

COVID-19 and the Intensive Care Unit: Coordinating a Multisite Intensive Care Unit Ramp-up Strategy in Singapore

Dear Editor,

On 11 March 2020, the World Health Organization declared COVID-19 a global pandemic.¹ Since then, COVID-19 cases have risen exponentially in Singapore,² resulting in a corresponding need to rapidly increase our national treatment capacity, especially for patients requiring intensive care. With direction from Singapore's Ministry of Health (MOH), Tan Tock Seng Hospital (TTSH) worked together with its affiliated institution, National Centre of Infectious Diseases (NCID), to comprehensively plan to increase ICU capacity across the 2 institutions.

NCID was purpose-built to treat patients with infectious diseases and to shoulder Singapore's outbreak response with peacetime capacity of 330 beds and flexibility to ramp-up to more than 500 beds.³ NCID is located adjacent to TTSH—one of Singapore's largest tertiary hospitals, with a large capacity of over 1,500 beds. NCID is currently the frontline healthcare institution for the screening and treatment of COVID-19 patients in Singapore.⁴

A decision was made from the onset to streamline all COVID-19 work processes within TTSH-NCID. Since January 2020, all COVID-19 patients requiring intensive care in TTSH-NCID were managed within NCID's 2 ICU wards.¹ TTSH's 4 ICU wards (Medical, Cardiac, Surgical and Neuroscience) continued to treat all non-COVID-19 'business-as-usual' (BAU) patients. As national cases steadily rose throughout March, and in anticipation of a potential exponential increase, TTSH-NCID (with direction from MOH) formulated an integrated plan to increase ICU capacity. Although TTSH-NCID's target ICU capacity was aligned to MOH's national objectives, TTSH-NCID planned to progressively ramp-up in phases according to real-time utilisation and demand. This plan was executed in April, as national cases started to rise exponentially.

The ramp-up in Outbreak ICU (OICU) capacity to treat COVID-19 patients was achieved via 3 phases: (1) converting 2 BAU ICU wards in TTSH into OICU wards, (2) repurposing COVID-19 General Wards (GWs) in

NCID into OICU wards, and (3) consolidating all COVID-19 GWs across TTSH-NCID and decanting mild COVID-19 patients out to community medical facilities. This plan effectively increased the OICU capacity by 25-fold.

For phase 1, existing patients within TTSH's Medical and Cardiac ICU wards were decanted to the remaining 2 ICU wards in TTSH, forming 2 multidisciplinary BAU ICUs. In phases 2 and 3, COVID-19 GW patients in NCID were either transferred to other COVID-19 GWs in TTSH-NCID or to Community Care Facilities built by the Singapore government for this pandemic. Streamlining the processes across TTSH-NCID maximises overall treatment efficiency, minimises need for excessive ICU capacity/resource buffer and prevents duplication. This model also ensured precious hospital resources were reserved for severely ill patients, and directed external/government support to focus on the majority of mild COVID-19 patients who require less intensive resources.

Given the significantly larger scale of manpower, resources and operations being deployed across the 2 institutions, a new OICU HQ was set up with the following terms: (1) formulate and execute a phased ramp-up in OICU capacity, (2) facilitate the triaging of OICU patients, especially when ICU resources become limited, (3) balance the load among the OICU wards, (4) centralise information flow and maintain operational oversight over all ICU resources, (5) disseminate relevant information to stakeholders, and (6) facilitate the resolution of operational issues encountered.

A 'whole-of-hospital' approach refers to engagement of all levels of the hospital towards a common goal. To minimise bureaucratic delays, a hospital-level taskforce was created, comprising 3 sub-committees: manpower; training; and equipment, drugs and consumables (EDC). These sub-committees brought together stakeholders from every level of the hospital organisation and were empowered to effect hospital-wide policy changes.

The manpower sub-committee strategised inter-department manpower deployment to sustain both COVID-19 and BAU operations. The training sub-committee deliberated on how best to train and orientate

¹ NCID has a capacity of 38 ICU beds, of which only 10 are operational during peacetime.

these cross-deployed personnel, while ensuring minimal disruptions to their daily routines. The increase in ICU manpower was achieved via 3 key strategies: (1) designating specific departments/wards supported by ICU manpower and pre-identifying suitable manpower from within, (2) decreasing elective and daily workload for these departments/wards, and (3) dedicated ramp-up training for cross-deployed personnel.

