Understanding the Singapore COVID-19 Experience: Implications for Hospital Medicine

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One of the worst public health threats of our generation, coronavirus disease 2019 (COVID-19), first emerged in Wuhan, China, in December 2019 and quickly spread to Singapore, Hong Kong, and Taiwan. These three countries have been praised for their control of the pandemic,[1,2] while the number of cases worldwide, including those in the United States, has soared. Political alignment, centralized and integrated healthcare systems, small size, effective technology deployment, widespread testing combined with contact tracing and isolation, and personal protective equipment (PPE) availability underscore their successes.[1,3-5] Although these factors differ starkly from those currently employed in the United States, a better understanding their experience may positively influence the myriad US responses. We describe some salient features of Singapore's infection preparedness, provide examples of how these features guided the National University Hospital (NUH) Singapore COVID-19 response, and illustrate how one facet of the NUH response was translated to develop a new care model at the University of California, San Francisco (UCSF).

THE SINGAPORE EXPERIENCE OVER TIME

Singapore, a small island country (278 square miles) city-state in Southeast Asia has a population of 5.8 million people. Most Singaporeans receive their inpatient care in the public hospitals that are organized and resourced through the Singapore Ministry of Health (MOH). In 2003, severe acute respiratory syndrome (SARS) infected 238 people and killed 33 over 3 months in Singapore, which led to a significant economic downturn. Singapore's initial SARS experience unveiled limitations in infrastructure, staff preparedness, virus control methodology, and centralized crisis systems. Lessons gleaned from the SARS experience laid the foundation for Singapore's subsequent disaster preparedness.[6]

Post-SARS, the MOH created structures and systems to prepare Singapore for future epidemics. All public hospitals expanded isolation capacity by constructing new units or repurposing existing ones and creating colocated Emergency Department (ED) isolation facilities. Additionally, the MOH commissioned the National Centre for Infectious Diseases, a 330-bed high-level isolation hospital.[7] They also mandated hospital systems to regularly practice mass casualty and infectious (including respiratory) crisis responses through externally evaluated simulation.[8] These are orchestrated down to the smallest detail and involve staff at all levels. For example, healthcare workers (HCW) being "deployed" outside of their specialty, housekeepers practicing novel hazardous waste disposal, and security guards managing crowds interact throughout the exercise.

The testing and viral spread control challenges during SARS spawned hospital-system epidemiology capacity building. Infectious diseases reporting guidelines were refined, and communication channels enhanced to include cross-hospital information sharing and direct lines of communication for epidemiology groups to and from the MOH. Enhanced contact tracing methodologies were adopted and practiced regularly. In addition, material stockpiles, supplies, and supply chains were recalibrated.

The Singapore government also adopted the Disease Outbreak Response System Condition (DORSCON) system,[9] a color-coded framework for pandemic response that guides activation of crisis interventions broadly (such as temperature screening at airports and restrictions to travel and internal movements), as well as within the healthcare setting.

In addition to prompting these notable preparedness efforts, SARS had a palpable impact on Singaporeans' collective psychology both within and outside of the hospital system. The very close-knit medical community lost colleagues during the crisis, and the larger community deeply felt the health and economic costs of this crisis.[10] The resulting "respect" or "healthy fear" for infectious crises continues to the present day.

THE SINGAPORE COVID-19 RESPONSE: NATIONAL UNIVERSITY HOSPITAL EXPERIENCE

The NUH is a 1,200-bed public tertiary care academic health center in Singapore. Before the first COVID-19 case was diagnosed in Singapore, NUH joined forces with its broader health system, university resources (schools of medicine and public health), and international partners to refine the existing struc-

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tures and systems in response to this new infectious threat.

One of these structures included the existing NUH ED negative-pressure "fever facility." In the ED triage, patients are routinely screened for infectious diseases such as H1N1, MERS-CoV, and measles. In early January, these screening criteria were evolved to adapt to COVID-19. High-risk patients bypass common waiting areas and are sent directly to the fever facility for management. From there, patients requiring admission are sent to one of the inpatient isolation wards, each with over 21 negative-pressure isolation rooms. To expand isolation capacity, lower-priority patients were relocated, and the existing negative- and neutral-pressure rooms were converted into COVID-19 pandemic wards.

The pandemic wards are staffed by nurses with previous isolation experience and Internal Medicine and Subspecialty Medicine physicians and trainees working closely with Infectious Diseases experts. Pandemic Ward teams are sequestered from other clinical and administrative teams, wear hospital-laundered scrubs, and use PPE-conserving practices. These strategies, implemented at the outset, are based on international guidelines contextualized to local needs and include extended use (up to 6 hours) of N95 respirators for the pandemic wards, and surgical masks in all other clinical areas. Notably, there have been no documented transmissions to HCW or patients at NUH. The workforce was maximized by limiting nonurgent clinical, administrative, research, and teaching activities.

In February, COVID-19 testing was initiated internally and deployed widely. NUH, at the time of this writing, has performed more than 6,000 swabs with up to 200 tests run per day (with 80 confirmed cases). Testing at this scale has allowed NUH to ensure: (*a*) prompt isolation of patients, even those with mild symptoms, (*b*) deisolation of those testing negative thus conserving PPE and isolation facilities, (*c*) a better understanding of the epidemiology and the wide range of clinical manifestations of COVID-19, and (*d*) early comprehensive contact tracing including mildly symptomatic patients.

