to develop a system for calibrating PHSMs, and (5) to update and expand the S-EDAR to include readiness and health system and community resilience, based on the lessons learnt.

## Methods

This multi-level mixed-methods study synthesised evidence from the literature and policy document reviews, including (1) a review of Hong Kong's preparedness and response plan, (2) a review of the transmissibility, transmission routes, and clinical manifestations of COVID-19, (3) a review of the effectiveness of non-pharmacological measures and associated implementation barriers and facilitators, (4) a scoping review of the effectiveness, limitations, and barriers of different social-distancing measures, (5) a scoping review of the readiness of preparedness-response plans, and the linkage between readiness

and health system and community resilience, and (6) a literature review on calibration and adjustment of PHSMs.

Comparative case studies were conducted on the containment, control, and mitigation policies and measures in Hong Kong SAR, Japan, Malaysia, South Korea, Singapore, and Shanghai during the early phases of the pandemic. Comparative case studies were also conducted in the later phase of the pandemic on the experiences of Hong Kong SAR, Singapore, and Victoria and New South Wales of Australia regarding how their health systems adapted during outbreaks of the Delta and Omicron variants that overwhelmed their health systems. Modelling studies were conducted to evaluate the transmissibility of the infection and effectiveness of control measures. Key informant interviews were conducted with policymakers, administrators, and managers in healthcare settings, business sector, elderly homes and disability institutions, social service operators from non-governmental organisations, healthcare professionals, and patient groups during the early and recovery phases of the pandemic. Focus-group discussions were conducted with the healthcare sector (including frontline doctors, nurses, and pharmacists) and the community sector (including subdivided unit residents, ethnic minorities, older adults with no family support, and immunocompromised individuals) to document their experiences as well as barriers and facilitators for compliance with PHSMs. In addition, expert workshops were conducted to develop the components and implementation strategies for S-EDAR, which were later reviewed by international experts. Finally, a group Delphi study was conducted to affirm the feasibility and relevance of the components for the enhanced S-EDAR framework for preparedness, readiness, response and recovery.

## Results

Conceptualisation of the initial S-EDAR framework

and its domains was based on a review of the literature and policy documents. The S-EDAR was further expanded and enhanced based on updated knowledge from the literature, a scoping review on ‘readiness’, updated findings from the second round of key informant interviews, focus-group discussions, and comparative case studies conducted during the later stage of the pandemic.

Comparative case studies showed that there were limitations in timely response and resource mobilisation despite having preparedness plans. This underscored the importance of ‘readiness’ in linking effective preparedness to a rapid and effective response. Key enablers for building a resilient health system included operational readiness, a clear and consistent roadmap, effective use of science and technology, private sector engagement, transparent communication, and support for vulnerable populations.

Case finding and contact tracing was a key component of response in the enhanced S-EDAR framework. We conducted modelling studies of the transmissibility of the infection and the effectiveness of control measures at different stages of the pandemic. Early-phase modelling helped characterise the nature of unlinked cases and assess the superspreading risks, which guided targeted interventions. In later phases, modelling studies evaluated the feasibility of contact tracing measures under different scenarios of disease transmissibility, adherence, tracing, and vaccination coverage. At the level of vaccine effectiveness to prevent Omicron infection, the effectiveness of contact tracing in lowering outbreak potential was primarily determined by variant transmissibility. These findings supported better calibration of PHSMs and the design of evidence-informed strategies for the S-EDAR.

The enhanced whole-of-society S-EDAR framework for emergency preparedness, readiness, response, and recovery (Fig 1) is critical for a rapid and effective response in the prevention, control, and