The EDC sub-committee oversaw stockpiling, consumption and procurement of all critical logistics at a hospital-level. Of note, after OICU HQ promulgated the plan, the EDC sub-committee anticipated increased OICU capacity would result in faster consumption of certain drugs and consumables, potentially depleting hospital stockpiles before their next resupply. This finding allowed TTSH-NCID to instate early mitigation measures, including rationalising use of certain items outside of ICU, delaying elective procedures that utilised these items, promoting judicious usage, and increasing/bringing forward resupplies.

Expanding OICU capacity had to be carefully weighed against the need to maintain GW and BAU ICU capacity. We adopted a multiphased approach, where wards were decanted and opened sequentially. In line with the natural progression of COVID-19,⁵⁻⁹ there was sufficient time to ramp-up the OICU capacity in phases by closely monitoring the COVID-19 GWs.

To minimise infrastructure, equipment and manpower downtime, OICU HQ developed 3 triggers (Fig. 1) to progressively raise the readiness posture of new OICU wards: (1) ‘Decant’—the ward will stop accepting new admissions and decant existing patients with essential renovation works to ensure wards are ready. ICU equipment were prepared and set aside for new wards; (2) ‘Standby’—nursing and medical manpower will undergo relevant ‘just-in-time’ training and set up necessary equipment within new wards. (3) ‘Open’—upon confirmation of the ‘opening’ date and time, final

preparations and detailed manpower roster planning will be carried out.

There remains a need to professionally and ethically assess each patient to determine the benefits of ICU care. The principle of ‘non-beneficence/futility’ of care must always be upheld regardless of disease pathology, and should be applied at all stages of the treatment process. Essentially, intensive care should not be offered/continued if there is no overall benefit to the patient. As the pandemic progresses, there may come a point when ICU demand will outpace ICU resources.¹⁰⁻¹³ This is when the second principle of ‘rationing’ will be applied.¹⁴ The main difference between the two principles is that ‘rationing’ entails withholding potentially beneficial treatment from a particular group of people due to limited resources (Fig. 2).

To operationalise the two principles, TTSH-NCID implemented a 3-stage triaging process. (1) Implementing an institutional ICU triage standard