The MOH plays a central role in coordinating COVID-19 activities and supports individual hospital systems such as NUH. Some of their crisis leadership strategies include daily text messages distributed countrywide, two-way communication channels that ensure feedback loops with hospital executives, epidemiology specialists, and operational workgroups, and engendering interhospital collaboration.[11]

A US HOSPITAL MEDICINE RESPONSE: UC SAN FRANCISCO

In the United States, the Joint Commission provides structures, tools, and processes for hospital systems to prepare for disasters.[12] Many hospital systems have experience with natural disasters which, similar to Singapore's planning, ensures structures and systems are in place during a crisis. Although these are transferable to multiple types of disasters, the US healthcare system's direct experience with infectious crises is limited. A fairly distinctive facet—and an asset of US healthcare—is the role of hospitalists.

Hospitalists care for the majority of medical inpatients across the United States,[13] and as such, they currently, and will increasingly, play a major role in the US COVID-19 response. This is the case at the UCSF Helen Diller Medical Center at Parnassus Heights (UCSFMC), a 600-bed academic medical center. To learn from other's early experiences with COVID-19, UCSF Health System leadership connected with many outside health systems including NUH. As one of its multiple pandemic responses, they engaged the UCSFMC Division of Hospital Medicine (DHM), a division that includes 117 hospitalists, to work with hospital and health system leadership and launch a respiratory isolation unit (RIU) modeled after the NUH pandemic ward. The aim of the RIU is to group inpatients with either confirmed or suspected COVID-19 patients who do not require critical care.

An interdisciplinary work group comprising hospitalists, infectious disease specialists, emergency department clinicians, nursing, rehabilitation experts, hospital epidemiology and infection-prevention leaders, safety specialists, and systems engineers was assembled to repurpose an existing medical unit and establish new care models for the RIU. This workgroup created clinical guidelines and workflows, and RIU leaders actively solicit feedback from the staff to advance these standards.

Hospitalists and nurses who volunteered to work on the UCSF attending-staffed RIU received extensive training, including online and widely available in-person PPE training delivered by infection-prevention experts. The RIU hospitalists engage with hospitalists nationwide through ongoing conference calls to share best practices and clinical cases. Patients are admitted by hospitalists to the RIU via the emergency department or directly from ambulatory sites. All RIU providers and staff are screened daily for symptoms prior to starting their shifts, wear hospital-laundered scrubs on the unit, and remain on the unit for the duration of their shift. Hospitalists and nurses communicate regularly to cluster their patient visits and interventions while specialists provide virtual consults (as deemed safe and appropriate) to optimize PPE conservation and decrease overall exposure. The Health System establishes and revises PPE protocols based on CDC guidelines, best available evidence, and supply chain realities. These guidelines are evolving and currently include surgical mask, gown, gloves, and eye protection for all patient interactions with suspected or confirmed COVID-19 and respirator use during aerosol-generating procedures. Research studies (eg, clinical trials and evaluations), informatics efforts (eg, patient flow dashboards), and healthcare technology innovations (eg, tablets for telehealth and video visits) are continually integrated into the RIU infrastructure. Robust attention to the well-being of everyone working on the unit includes chaplain visits, daily debriefs, meal delivery, and palliative care service support, which enrich the unit experience and instill a culture of unity.

MOVING FORWARD

The structures and systems born out of the 2003 SARS experience and the "test, trace, and isolate" strategy were arguably key drivers to flatten Singapore's epidemic curve early in the pandemic.[3] Even with these in place, Singapore is now experiencing a second wave with a significantly higher caseload.[14]

In response, the government instituted strict social distancing measures on April 3, closing schools and most workplaces. This suggests that the COVID-19 pandemic may fluctuate over time and that varying types and levels of interventions will be required to maintain long-term control. The NUH team describes experiencing cognitive overload given the ever-changing nature and volume of information and fatigue due to the effort required and duration of this crisis. New programs addressing these challenges are being developed and rapidly deployed.

Despite early testing limitations and newly minted systems, San Francisco is cautiously optimistic about its epidemic curve. Since the March 17, 2020, "shelter in place" order, COVID-19 hospitalizations have remained manageable and constant.[15] This has afforded healthcare systems including UCSF critical time to evolve its clinical operations (eg, the RIU) and to leverage its academic culture coordinating its bench research, global health, epidemiology, clinical research, informatics, and clinical enterprise scholars and experts to advance COVID-19 science and inform pandemic solutions. Although the UCSF frontline teams are challenged by the stresses of being in the throes of the pandemic amidst a rapidly changing landscape (including changes in PPE and testing recommendations specifically), they are working together to build team resilience for what may come.

CONCLUSION

The world is facing a pandemic of tremendous proportions, and the United States is in the midst of a wave the height of which is yet to be seen. As Fisher and colleagues wrote in 2011, "Our response to infectious disease outbreaks is born out of past experience."[4] Singapore and NUH's structures and systems that were put into place demonstrate this—they are timely, have been effective thus far, and will be tested in this next wave. "However, no two outbreaks are the same," the authors wrote, "so an understanding of the infectious agent as well as the environment confronting it is fundamental to the response."[4] In the United States, hospitalists are a key asset in our environment to confront this virus. The UCSF experience exemplifies that, by combining new ideas from another system with on-the-ground expertise while working hand-in-hand with the hospital and health system, hospitalists can be a critical facet of the pandemic response. Hospitalists' intrinsic abilities to collaborate, learn, and innovate will enable them to not only meet this challenge now but also to transform practices and capacities to respond to crises into the future.

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