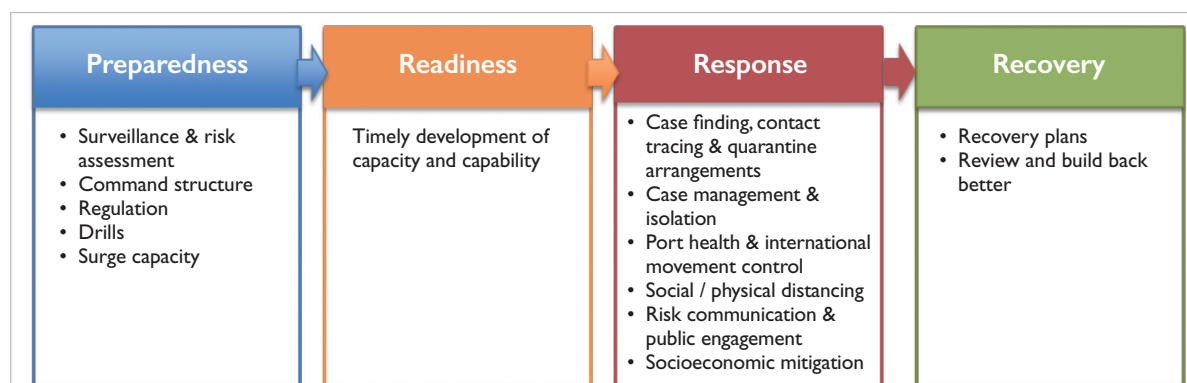
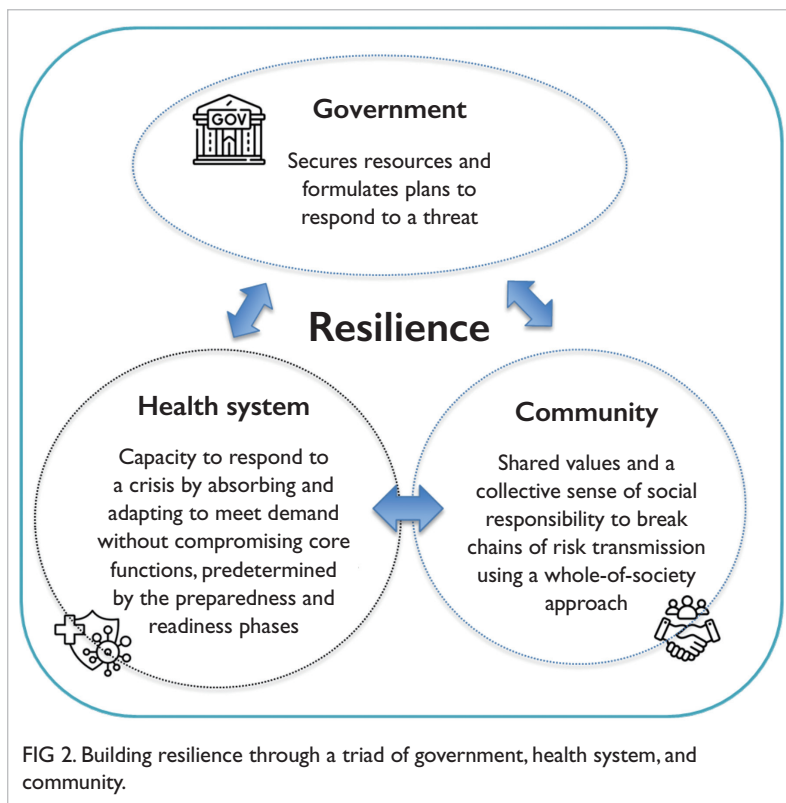


FIG 1. Conceptual framework of the enhanced system for early detection, assessment and response (S-EDAR) for emergency preparedness, readiness, response, and recovery.



eradication of the new public health threat. It should be integral to preparedness plans for infectious diseases and other hazards, with engagement from both the private sector and the community. The framework is designed to be comprehensive—covering emerging and re-emerging infectious diseases—and versatile enough to accommodate novel pathogens when little is known of their nature, transmission dynamics, clinical manifestations, and outcomes. Drawing on lessons learnt from the trajectory of different waves during the protracted pandemic, the framework highlighted the importance of building up resilience through a triad of government, health system, and community (Fig 2). It should be dynamic and adaptable to new scientific findings and knowledge, experiences, issues, and challenges, and be continuously reviewed for different transmission scenarios.

The extended study further highlighted the importance of the readiness stage, a concept emphasised by the World Health Organization,<sup>2</sup> to ensure timely development of the capacity and capability to tackle the imminent threat identified, linking effective preparedness to a rapid and efficient response. We then developed an operational readiness framework with domains for readiness assessment. Readiness plans comprise strategies and interventions to enable prompt adaptations of comprehensive ‘all-threats’ preparedness plans for the specific imminent threat identified for activation,

mobilisation of surge capacity, and scaling up of the response according to the levels of public health emergency.