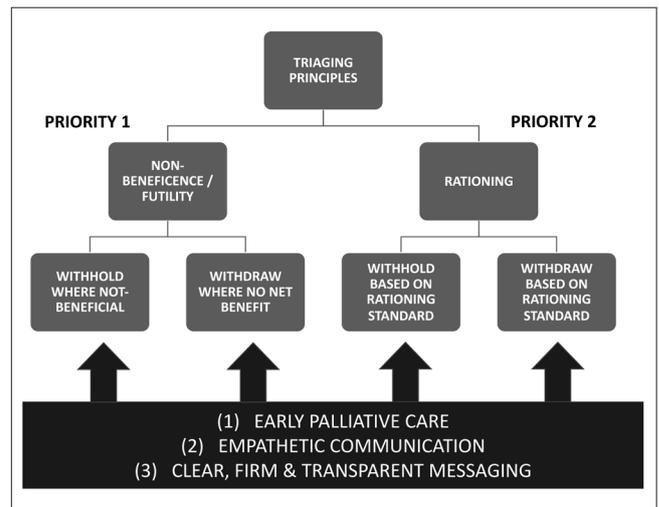


Fig. 2. Triaging principles for ICU resources

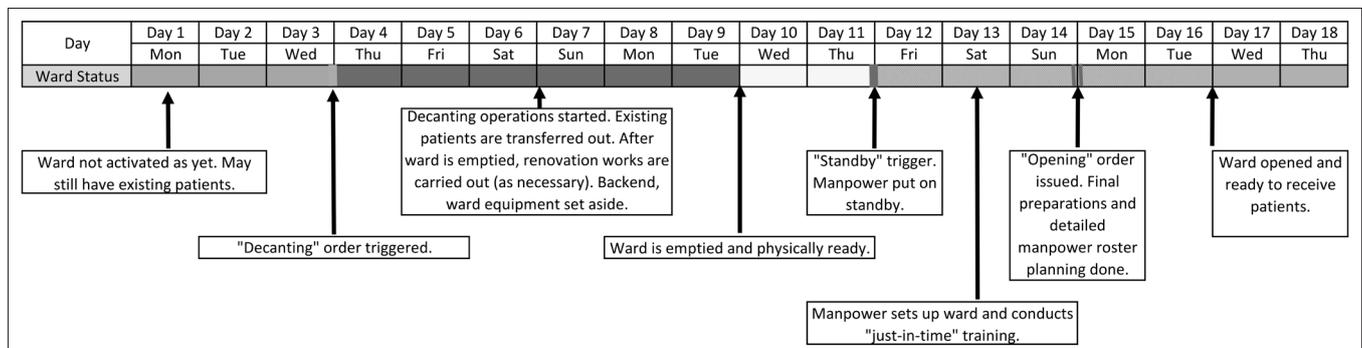


Fig. 1. Example of a ramp-up process of a new OICU ward

(IITS)—the IITS is based primarily on the principle of ‘futility’. In times of scarcity, the principle of ‘rationing’ will prioritise patients who have the highest likelihood to survive. The IITS draws reference from prevailing national standards and from countries that have implemented ICU triaging.¹⁵⁻¹⁸ By monitoring OICU occupancy rates, OICU HQ could pace the rate at which new wards are opened, and titrate the IITS accordingly. OICU HQ ensures uniform application of the IITS across all OICU wards. (2) OICU long-stayer/palliative care ward rounds—a weekly multidisciplinary combined OICU ward round was conducted, whereby patients who had stayed in OICU for more than 7 days or met the criteria for referral to palliative medicine were discussed. (3) The Institutional ICU Review and Appeals Committee (IIRAC)—a multidisciplinary IIRAC was appointed by senior hospital leadership, specifically for this COVID-19 outbreak. Complex and appeal cases could be raised to IIRAC through OICU HQ for resolution.

A physical OICU HQ operations centre was set up and a hotline was manned 24/7 to receive all OICU bed requests within TTSH-NCID. OICU HQ then balanced the load among all the OICU wards so patients receive timely and fair treatment. We recommend load-balancing as opposed to an overflow concept. This prevents OICU wards from withholding/withdrawing ICU care that is not aligned to prevailing IITS due to lack of beds or staff fatigue.

As national COVID-19 cases declined from May, and in preparation of an increase in BAU workload, OICU HQ took on a new role of scaling-down OICU operations. Scaling-down was achieved via 3 phases: (1) directing all new admissions to NCID’s OICU wards; (2) returning TTSH’s OICU wards to original BAU ICU functions; (3) handing over specific OICU HQ functions to NCID’s OICU wards. Upon closure of all OICU wards within TTSH in June, OICU HQ handed over the triaging and load-balancing responsibilities back to OICU teams in NCID. OICU HQ continued to maintain operational oversight over ICU resources; disseminate information to stakeholders; and stand by to ramp-up OICU capacity, if needed. This monitoring function continues to play a critical function in the ever-evolving COVID-19 situation, and as lockdown measures are gradually being lifted.

To encapsulate lessons learnt, one challenge we faced was uncertainty in predicting actual number of COVID-19 patients that would deteriorate and require intensive care. OICU HQ overcame this by delinking infrastructure from manpower resources and creating buffer capacity within each OICU ward. Instead of

opening up one ward at full capacity, OICU HQ would routinely open up two wards functioning at half capacity, with each ward staffed with half the manpower. The manpower needed to staff the remainder of the 2 wards would be placed on standby and allowed to carry on with their normal duties. During periods with high OICU admissions, the capacity of these OICU wards could be stretched by opening up to 2 more beds from their original half-capacity (as the whole ward was already fully equipped). OICU HQ would then activate the manpower to staff the wards to function at full capacity. Through this strategy, TTSH-NCID was able to accommodate the occasional surges in OICU admissions without fallback to rationing.

To preserve OICU capacity, patients were de-isolated in a timely manner and transferred to BAU ICU wards upon testing negative for COVID-19. Although this strategy resulted in a high turnover rate within OICU wards, it allowed TTSH-NCID to maintain overall OICU capacity at a relatively steady state while meeting the institutions’ and nation’s requirements. Following conscious implementation of this strategy for all OICU patients, TTSH-NCID managed to limit peak OICU occupancy to only 24 beds, despite experiencing an average of 27 (with a peak of 37) OICU admissions per week, from January until June 2020.

We found synergistic benefits in streamlining ICU processes across 2 healthcare institutions in proximity. A phased approach to increase OICU capacity with an OICU HQ, paced according to immediate and forecasted scale of operations accommodates treatment for both COVID-19 patients and BAUs, while relieving ICU physicians of operational and administrative burden of managing wards. Over-enthusiastic ring-fencing of hospital resources for COVID-19 ICU patients will inadvertently degrade other levels of care, leading to transient wastage/underutilisation of hospital resources.

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