Initial domains and statements of the enhanced S-EDAR were based on findings from comparative case studies, expert workshops, key informant interviews, and inputs from international experts. These were further revised based on ratings and suggestions in the group Delphi study to reach a consensus on acceptability and feasibility, incorporating the components of readiness and health system and community resilience. We developed 37 recommendations across the four phases of preparedness, readiness, response, and recovery.

## Discussion

The COVID-19 pandemic exposed the vulnerability of health systems, delivery of social care, and socio-economic systems. Each society has a unique risk profile with deficiencies within and outside the health system, and hence differences in the impact during the pandemic. This speaks for tailored preparedness, readiness, and response plans informed by contextualised public health intelligence to rapidly scale up and stand down response controls in anticipation of dynamic changes in the pandemic trajectory.

The enhanced S-EDAR offers a comprehensive and structured framework and can be applied for effective emergency management of novel infections. It is not a linear framework; when there is unanticipated emergency, a response plan needs to commence even the preparedness and readiness plan is incomplete. To prevent and better manage future pandemics, it is crucial to review and update the emergency-preparedness-readiness-response-recovery plans (EPRRP), derived from the S-EDAR. The operational readiness framework enables deliberations of the immediate actions required to adapt the preparedness plans for a prompt and effective response and enhances health system resilience. Effective implementation of EPRRP in a whole-of-government and whole-of-society response enables effective mitigation of threats. A One Health approach at national and international levels is vital to detect, prevent, and respond to zoonotic diseases with pandemic potential.

## Conclusions

The enhanced S-EDAR highlights the criticality of readiness and health system and community resilience for an effective response, which was from lessons learnt in the trajectory of the different waves during the protracted COVID-19 pandemic. Building health system resilience requires strengthening of the capacity to forecast, prevent, detect, absorb, adapt, and respond to a wide range of shocks, while

maintaining essential health services and learning from the lessons for a transformation to a resilient health system. Additionally, engagement with local communities is essential for managing public health emergencies. Community resilience fosters social capital and incorporates equity and social justice principles into various public health initiatives related to preparedness and response. Communities enhance the implementation and coordination of government strategies and interventions, facilitating public health measures and education. Local communities and business enterprises complement the distribution of daily necessities, delivery of health and social care, and mitigation of the socioeconomic impact of the pandemic. Community resilience relies on shared values and a collective sense of social responsibility to break chains of transmission using a whole-of-society approach. The enhanced S-EDAR provides an important reference in building operational effectiveness for health system and community resilience.

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## Disclosure

The results of this research have been previously published in:

1. Yeoh EK, Chong KC, Chiew CJ, et al. Assessing the impact of non-pharmaceutical interventions on the transmissibility and severity of COVID-19 during the first five months in the Western Pacific Region. *One Health* 2021;12:100213.
2. Wong H, Wei Y, Hung CT, et al. Association of nirmatrelvir-ritonavir with post-acute sequelae and mortality in patients admitted to hospital with COVID-19: a retrospective cohort study. *Lancet Infect Dis* 2024;24:1130-40.
3. Yeoh EK, Kwon SM, Ng CW, et al. Government response measures to COVID-19: key policy lessons. Accessed 31 January 2024. Available from: [https://hspr.cuhk.edu.hk/wp-content/uploads/Government-Response-Measures-to-COVID-19-Key-Policy-Lessons\\_v1.pdf](https://hspr.cuhk.edu.hk/wp-content/uploads/Government-Response-Measures-to-COVID-19-Key-Policy-Lessons_v1.pdf)
4. Jiang X, Wang J, Li C, et al. Impact of the surge of COVID-19 Omicron outbreak on the intention of seasonal influenza vaccination in Hong Kong: a cross-sectional study. *Vaccine* 2023;41:7419-27.
5. Chong KC, Chan PK, Hung CT, et al. Changes in all-cause and cause-specific excess mortality before and after the Omicron outbreak of COVID-19 in

Hong Kong. *J Glob Health* 2023;13:06017.

6. Guo Z, Zhao S, Mok CKP, et al. Comparing the incubation period, serial interval, and infectiousness profile between SARS-CoV-2 Omicron and Delta variants. *J Med Virol* 2023;95:e28648.
7. Guo Z, Zhao S, Yam CHK, et al. Estimating the serial intervals of SARS-CoV-2 Omicron BA.4, BA.5, and BA.2.12.1 variants in Hong Kong. *Influenza Other Respir Viruses* 2023;17:e13105.
8. Guo Z, Zhao S, Ryu S, et al. Superspreading potential of infection seeded by the SARS-CoV-2 Omicron BA.1 variant in South Korea. *J Infect* 2022;85:e77-e79.
9. Wong NS, Lee SS, Chan DPC, et al. Trajectory patterns of SARS-CoV-2 neutralising antibody response in convalescent COVID-19 patients. *Commun Med (Lond)* 2022;2:53.
10. Sun KS, Lau TSM, Yeoh EK, et al. Effectiveness of different types and levels of social distancing measures: a scoping review of global evidence from early stage of COVID-19 pandemic. *BMJ Open* 2022;12:e053938.
11. Guo Z, Zhao S, Lee SS, et al. A statistical framework for tracking the time-varying superspreading potential of COVID-19 epidemic. *Epidemics* 2023;42:100670.
12. Wang H, Wei Y, Hung CT, et al. Relationship between antidepressants and severity of SARS-CoV-2 Omicron infection: a retrospective cohort study using real-world data. *Lancet Reg Health West Pac* 2023;34:100716.
13. Chong KC, Li K, Guo Z, et al. Dining-out behavior as a proxy for superspreading potential of SARS-CoV-2 infections: modelling analysis. *JMIR Public Health Surveill* 2023;9:e44251.
14. Wei Y, Jia KM, Zhao S, et al. Estimation of vaccine effectiveness of CoronaVac and BNT162b2 against severe outcomes over time among patients with SARS-CoV-2 Omicron. *JAMA Netw Open* 2023;6:e2254777.
15. Zhao S, Guo Z, Sun S, et al. Effectiveness of BNT162b2 and Sinovac vaccines against the transmission of SARS-CoV-2 during Omicron-predominance in Hong Kong: a retrospective cohort study of COVID-19 cases. *J Clin Virol* 2023;166:105547.
16. Kwan TH, Wong NS, Yeoh EK, Lee SS. Shifts of SARS-CoV-2 exposure settings in the transmission clusters of 2 epidemic waves in Hong Kong. *Int J Environ Health Res* 2023;33:911-23.
17. Wong NS, Lee SS, Kwan TH, Yeoh EK. Settings of virus exposure and their implications in the propagation of transmission networks in a COVID-19 outbreak. *Lancet Reg Health West Pac* 2020;4:100052.
18. Chong KC, Jia K, Lee SS, et al. Characterization of unlinked cases of COVID-19 and implications for contact tracing measures: retrospective analysis



of surveillance data. *JMIR Public Health Surveill* 2021;7:e30968.

19. Kwan TH, Wong NS, Yeoh EK, Lee SS. Mining relationships between transmission clusters from contact tracing data: an application for investigating COVID-19 outbreak. *J Am Med Inform Assoc* 2021;28:2385-92.

20. Guo Z, Zhao S, Lee SS, et al. Superspreading potential of COVID-19 outbreak seeded by Omicron variants of SARS-CoV-2 in Hong Kong. *J Travel Med* 2022;29:taac049.

## References

1. World Health Organization. Evidence, policy, impact: WHO guide for evidence-informed decision-making. Accessed 31 January 2024. Available from: <https://www.who.int/publications/i/item/9789240039872>
2. World Health Organization. Strengthening health systems resilience: key concepts and strategies. Policy Brief 36. Accessed 31 January 2024. Available from: <https://iris.who.int/bitstream/handle/10665/332441/Policy-brief%2036-1997-8073-%20%e2%80%8e%e2%80%8eeng.pdf?sequence=1&isAllowed=y>